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MATERIAL CULTURE OF THE LATE MIDDLE AGES

An Interactive Qualifying Project Report

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by

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This project is a study of European material culture during the 15th Century, done in conjunction with the Higgins Armory Museum. It explores the processes and products of the time period, such as metallurgy, textiles, clay and armor in a web based format available for public use and research.

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Introduction and History of Technology

This project is a study of the material culture of the 15^{th} century, its products and processes. Our goal is to create a web based collection of documents detailing various aspects of material culture. The written document is used as a reference at the Higgins Armory and the web page is available for public browsing as well and for use in future Higgins Armory IQPs.

This document has been organized into two sections- processes and products. When reading this document you will find that some products and processes are very closely linked- textiles and clothing, leather processes and products, clay, glass and horn. It is our opinion that separating these items into their production and products is beneficial to the organization of the project as a whole. A section outlining the general history of this century is also provided. This is to give the reader a background for the information presented here. A few sections also include glossaries of terms within them to help the reader understand the information better. Pictures and captions are included to help the reader understand the mechanics of the various technologies and products.

Material culture is tied inextricably with society- the two feed and change each other. Necessity breeds development and development makes change. These changes in turn revolutionize society and create new necessities, beginning the cycle anew.

The 15^{th} century marks the end of the Middle Ages. It saw the development of the materials and processes which would allow the rapid technological advancement of the Renaissance. For instance, the moveable type printing press, invented in the middle of the century, was the culmination of techniques which had existed for years, but only now could find the social environment in which rapid and accurate dissemination of information could flourish. In fact, the entire period is marked by the synthesis of existing methods and materials into new and better ones.

Perhaps the most important development of the time came in mechanization and power technology. Systems for transferring power and transforming motion began to see widespread use. The waterwheel, used for years to grind flour, was adapted to combat the perennial problem of mine drainage, to saw boards in lumber mills, to full cloth, and to operate bellows and drop hammers for smithcraft. Mathematical gearing, springs, and the vital crank-and-connecting-rod system all began to come into their own in the 15th century, ready to solve the problems that would confront the coming industrial age.

The greatest change in techniques came for the military, with the invention of the blast furnace and a reliable method of creating cast iron. Cast iron, not markedly superior to wrought iron for most civilian uses, allowed the military to build affordable, mass-producible firearms and armor, changing the face of warfare. Plate armor reached its zenith in the 1400s, as the technique of casehardening allowed armorers to make a layer of steel on the outside of the armor. Then, near the turn of the 16th century, armor on the battlefield began to disappear as increasingly reliable firearms, against which an armored knight was helpless, became the weapon of choice.

The cannon changed architecture, as well. The era of the castle was over, since cannonballs could shatter high walls built to withstand archers. Walls became shorter and thicker, and more and more people moved to fortified manors, where two advancements in building improved the quality of home life. Trussed roofs could support their own weight, eliminating the need for central poles, and the chimney allowed the hearth to move away from the center of the room. Since the smoke from the fireplace no longer escaped through the roof, ceilings were lowered, making rooms warmer and eventually leading to the development of the second story.

Other crafts had already reached their mature forms. Some techniques of today are the same as those used 600 years ago, save for automation and finer materials. We wear the same weaves as our ancestors, albeit made of synthetic fibers. Carpenters still carve the same joints and cut logs down to boards by the same techniques, only with bandsaws and power mills. Potters have powered wheels and hotter kilns, yet they still turn and fire clay to make their pieces.

Technological and social change drove each other in the 15th century—one of bloody wars, but also of increasing enlightenment. Firearms turned killing into a wholesale business, even as the printing press and lateen-sailed galleon made an age of information and exploration possible. So it stood at the end of the century: almost every nation in Europe was at war, even as the continent was poised for the Renaissance.

History

The Fifteenth century seems to be the time of transition from what is known as the "Middle Ages" to the "Renaissance". During the first half of the century, England and France were still fighting the Hundred Years War, which had been going on since 1339. During this time, England also had to deal with various rebellions and political intrigues. After England and France had stopped fighting the Hundred Years War, there was a war for the possession of the English Crown primarily between the noble houses of Lancaster (the reigning rulers) and York (the usurpers). It was called the "War of the Roses" due to the fact that the house of Lancaster's heraldry included a red rose and the house of York's heraldry included a white rose. The Hussite revolt and the Italian wars all merely added to the strife of the period.

On the religious front, the Great Schism, which caused the election of multiple Catholic popes, was healed in the first quarter of the century with the Council of Constance. The Hussites rebelled against Catholic oppression in 1419 after their leader, John Huss, was killed as a heretic during the Council of Constance. Jeanne d'Arc, a young peasant girl who claimed that angels gave her orders from God, emerged from obscurity, managed to get Charles VII crowned king of France, then was captured and burned as a heretic by Burgundian clerics. The Catholic Inquisition in Spain was established during the last quarter of the fifteenth century, which resulted in the expulsion of the Jews and Moors from Spain as well as much civil strife until the middle of the eighteenth century.

England in the 15th century

England's king, Henry IV, came to the throne in 1399 due to a lot of political maneuvering and the deposing of Richard II by Parliament. As a result the political atmosphere in the beginning of the 15th century was rather unstable, which was not helped by the continuing war with France. John Wyclif, a religious reformer in England at the time, had begun a movement known as Wyclifism, or Lollardry, during the last part of the 14th century. Henry IV's reign begun with severe repressive measures against the Lollards. The statute called *De haeritico comburendo* ("on the burning of the heretic") was passed by Parliament in 1401.[1] Owain Glyndwr of Wales and the Percies of Northumberland also opposed Henry's rule. Owain Glyndwr and Henry Percy made an alliance in 1402 after Glyndwr captured Edmund Mortimer, the young nephew of the Earl of March who was also a possible heir to the English throne. Their revolt was put down slowly after Henry "Hotspur" Percy was killed on July 21, 1403 at the battle of Shrewsbury and the Percy earls were exiled. By 1409, the rebellion was all but forgotten. Henry IV died in 1413 and was succeeded by his son, Henry V. Continuing pressure by both religious and secular authorities caused the Lollards to rebel in 1414. They were led by John Oldcastle, who was executed in 1417.[2]

Under the leadership of Henry V, the English managed to push their territory far into France. With the Treaty of Troyes (May 21, 1420), Henry V became Charles IV's heir to France. But Henry V died soon after on August 31, 1422 followed by Charles IV on October 21, 1422, leaving his 8-month old son, Henry VI as the heir to the thrones of

[1] www.bartleby.com/65/ . [9–26–2001].

both England and France. John duke of Bedford, Humphrey duke of Gloucester, and Henry Beaufort, Bishop of Winchester all vied for power in the aftermath. John, duke of Bedford was appointed as regent of France until his death in 1435,[3] and his brother Humphrey duke of Gloucester was regent in England.[4] The Lollards rebelled a second time in 1431, but the suppression by both the religious and secular authorities drove the movement underground.[5] In 1435, the Duke of Burgundy signed the Treaty of Arras and withdrew from Burgundy's alliance with the English.

Gloucester and Beaufort both died in 1447, but William de la Pole, duke of Suffolk, and Richard, duke of York filled the political vacuum. The Hundred Years War was slowly brought to a close as the English forces continued losing ground in France. In 1436 the English forces fled Paris and in 1441 they were forced out of the Seine valley. In 1444, desperate for something to go right, Suffolk arranged for Henry VI to be betrothed to Margaret of Anjou. They were married in 1445, but soon after in 1450 the French recaptured Normandy. In 1451, the English were driven out of Gascony, returned in 1452, and were soundly defeated on July 17, 1453 at the battle of Castillon.[6] The English had lost all territory in France, and the Hundred Years War ended. This did not mean the strife in England was over.

In 1454, Jack Cade of Kent led a rebellion that marched to London and demanded that the nobles who were left out of the decision-making process were reinstated.[7] The rebellion was soon put down. Henry VI lost his wits in 1453 and Margaret of Anjou gave birth to a son, Edward. There was open warfare between the houses of Lancaster (the

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[2] Ibid
[3] Hay. 1966. p132 – 135.
[4] http://Orb.rhodes.edu/textbooks/Muhlberger/hyw_end.html [9-26-2001].
[5] www.bartleby.com/65/

King's family) and York. In 1460, the Yorkists managed to capture Henry, and Margaret fled with her son. She soon gathered supporters and struck back, defeating the Yorkists and killing Richard, duke of York, and York's son was proclaimed Edward IV. The two sides fought again, and this time many of the Lancaster leaders were killed. Henry VI fled to Scotland with Margaret and their son, but was captured in 1465 and put in the Tower of London. However, a political disagreement caused the Duke of Warwick, George of Clarence, and Louis XI of France to ally and depose Edward. Henry was placed back on the throne, and Edward fled. Edward soon returned, allied with Charles "the Bold" of Burgundy. The resulting battle caused the death of Edward, prince of Wales (Henry VI's son), and the imprisonment of Henry VI and Margaret.

In 1483, Edward IV was succeeded by his son, Edward V. However, his uncle (who was regent at the time) deposed him and claimed the throne as Richard III, then ordered the Queen (Edward IV's wife) and her family killed,[8] had the two princes pronounced illegitimate, and locked them in the tower of London.[9] In 1485, Henry Tudor defeated and killed Richard III at Bosworth Field and was crowned Henry VII, beginning the Tudor dynasty.

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[6] Hay. 1966 p132 – 135.
[7] Ibid, Muhlberger.
[8] Hay. 1966. pp 132 – 135.
[9] Ibid, Muhlberger.

France in the 15th century

During the beginning of the 15th century, Charles VI was ruling France. However, he was afflicted with dementia, causing his relatives to all squabble for power. The two most militant factions were the Burgundians (from Burgundy) and the Orleanists (from Orleans). In 1419, supporters of the dauphin (Charles VII) murdered John "the Fearless" of Burgundy. His successor, Philip, sided with England in retaliation and became co-regent of France under Henry V. On May 21, 1420, Charles VI and Henry V signed the Treaty of Troyes, which made Henry V Charles VI's heir and evicted Charles VII from succession.

On October 21, 1422, Charles VI died soon after Henry V, which left the issue of succession to an 8-month old child, Henry VI. In 1429, a peasant girl by the name of Jeanne d'Arc emerged. She lent relief to the siege of Orleans, boosted morale of the French army, and persuaded Charles VII to march to Rheims where he was crowned King of France on July 17, 1429. Charles VII was an indecisive ruler, and was easily swayed by a variety of corrupt courtiers, such as Georges de La Tremoille.[10] His tenuous political position was one of the reasons why he made no attempt to reclaim Jeanne d'Arc when she was captured by Burgundians in 1430, tried as a heretic, and burned at the stake in 1431. However, in 1456, when he was more politically sure of himself, he did redeem Jeanne d'Arc causing her charges to be revoked posthumously.

Burgundy, meanwhile, had been putting forth terms of alliance with Charles VII, first in 1423, then 1429. Finally in 1435, Burgundy and Charles VII signed the Treaty of Arras in which the duke of Burgundy made peace with Charles VII, and dropped its support for England. From then on, the French forces slowly recaptured land from

England. In 1436 they reclaimed Paris, 1441 they retook the Seine valley, in 1452 they conquered Normandy, and finally in 1453, they pushed the English out of France altogether. In 1454, Philip ceremoniously volunteered to champion a crusade with the "Vow of the Pheasant".[11] This was a very controversial decision.

In 1461, Charles VII died and his son, Louis XI, was crowned king of France. Louis XI began his reign inauspiciously by immediately dismissing all of his fathers advisors. He constantly alienated his peers, (causing them to rebel more than once) signed treaties and broke them. In 1467, Charles "the Bold" succeeded Philip as duke of Burgundy. Throughout the last quarter of the 15th century, France was under attack from one source or another. Charles "the Bold" led an insurrection of nobles but was killed on January 5, 1477 by the Swiss.

In 1483, Louis XI died and was succeeded by Charles VIII. Under Charles's prodding and urged by Ludovico Sforza, France invaded Italy in 1494, which sparked the Italian Wars during which almost every major European power attempted to invade Italy and claim a portion. The French swept through northern Italy until they reached Naples, then were pressed back by a coalition of Milan, Venice, Spain, Holy Roman Emperor Maximilian I, and Pope Alexander VI's forces.[12] In 1498, Charles VIII died and was succeeded by Louis XII.

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[10] www.bartleby.com/65/ . [9-26-2001].
[11] Hay. 1966 pp. 140 – 145.
[12] www.bartleby.com/65/ . [9-26-2001].

Spain in the 15th Century

In the beginning of the 15th Century, Spain was divided into three major territories; Aragon, Castille, and Granada. In 1410, Martin I of Aragon died, and his succession was disputed by 6 claimants. In June 1412, the Compromise of Caspe was reached and the 9 delegates agreed on Ferdinand of Castille as king of Aragon.[13] In 1406, Juan II ascended the throne of Castille as a child. His uncle, Ferdinand proved an able regent until he became king of Aragon. When Juan II died in 1454, his death marked a period of turmoil and issues in succession. This lasted until around 1470. In 1469, Isabella of Castille married Ferdinand of Aragon. This united two out of the three states. In 1474, Isabella gained the throne of Castille from her half-brother, sparking a small civil war over succession which was quickly silenced. In 1479, Ferdinand was crowned King of Aragon. In 1478, Sixtus IV established the inquisition under royal command and in 1480 began persecuting the converted Jews.[14] In 1481, Castille and Aragon began the conquest of Granada, which surrendered in 1492. Also in 1492, Isabella and Ferdinand sponsored Columbus's expedition that discovered the continents of North and South America and the Moors from captured Granada were forcibly converted or expelled, as were the Jews from the rest of Spain. In 1494, Spain and Portugal divided the "new world" between themselves with the Treaty of Tordesillas. Ferdinand also began Spain's struggle with France for control of Italy during the late 1490s and on into the 16th century.

[13] Hay. 1966. p146 – 153.
[14] Ibid. p146 – 153.

Moscow (Muscovy) in the 15th century

Prior to the mid-1400s, what is known today as Russia was ruled over by the Tatars of the Golden Horde. Ivan III seized the throne of the city-state of Moscow and began expansion in the late 1470s. In 1480, he freed Moscovy (the state of Moscow) from the Tatars formally and continued his expansion. He married Sophia, who brought the Byzantine culture to Moscow. He hired Italian architects to build cathedrals, fortifications, and palaces. Laws were formally codified and the idea of Moscow being the "third Rome" became popular in some circles.[15]

Italy in the 15th century

In the 15th century, Italy was divided into many city-states, the largest being Rome (papal rule), Milan (dynastic despotism), Florence (republic), and Venice (merchant oligarchy). These city-states constantly fought with each other for prominence, occasionally conquering each other for a time before being repulsed by another force.

In Milan in 1402, Giangaleazzo Visconti, duke of Milan died leaving the succession to two sons. In 1447, Filippo Maria Visconti died, making no additional arrangements for succession and causing a brief stint of turmoil until Francesco Sforza (who had married Bianca, the bastard daughter of Filippo) seized power. He used the pre-existing foundations, such as the councilor administration and justice system, instead of totally re-vamping the governmental structure. However, the council was basically a

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[15] www.bartleby.com/65/. [9-26-2001].

"rubber stamp" for ducal policies.[16] In 1480, Ludovico Il Moro became the de facto ruler of Milan, but was forced to flee when the French invaded in 1494.

The city of Venice was characterized by its dependence on the merchant class. From 1400 until 1457, they had a series of strong, almost princely leaders, as did Pisa. Genoa was constantly under the yoke of one invading force or another.

The Council of Pisa was an unrecognized council held in 1409 (in Pisa of course). It was convened to attempt to heal the Great Schism, which had happened when the Byzantine empire split off from the Roman Catholic church and elected a pope of its own. During the council, the delegates decided to depose both popes Gregory XII and Benedict XIII and elect one single pope for both branches, anointed Alexander V. However, both Gregory and Benedict refused to agree with this solution so instead of healing the Great Schism and having only one pope there were now three popes. This was the first appearance of the "counsiliar theory" which held that religious councils were supreme and even the Pope must obey their decrees.[17]

Florence was ruled for most of the 15th century by the Medici family, which specialized in banking. In 1433, the Albizzi family expelled the Medici family from Florence, but the Medicis returned in 1434 and evicted the Albizzis. When the Medici family was exiled from Florence in 1494, a priest named Girolamo Savonarola seized power and established a strict puritan regime. He was famous for his "bonfires of the vanities" in which corrupt books and images were set alight. When Charles VIII invaded Italy later that year, Savonarola supported him hoping he would establish a democratic government in Florence and depose Pope Alexander VI. The pope excommunicated

[16] Hay. 1966 p165 – 181.
[17] www.bartleby.com/65/ [9-26-2001]

Savonarola in 1497. Savonarola and two of his disciples were captured and tortured, and Savonarola was announced to have confessed to being a false prophet and hanged for heresy and schism in March 1498.

In 1494, Charles VIII invaded Italy at the urging of Sforza, sparking what is known as the "Italian Wars". This was a period where almost every European power attempted to gain control of a portion of Italy until the mid 16th century.

The Germanic States in the 15th century

What has been referred to as the Germanic States, which was a collection of small countries from what today makes up Germany, the Czech Republic, Slovakia, Austria, Hungary, and other portions of the former Holy Roman Empire, was ruled by the Holy Roman Emperor in the 15th century, as well as their individual regents. The Emperor was either "crowned" or "uncrowned" by the Pope in Rome, or was merely granted the title of emperor as a formality. The Emperor was elected by a complicated electorial process involving both secular and ecclesiastical electors.[18] Wenceslas IV was the Emperor from 1378 until 1400. In 1400, the electors deposed him and elected Rupert of the Palatinate as Emperor. Wenceslas was still king of Bohemia, but he no longer had the title of Holy Roman Emperor. In 1410, Rupert died, and because the Great Schism had split the church, two Emperors were elected. Wenceslas's cousin, Jobst, who was also Margrave of Morovia, and Sigmund, the King of Hungary. Sigmund (also spelled Sigismund in some texts) quickly persuaded Wenceslas and Jobst to allow him to become the undisputed emperor. From 1411 until his death in 1437, Sigmund played at politics all

[18] Hay. 1966. p187 – 196.

over Europe. One of his greatest triumphs was the Council of Constance, which healed the Great Schism of the church.

The Council of Constance was a large, multi-sessioned council that was held from 1414 until 1418. It consisted of a caucus of nations (Germany, France, England, Italy, and Spain) and each nation would have one vote. They established the Articles of Constance, deposed the three popes, and elected Martin V as the new undisputed pope.[19] During the course of the council, the representatives also discussed papal reform, heresy, church reform, and established the supremacy of the councilor theory, which stated that councils of ecclesiastical authorities were above everything, even papal bull. During this meeting, John Huss and Jerome of Prague were tried and burned for heresy, and St. Bridget of Sweden was canonized.

The burning of John Huss sparked what is known as the Hussite Wars. Huss was a follower of Wyclif and a reformer of the church, but his sermons attracted the enmity of the clergy, and caused riots in Prague when the Archbishop there tried to suppress his teachings. The University of Prague acclaimed Huss as a martyr and his followers revolted under the oppression. The rebellion took on a violent form when several councilors appointed by King Wenceslas were thrown out of the town hall's windows after a riot. This was known as the First Defenestration of Prague and took place on July 30, 1419.[20] In 1420, they drew up a document (called The Four Articles) demanding freedom of preaching, changes in church doctrine, and limitation of the amount of property held by the church. However, they were split into two factions consisting of the Utraquists, which consisted of the upper classes and except for the Four Articles agreed

[19] www.bartleby.com/65. [9-26-2001].
[20] Ibid.

with the Catholic church, and the Taborites, who consisted mostly of the peasantry and worked for the abolishment of the feudal system altogether hoping to create a classless society.[21] The Utraquists reached an agreement with the Catholic church in 1436 but the Taborites refused to accept it and continued to fight. This forced an alliance between the Utraquists and the Church against the Taborites, who were defeated militarily during the early 1500s, causing it to disappear almost entirely.

In March 1438, Albert duke of Austria was elected Holy Roman Emperor but died almost immediately from disease.[22] In 1440, Frederick of Styria was elected Emperor. During his reign, he worked to secure the ecclesiastical integrity of Germany and also attempted to restore imperial power. However, his efforts were distracted by the revolt of the Hussites and caused strife by themselves. In 1485, Matthias Corvinus drove Frederick from Vienna. They both agreed on the election of Frederick's son, Maximilian, as Emperor. Maximilian managed to restore most of the Hapsburg power in Austria, but did not manage to strengthen imperial power.[23] In 1493, Maximilian established the imperial supreme court on a permanent basis, bringing the Germanic states into the next century.

[21] Ibid.
[22] Hay. 1966. p187 – 196.
[23] Ibid. p187-196

Mechanization and Power Technology

The development of power technology and the mechanisms to convert that power cannot really be separated. Aside from the crank and connecting shaft assembly, the fundamentals of power generation and conversion were well in place by the 1400s.

Water Power

The waterwheels of the 15th century hung suspended from a horizontal shaft and turned in the plane of the stream. Water wheels came in three varieties: undershot, breast, and overshot. The stream passed beneath undershot wheels, struck the middle of breast wheels, and fell from a height to strike the top of overshot wheels. Overshot wheels generated the most power by far.[24] These wheels directly turned millstones; one of the earliest applications of water wheels was for flour milling.[25]

Windmills

Windmills, like waterwheels, generated rotary motion, and were thus used for many similar processes to waterwheels.[26] It was necessary to turn the blades into the wind, so windmills came in two main types to accomplish this: the post mill and the tower mill. The entire external structure of the post mill turned. Tower

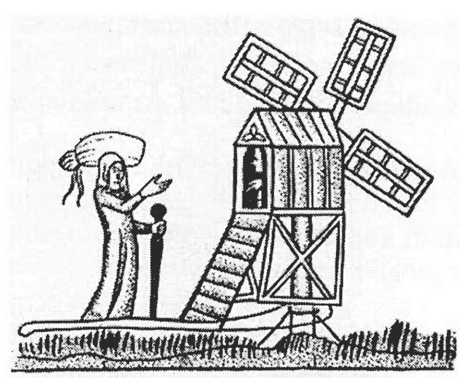

Figure 1 A post mill. (From Singer, 1956)

[24] Clark. 1962. p82.
[25] Ibid. p84.
[26] Ibid. p87.

mills, on which on the cap of the structure rotated, were not developed until later in the century.[27] The fantail, a blade on the reverse of the mill which automatically turned it into the wind, was not invented until the 1500's. In Holland, which lay mostly below sea level, windmills using water wheels in reverse drained flooding over the dikes.[28]

Animal Power

Animal power was used in primarily the same fashion as wind and water power. Horses, oxen, or people would be harnessed to a wheel set horizontally and turn it, producing rotary motion, much like the capstan. People and animals also turned treadmills, which were essentially large hamster wheels, though they walked on the outside.[29]

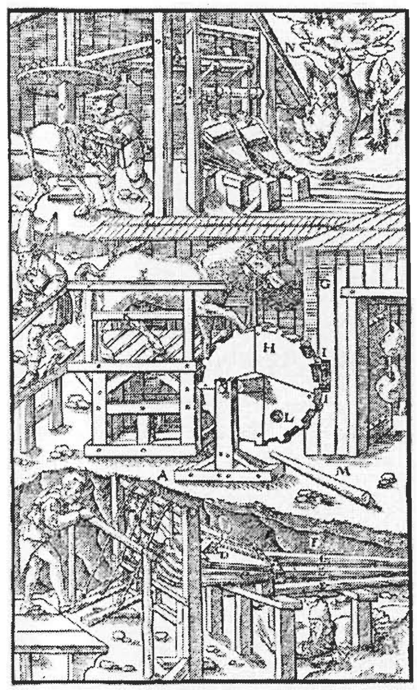

Figure 2 The original horsepower. (From Agricola, 1950)

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[27] McNeil. 1990. p247-48.
[28] Ibid. p249.
[29] Ibid. p260.

Camshafts

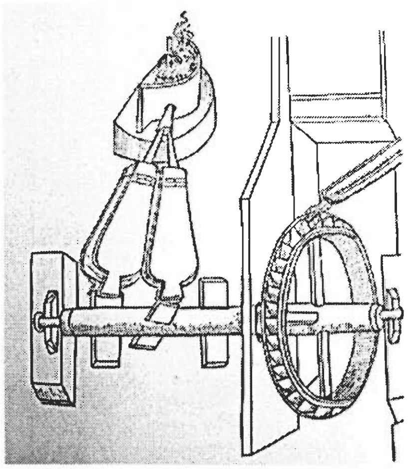

Figure 3 An overshot waterwheel and camshaft. (From Singer, 1957)

Waterwheels, windmills, and treadmills would turn camshafts. Cams are devices that turn rotary motion into reciprocating motion.[30] They were used to drive bellows, which produced large enough speeds and volumes of air to obtain the temperatures necessary for blast furnaces and cast iron. They also drove drop hammers used to work both cold and cast iron. The reciprocating motion from cams also drove saws for sawmills and wooden hammers for fulling mills.[31]

Springs

Springs provided power storage, though not in today's familiar coiled form. Both lathes and mechanical clocks used springs to store power and release it gradually. The first lathes, pole lathes, used a whippy branch as a spring a belt to create back-and-forth rotary motion. Though the principle of the spring was readily understood, they were not used for any heavy applications, since the techniques necessary to make a strong metallic laminate spring were not available.[32]

Flywheel

The flywheel, a heavy wheel with most of the weight concentrated at the circumference, resists changes in motion and smoothes the rotation of a shaft driven by

[30] White. 1962. p72
[31] Ibid. p77

irregular motions, such as that of a camshaft or treadle.[33] The 15th century also saw the development of governors other than flywheels to steady the motion of crankshafts. One of the earliest is heavy balls on the end of chains attached to the shaft, which spun up and reduced changes in speed.[34]

Gearing

Refinement of gearing came during the 1400s. Mathematical gearing allowed for more accurate mechanical clocks, the redirection of motion and force, and overall more complicated devices.[35] The screw, one of the earliest gears, could be produced quickly on the lathe, though artists of the time frequently misunderstood the use of mechanisms, depicting opposite-handed threads meshing and impossible cranks. A firmer understanding of gears allowed engineers to make reliable use of differentials for the first time. Spinning wheels had used the

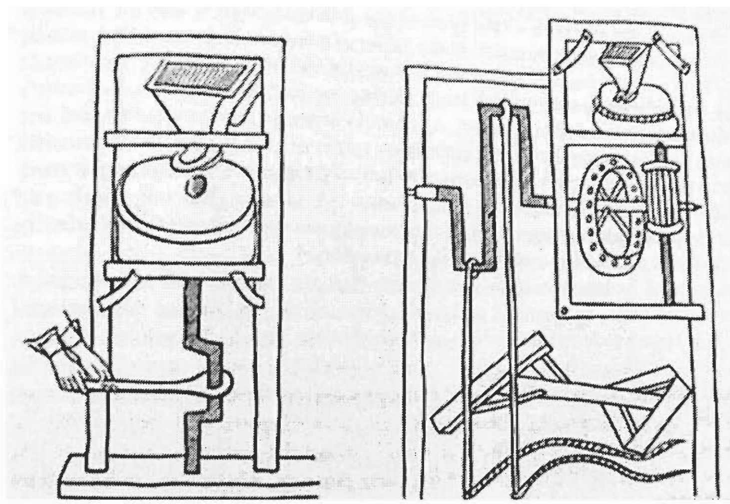

Figure 4 Two examples of the crank-and-connecting rod. In the right-hand picture are a flywheel and a gear. (From Singer, 1957)

[32] White. 1962. p117-118.
[33] Ibid. p115
[34] Singer. 1956. p451.
[35] McNeil. 1990. p16.

differential principle for years—one spin of the large wheel produced many turns of the spindle. Gearing up and down gave much more flexibility in the use of power.[36]

Crank and Connecting Rod

The greatest mechanical advancement of the 1400s was the increasing exploitation of the crank and connecting rod. This invention is obvious to the modern mind, but the leap from reciprocating to continuous motion was an innovation. Cranking provides a mechanical advantage and marked the real takeoff point in the movement toward an industrial society.[37]

Metallurgy

Mining

Mining in the late Middle Ages was deeply traditional, and used many of the same techniques that had been developed in antiquity.[38] Still, the mining industry was one of the first to adapt new mechanization and power technologies. It had to in order to meet Europe's growing demand for high-quality metals.

Once a deposit was located, usually by serendipity (the use of divining rods and astrological metallurgy declined in the 1400s), miners could sink shafts for ventilation and drainage.[39] Usually, mineshafts were vertical, but depending on terrain, they could

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[36] McNeil. 1990. p32.
[37] White. 1962. p103-04.
[38] Derry. 1960. p129.
[39] Gille. 1986. p536.

be oblique. Shafts were well constructed and generally rectangular for easier timbering, with a small hut at ground level to protect the shaft and equipment from the elements.[40]

Gallery construction was difficult, so medieval engineers built many shafts to avoid having long galleries, which were prone to cave in. Often there would be many independent groups working on the same deposit with no coordination, and their galleries would run together and collapse.[41]

Miners worked deposits with hand tools like rock picks, pickaxes, levels, sledgehammers, and wedges.[42] They understood the many of the dangers of mining, such as pockets of bad air and 'damps' that would extinguish lamps—thus the necessity of galleries built solely for proper ventilation and barred for any other use. As mechanization became more prevalent, miners began to use bellows and rotary fans to clear and circulate the air.[43]

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[40] Ibid. p493.
[41] Ibid. p493.
[42] Agricola. 1950. p50.
[43] Gille. 1986. p495.

However, the primary use of mechanics and power was in removing and processing the ore. Mined ore would be hauled up shafts by windlasses, turned by hand and horse power. On those sites close enough to fast moving streams, water wheels could also be used.[44]

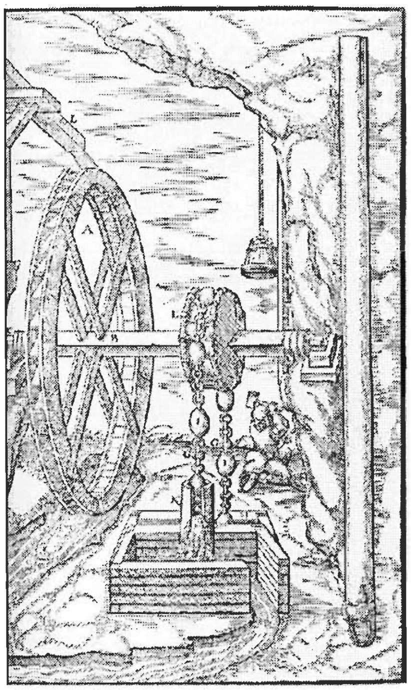

Figure 5 Rag and chain pump used to bring water out of mines. (From Agricola, 1950)

One primary problem in mining was drainage. Many mines were abandoned because they flooded. Miners were quick to apply powered solutions such as chain and bucket and rag and chain pumps. A rag and chain pump forced water up through a pipe with a ball of rag acting as a piston.[45]

Processing

Once mined, the ore had to be processed to separate worthless impurities from the metal within. By the 15th century, techniques for doing this had changed little from those used in Roman times.

Figure 6 Breaking and sorting ore. (From Agricola, 1950)

[44] Agricola. 1950. p160.
[45] Ibid. p171-72.

After metallic ores had been sorted from the waste rock that was mined with them, they were broken into smaller pieces and washed down to remove soluble and light impurities. These three steps could be repeated several times. A significant improvement from antiquity was the use of hydraulic hammers to break the ore, rather than laborious hand breaking.[46]

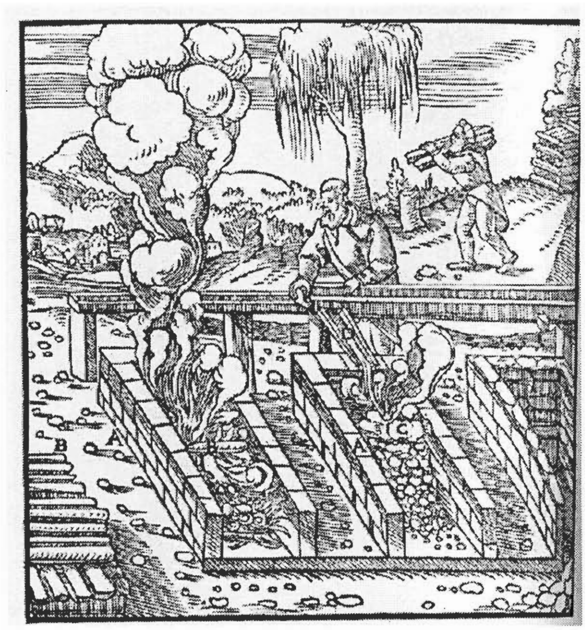

Figure 7 An outdoor roasting furnace. (From Agricola, 1950)

The ore would then be roasted over charcoal, or later coal as Europe became increasingly deforested.[47] This process removed volatiles, sulfur, and oxides, and also made the ore more brittle for another round of breaking, washing, and sorting if necessary.[48]

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[46] Agricola. 1950. p269-71.
[47] Singer. 1957. p50.
[48] Agricola. 1950. p273.

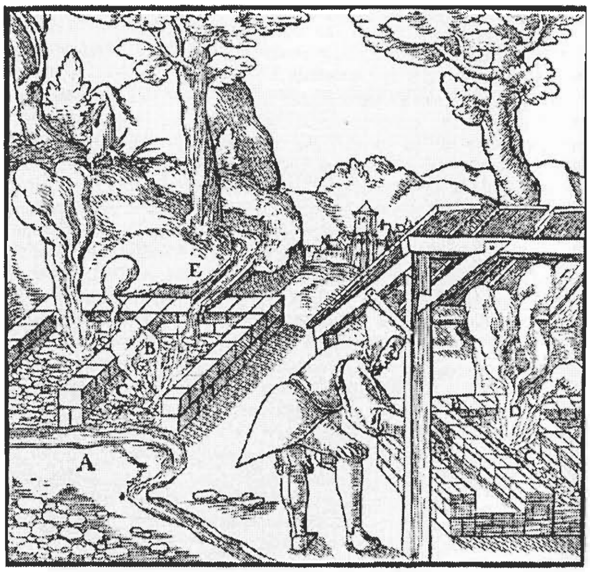

Figure 8 Smelting. (From Agricola, 1950)

Then, the ore would be smelted, or heated in a furnace until it separated into two layers. Slag rose to the top, and pure metals fell to the bottom.[49] In the 1400s, only charcoal could be used to fuel smelting furnaces, since the coal mined then, before the coking process was developed, had too many impurities, which it transferred to the metal.[50]

The processing of nonferrous metals, especially copper, saw no real improvement since the Romans. The real advances of medieval metallurgy were in the production of iron and steel. Smiths had worked with wrought iron, which is produced at relatively low temperatures, since antiquity, but with the development of truly efficient blast furnaces, smiths could for the first time produce cast iron reliably. Blast furnaces produced the sustained high temperatures necessary to diffuse carbon through the iron. The *Stückofen*, the most efficient of the blast furnaces, had a main shaft, like a chimney, from 10 to 14 feet high, with a hole for a water-driven bellows which produced the airflow that kept the temperature high.[51]

[49] Ibid. p381-82.
[50] Singer. 1957. p62
[51] Singer. 1957. p73.

The necessity of having water power to drive hammers and bellows caused the ore processing facilities to move away from the mines and toward fast-moving streams which could be used to turn the water wheels.[52]

Iron

Iron is all but unavailable in its native state on Earth. Some small deposits of meteoric iron can be found, but primarily iron must be recovered from its ores, which are generally oxides with trace impurities. Iron is useable in two forms: wrought iron and cast iron.[53]

Wrought iron is worked hot and can be hammered and welded, but it is a relatively soft metal and cannot be melted or cast. It was the earliest form of useable iron. At about 700°C, iron becomes very malleable and can be formed into any shape. This state is called a 'bloom'.[54] However, even after cooling, it remains relatively soft and cannot hold an edge.

With the advent of blast furnaces, cast iron could be made. Cast iron, as its name suggests, can be melted and cast in molds. However, it cannot be worked and is far more brittle than wrought iron. The important difference between wrought iron and cast iron is the carbon content of the metal. Cast iron contains carbon; wrought iron does not.[55] Much of the cast iron produced in Europe went right back into the bloomery furnace to be turned into wrought iron. The cast iron process, using larger furnaces with more heat,

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[52]Ibid. p75
[53] McNeil. 1990. p147.
[54] Ibid. p151.
[55] McNeil. 1990. p149.

could produce much larger quantities of metal. Smiths didn't know what to do with cast iron--until the demand for cannon picked up in the latter half of the 15th century.[56]

Steel

Steel is the compromise between wrought iron and cast iron. At around 1% carbon inclusion, iron becomes steel, a metal which can be both hammered and cast, and has the ability to hold an edge. In the Middle Ages, steel was expensive to produce and accordingly rare, since it was difficult to control through the smelting process the exact carbon content of the metal. The only way a smith had to judge the composition of his metal was by the color it glowed in the furnace. Thus, a layer of steel would be produced on the outside of the a piece by carburizing, or allowing the carbon from charcoal embers to diffuse slighty into the surface of the metal in a process called casehardening.[57]

Gold

Gold is an extremely non-reactive metal, and thus is seldom found except in its native state. Often veins of gold are found with quartz. Because it is a soft metal, gold is poorly suited to any but ornamental use in a pre-electronic society, and its rarity makes it valuable.

The cupellation and liquation methods, known from antiquity, were still used to separate gold from the rock in which it was mined. In cupellation, impure gold and silver would be melted together with lead. The more reactive lead would oxidize with the impurities, leaving a silver-gold alloy at the bottom of the furnace. This alloy would then

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[56] Ibid. p152.
[57] Ibid. p159.

be treated in the furnace with sulfur, sulfides, or any of a variety of salts. The silver would bond to them as a chloride or sulfide, leaving pure gold.[58]

Since silver and gold are much more soluble in lead than lead is in copper, in liquation, copper known to contain silver and gold was melted together with three or four times its weight in lead. The lead would alloy during this process with the silver and gold, and after the entire metallic mass was cooled, the lead would be slowly melted from the copper. The lead-silver-gold alloy would then be treated by cupellation, as described above.[59]

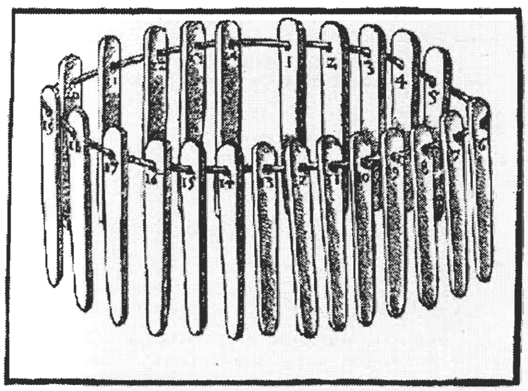

Figure 9 A ring of needles used to assay gold. (From Singer, 1950)

The touchstone, a hard black mineral such as basalt or jasper, was used to assay, or test the components of a sample of gold. When rubbed against the touchstone, gold alloys would leave different colored streaks depending on their purity. Miners would carry rings full of needles made of a known percentage of gold, to use as a comparison against the touchstone with an unknown sample after refining.[60]

Silver

Native silver is rare. By far the most important silver ore in the 1400s was galena, or lead sulfide (PbS). Silver can sometimes be found in a substitution for up to 1% of the lead in lead sulfide. By roasting and smelting, pure lead could be obtained from the

[58] Singer. 1957. p42.
[59] Singer. 1957. p43.

sulfide. The higher the lead concentration, the more silver per weight was available. After several rounds of melting and cooling, lead cakes could be treated by cupellation (as described above in the section on gold) to obtain nearly pure silver.[61]

Copper

Copper can be found uncombined in small amounts. Its most common ores, and thus the most used in the Middle Ages, were the sulfides. The richest European source of copper and its ores in the 15th century was Spain.[62]

To purify copper was a three-stage process. Step one, as with other metals, was to roast the ore, removing sulfur and volatiles and partially oxidizing iron impurities. Stage two was smelting with fluxes. A flux is any mineral added to smelting to prevent oxides from forming in the desired metal, the 'matte.' Once the matte and slag had separated, step three was to melt the matte with charcoal and blow air over its surface, oxidizing most of the remaining impurities, such as iron and lead.[63]

The primary alloys of copper are brass (copper and zinc), which was difficult to make in the Middle Ages, and bronze (copper and tin), which was exceedingly common.

Bronze

Bronze is the name for almost any copper alloy. In the Middle Ages, bronze most commonly referred to a copper/tin alloy. Bronze is an extremely versatile alloy, and was

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[60] Agricola. 1950. p252.
[61] Singer. 1957. p43-45.
[62] Ibid. p48.
[63] Ibid. p48-49.

used for everything from sculpture to cannons.[64] Bronze has a low melting point and can be cast, making it an extremely useful metal.[65]

Tin

Tin was scarce in medieval times, since is rarely found uncombined and there are no extensive ore deposits in Europe. Its primary ore is cassiterite. The main European source was Cornwall, England, which produced around 700 tons per year.[66] Tin is separated from its ore by roasting to remove impurities as oxides, and then smelting. Its primary alloys are bronze (copper and tin) and pewter (lead and tin, sometimes with small amount of antimony, copper and bismuth).

Brass

Brass is an alloy of copper and between 10% and 45% zinc. The method of production used from antiquity to the 16th century requires a temperature of 1300°C to boil zinc from its ore, which allows it to diffuse through copper and form a layer of brass, in a process called cementation. Brass was seldom used in the 1400s because zinc was extremely scarce,[67] and because the distillation process by which zinc oxide is vaporized and recondensed as metallic zinc in a cooler portion of the furnace had not yet been introduced to Europe from Asia Minor.[68]

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[64] Derry. 1960. p125.
[65] McNeil. 1990. p67.
[66] Ibid. p67.
[67] Singer. 1957. p45.
[68] McNeil. 1990. p78.

The medieval term 'latten' refers to any alloy of yellow color which closely resembled brass, and often hammered into flat sheets. It was often used in the manufacture of church utensils such as candlesticks.[69]

Zinc

Metallic zinc was not available to medieval metallurgists, and was thus only used in alloying with copper to make brass.[70] The zinc was vaporized from its oxides and allowed to diffuse into copper without recondensing into a metal. There is little evidence that Europe even recognized zinc as a metal until the 16th century.[71]

Lead

Lead is almost never found uncombined, though it is still a common element. One of the largest lead (and consequently silver) mines in Europe was at Rammelsburg, Germany, which tradition holds was discovered by Ramelius the horse, who pawed at the ground and uncovered a vein of silver-bearing ore.[72]

In the Middle Ages, lead was most often obtained from galena, or lead sulfide (PbS). Galena would be roasted and smelted to obtain lead, and the lead cupelled to remove any silver possibly in combination with it (see the section on silver).[73] The primary lead alloy is pewter (lead and tin, sometimes with small amounts of antimony, copper, or bismuth).

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[69] http://dictionary.oed.com/ . "latten"
[70] Singer. 1957. p54.
[71] McNeil. 1990. p80.
[72] Agricola. 1950. p37.
[73] Singer. 1957. p43.

Pewter

Pewter is an alloy of tin and lead, and was used in the 1400s to a some degree in making solders, utensils, and tableware, since it was easily workable. Much more of the available tin went to making bronze.[74]

Wood

During the 15th century, most crafts were divided into a number of sub-crafts. It was the same way for those crafters who worked with wood. The main trades were carpenters (who primarily made houses), joiners (who made furniture and paneling), carvers (who carved wood), turners (who used lathes to make turned furniture), arkwrights (who made trunks and arks), coopers (who made barrels, bathing tubs, and buckets), and woodblock cutters. Each sub-craft will be discussed in detail by itself, along with the tools of the trade.

Timber was in demand for building ships, houses, wagons, interior woodworking of homes and churches, and for furniture. Wood was also used in such things as bowls, eating utensils, firewood, parts of clothing such as shoes, and military technology. Siege weapons were made almost entirely out of wood, as were bows and arrows, water mills, and wind mills. However, by the end of the 15th century, Europe was facing an ever-increasing shortage of timber due to overuse.

[74] Derry. 1960. p125.

Most Common Woods and Their Uses

Timber resources were spread unevenly throughout Europe. England had huge stands of oak, but very few conifers. Germany on the other hand had lots of fir and pine but fewer deciduous trees. Each type of wood was commonly used for very few purposes, and more expensive woods were imported to countries where they were not native. Ash and beech were considered "moist" woods, and were most commonly used for making bed frames and carriages. Beech was also used to make tables, chairs, and caskets. Cedar had good weathering qualities and was used primarily in ships and buildings. Fir and pine were easily shaped, and were used for doors, panels, carriage-building, and shingles. Several varieties of oak were used for just about everything. Maple was used for beds and tables. Cypress was used for chests because of its resiliency. Buckthorne, holly, lime, and boxwood were considered the best materials for turning. Terebinth, citron, and maple were considerably more costly and usually used for decorative purposes in rich homes.[75]

Crafters who used wood most often had standards of trees which they cultivated carefully. The term "standard" was used to describe a group of trees that were cultivated for timber. The term "coppice" was used to describe a standard of young trees which would be cut to ground level every few years. These trees were used to make poles. "Timber" was a tree whose trunk was suitable for conversion into structural members as opposed to "wood" which was used for firewood, rods, poles, and light construction work.[76]

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[75] Singer. 1956. p226 – 227.
[76] Milne. 1992. p19

Making Boards

During the process of converting a felled tree to boards, several steps were taken. First, the branches were chopped off using either a saw or an axe, depending on the thickness of the limb. Next, the bark was stripped away, in most cases using an axe. The soft outer layer underneath the bark (sapwood) was usually taken away, leaving the hard interior (heartwood).[77] Finally, the log was sawed into boards.

Figure 10 Squaring a piece of timber with an axe. (From Singer, 1956)

There are three ways medieval woodworkers sawed a log into boards. The first was to cross-cut it. The craftsman sawed the log into boards straight across, then trimmed the sides of the boards to make them square. The other two ways were called wainscot and clapboard. Both originally referred to oak only, but the term soon was used for all forms of wood.

Wainscot was a board that was sawn along the radii of the log from outside to center. It had less of a tendency to warp or twist than boards that were sawn straight across (aka cross-cut), and shrinkage was minimized. This style of cut was most popular in England, where it was used for everything from furniture to wall panels.[78]

Clapboard was a kind of board that was not sawed, but instead was riven or split along the grain using a riving iron and mallet at the weakest point. This also had less of a tendency to warp, twist, or shrink than cross-cut boards. This sort of wood was used

[77]Ibid. p20.
[78] Singer. 1956. p243.

most extensively by coopers for their wine-casks, but was also good for panels.[79] However, wainscot and clapboard were wasteful because the boards had to be squared from their wedge-shape before they could be used.

The carpenter used an axe instead of a saw to square the boards after they were cut. The adze was no longer the all-purpose wood shaping instrument and was gradually being replaced by the axe for course shaping. The adze was still used for fine work. Large logs were sawn into planks with a pit saw. The saw cut would be measured with a string covered in chalk or another sort of pigment, which was wrapped around the circumference of the log, then released, marking the log. One person would stand in a pit, across which the log would be braced. The other person would stand on the top of the log and both would use their mass to move the saw down the length of the log. The saw blade was turned 90 degrees to the frame, which fit around the outside of the log while the saw cut down the length.[80]

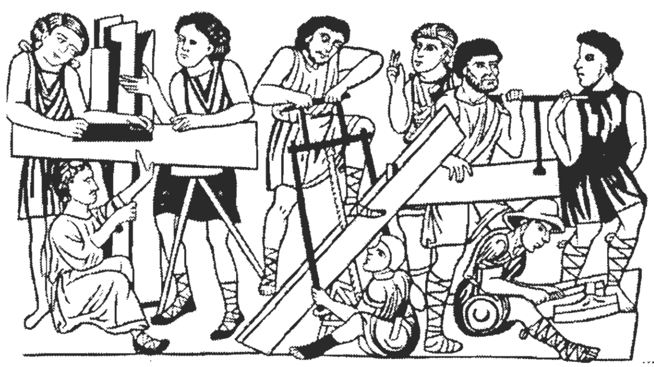

Figure 11 Early image of carpenters working. The center set of figures features a pit saw, as described in the paragraph. (From Singer, 1956)

Seasoning the Wood

Two methods for seasoning are as follows. For soft wood, the timber had its bark cut off while it was still standing so the wood was exposed to the elements and sap would flow out. For wood that split easily, it was instead felled and covered in manure.[81]

[79] Ibid. p244.
[80] Ibid. p391 – 392.

Woodworking Tools

Because there were many crafts that worked with wood in different ways, there were many tools that were used. Each craft had its variations, but listed below are the basic tools.

<u>Adze</u>

Axe-like tool used to strip slices off of the surface of the wood. Used for coarser work than the plane. The blade was parallel to the surface of the wood and perpendicular to the handle.

<u>Auger</u>

Spoon-like tool with a long neck ending in a perpendicular handle. It was used to scoop out large holes in wood.

<u>Awl</u>

Used for boring holes into wood. The awl could be any thickness to create any thickness of hole. It consisted of a long, slender rod that came to a sharp point at the end and was usually made out of iron, or later steel. The bit was usually square because square bits broke the grain of the wood better than round bits, and thus prevented splitting.[82]

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[81] Ibid. p233.
[82] Moxon. 1703. p114.

Bow-drill

Tool that was used to punch holes through wood. It consisted of a bow and a long threaded metal rod. The string on the bow would be wrapped around the rod, and by drawing the bow back and forth the rod would turn, creating friction.

Chisel

Sharp wedge used to cut sections out of wood. Carpenters drove the chisel into the wood using a mallet to pound the head, while joiners used only the strength of their arms.[83] A variation on the chisel, called the ripping chisel, was a blunt chisel used to separate pieces of wood that had already been fastened together.[84]

Draw-knife

Double-handled blade that was used to scrape sections off of the surface of wood. Force was created by pulling the blade towards the artisan's chest.

Gouge

Spoon-shaped tool which was used to take a semi-circular section out of the surface of a piece of wood. Usually driven with a hammer or mallet.

Hammers and mallets

Wooden or steel bludgeoning devices attached to a handle. Used to drive objects such as nails, pegs, and chisels into wood. Mallets were generally for pounding wooden

[83] Ibid. p121.
[84] Ibid. p122.

objects, and hammers were used for pounding metal objects, such as nails. Certain hammers (called claw-hammers) had a divided rear section which could be used for prying up nails. Moxon refers to a mallet with a 3-foot long handle which was used for knocking frames into place and driving small wooden piles into the ground.[85]

Hook-pin

Long rod with a sharp point at one end and a hook on the other. It was used by carpenters to fasten the angles of roof or wall frames temporarily while it was being fitted into position.[86]

Plane

Stripped slices off of the surface of the wood to make the surface smoother. The plane consisted of a knife-like edge attached at an angle to a wooden handle. The plane would be pushed along the board, slicing thin sections off of the surface.

Plumb-line

A string with a weight attached to the end of it. This would be suspended from a board to make sure the board was completely perpendicular.[87]

Rasp

Rough-surfaced rectangular tool that was used as a file to scrape away portions of wood.

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[85] Ibid. p125.
[86] Ibid. p123.

Saw

Used to slice wood into smaller sections. It had a serrated edge made out of iron or steel attached to a frame or bow, which served as a handle. Cutting was produced by friction.

Carpenters

By the beginning of the 15th century, the other artisans had split off from the carpenters, and now they were primarily concerned with building the frames, roofs, and floors of a house. In most areas, oak, fir, and pine were the primary materials for housing construction. Since the timber resources were distributed unevenly throughout Europe, local wood had to suffice for most houses. However, the rich often imported other more costly woods.[88]

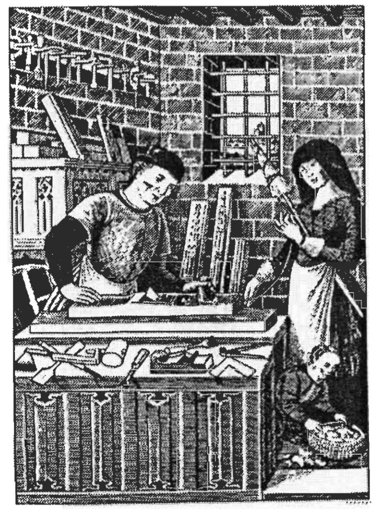


Figure 12 A Carpenter and his Family. In the foreground are several tools used by the carpenter in his trade. (From Singer, 1956)

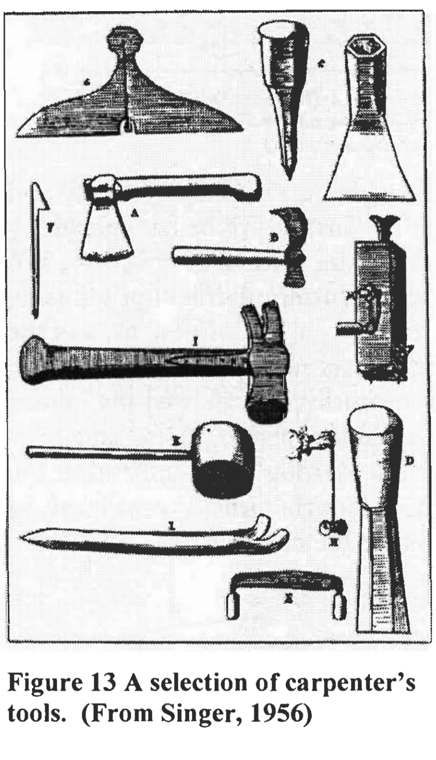


Figure 13 A selection of carpenter's tools. (From Singer, 1956)

The frames of medieval houses were constructed so that the timbers supporting the roof were an integral part of the frame. This meant that if the roof fell in the house would likely fall down. In

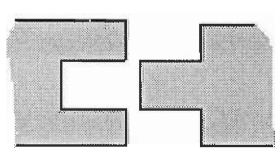
[87] Ibid. p123.
[88] Singer. 1956. p240.

England, it became common for roofs of churches and halls to use open timber construction instead of vaulted stone. The carpenter was also in charge of making the scaffolding that was needed when creating stone buildings, as well as the wooden frame that held the stone in place until the keystone was lowered into place.

Joinery

The joiners mostly concentrated on making furniture in the 15th century, although they did have several offshoots such as the ceilers and carvers. The art of joinery was especially useful for making furniture less bulky and heavy. Their primary products were ambries, chairs, stools, beds, presses, tables, court-cupboards, benches, settles, house-fitments, and paneling. The joiners used several kinds of joints in their work, including the tongue-and-groove joint, the mortise-and-tenon, dove-tail, and paneling.[89] These joints are illustrated below:

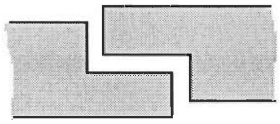
Tongue-and-Groove Joint



The tongue-and-groove joint consists of one piece of wood having a trough gouged down the center of the face that is to be joined. The other half of the joint has a raised portion that is cut to fit snugly into the trough of the first piece. The two pieces could then be nailed in place, because glue was prohibited by guild regulations.

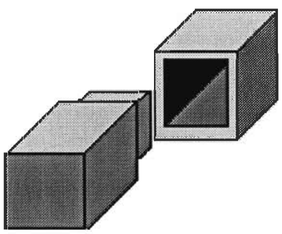
[89] Ibid. p243.

Dove-tail joint



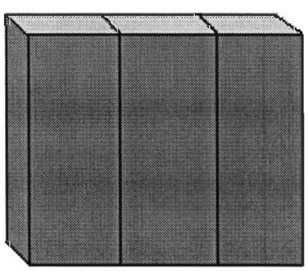
The dove-tail joint is again two pieces of wood. Each has a half of the face that is to be joined cut away. The two pieces are laid on top of each other and pegged in place.

Mortise-and-Tenon Joint



The mortise-and-tenon joint consists of a recessed part of one section that is made to fit around a raised part of the other half of the joint. The sections can be nailed or pegged in place, or in some cases left plain, depending on how snug the fit is. This is similar to a tongue-and-groove joint.

Paneling



Paneling consists of a number of boards being laid side-by-side and nailed into place. Panels could also use dove-tail or mortise-and-tenon joints for extra stability. Paneling could also consist of a board encased in a frame of wood.

Because joiners dealt with paneling, the ceilers emerged as a sub-group of that craft. This group dealt primarily with paneling. Wood panels (also called ceiling) kept the dampness and cold out, so were popular with all classes of people who could afford them. In joiners' shops, these boards were mass-produced by the middle of the 15th century. They could be either made of thin plain boards or be enclosed in a frame. When the thin boards were enclosed in frames, the panels were held loosely in the groove cut into the frame to prevent splitting as the wood shrank.[90] In the early part of the century, a kind of paneling called linen-fold became popular in Germany, France, and England. This sort of paneling was carved using a molding-plane, which created crescent-shaped gouges, and the edges were finished off by a carver's chisel.

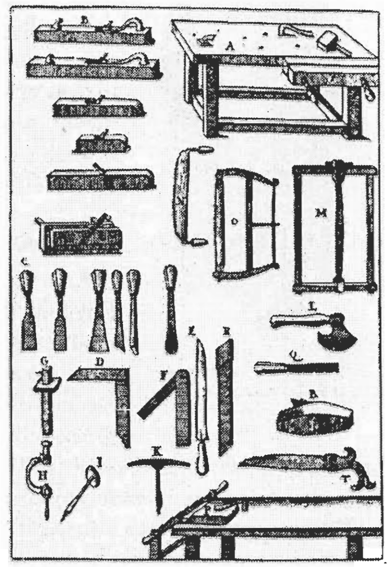


Figure 14 A selection of joiners tools. (From Singer, 1956)

The carver was another sub-section of the joiners' craft. For carvers to be able to apply their trade, the pieces had to be carved before they were assembled. Carvers used many techniques to carve designs into furniture and panels, which are described below.[91]

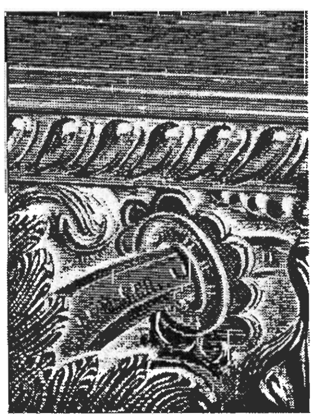


Figure 15 Carving in relief. (From Singer, 1956)

When carving "in relief" or "in the round", the patterns or figures were left raised out of the background and the edges were usually smoothed out. This technique was used more

[90] Ibid. p. 245.
[91] Ibid. p245 – 247.

often to depict objects, such as flowers or fruit, rather than abstract designs. A similar form of carving was chip carving, except this form used a square-set and compass to create the pattern instead of drawing it freehand.

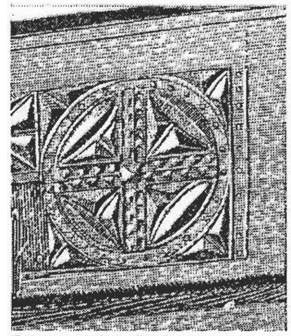


Figure 16 Chip carving. (From Singer, 1956)

For sunken carving, the background of the design was carved out of the wood, leaving the rest of the design raised and level with the main plane of the wood. The background was then stippled or poked with a sharp instrument. This had the effect of obscuring any unevenness of the background.

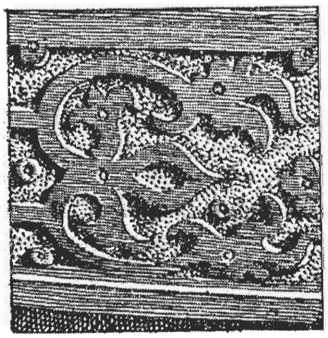


Figure 17 Carving with ground sunk. (From Singer, 1956)

Incised carving was created by scratching lines onto the surface of the wood using a gouge. A similar form of carving was gouge carving. A trough was created with a gouge, giving the effect of flutes. This technique was used in creating linen-fold paneling.

Stamping was another technique for creating designs in the wood. Patterns were tapped into the wood using a metal punch and mallet. The most common punches were shaped like stars, circles, and rosettes. This form of carving was usually used in combination with other forms of carving, such as sunken carving and carving in the round.

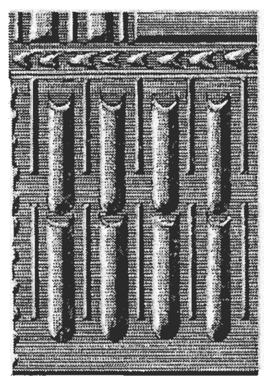


Figure 18 Gouge carving. (From Singer, 1959)

Turning

Figure 19 Turning a wooden bowl on a pole lathe. (From Singer, 1956)

Turners were another craft that worked with wood in the 15th century. They used machines called lathes to spin a piece of wood about its axis quickly while they used tools to scrape off layers from the outside. Lathes were not just used for wood, but also turned ivory, ebony, bone, horn, and soft metals like brass.[92] From these materials they made furniture, bowls, plates, and cups, as well as smaller items like cane-heads and ink horns.

There were three main types of lathes used. For turning chair and stool legs, a pole-and-treadle lathe was used. For heavy work, a great wheel lathe was used. For fine and light work, a treadle wheel lathe was used.[93] These are described below.

Pole-and-treadle lathe

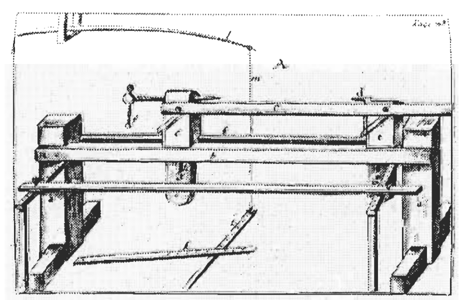


Figure 20 Pole-and-treadle lathe. (From Moxon, 1703)

The wood which is to be worked was roughly hewn into a cylindrical shape and placed between two uprights attached to a bed or table. A cord was attached to the end of a resilient pole, which was sometimes the branch of a living tree, wrapped around the work, then attached to a hinged board which was powered by pressing on it with the foot. This would pull on the cord and cause the work to rotate in one direction, and when the pressure was released the work would rotate in the opposite

[92] Moxon. 1703. p211.
[93] Singer. 1956. p250.

direction.[94] This meant the turner would press his tool to the surface when the treadle was being pressed down, then remove it when the treadle was released so the excess material could be removed.

<u>Great wheel lathe</u>

This lathe consisted of a great wheel usually standing almost the height of a man with two cranks attached to the hub and a groove cut along the edge, and the lathe table. The drive string was fastened into a circle by overlapping both ends by about 3 inches then wrapping the joint in gut. This fitted into a groove carved into the outside of the wheel and wrapped around the work in a figure-eight pattern. The wheel was then moved off perpendicular to the table to make the string taut. The turning of the work was provided by the cranks, and because the string always moved in the same direction, there was no need to remove the tool from the work at all except to examine it.[95]

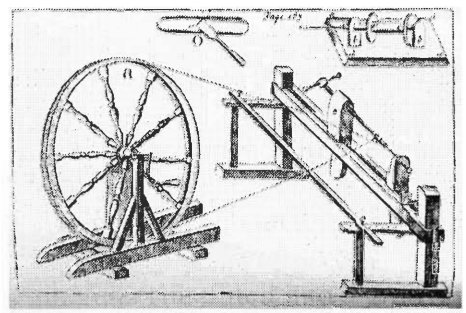


Figure 21 Great wheel lathe. (From Moxon, 1703)

[94] Ibid. p232.
[95] Moxon. 1703. p178 – 179.

Treadle-wheel lathe

This form of lathe had a wheel with a crank attached under the table, similar in shape to the great wheel. A leather drive string was wrapped around the wheel and configured in a figure-eight shape, with the wheel attached to a treadle. The treadle provided the force to turn the crank, which turned the wheel. However, it did not provide much power, so could only be used for small work, like turning ink horns and cane heads.

Bow-lathe

A variation of the treadle wheel lathe which could only be used for turning fine work. An archer's bow was used to power this lathe. The middle of the bow was fastened overhead its string parallel to the table. Another string was attached to the center of the bow string and looped around the work with the end attached to a treadle. [96]

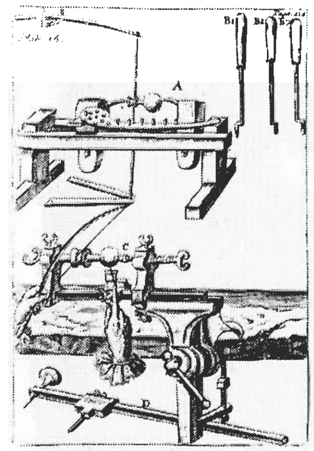


Figure 22 Treadle lathe (top) and Bow lathe (bottom). (From Moxon, 1703)

Arkwright

Arks were receptacles for holding meal or corn. They were made out of overlapping boards and had a lid that was hinged on wooden pins. They used wedged construction instead of mortise-and-tenon. The mortise-and-tenon joint is described under the joiner section, and

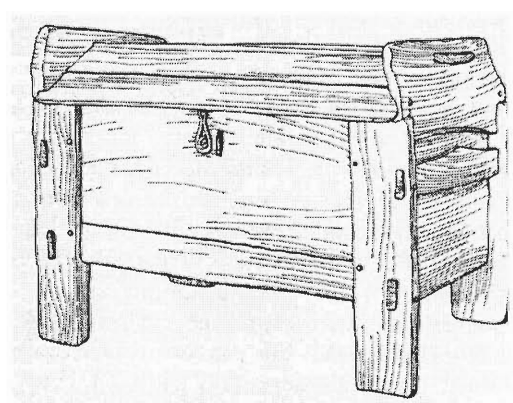


Figure 23 Wooden meal ark. (From Singer, 1956)

[96] Ibid. p178 – 179.

wedged joints had previously fallen out of fashion in the joiners trade. A wedged joint consisted of a dowel thrust through a snugly fitting hole. The dowel was split down the center at the end, and a wedge was driven into the split. The resulting tension caused the dowel to expand to fit the hole snugly without slippage. The boards that were used in the construction of the arks were riven or split boards (see section on making boards) like those used by joiners or ceilers for paneling.[97]

Cooper

The cooper made bathing tubs, buckets, and casks for wine and beer, as well as other wooden vessels for holding liquids.[98]

Coffer-maker

The coffer-maker used a wooden frame with leather stretched over it to make coffers, which were the medieval equivalent of a trunk. They also made a chair called the x-frame chair, which was covered in fabric or leather so that the wood was not exposed.[99]

[97] Singer. 1956. p254 – 255.
[98] Ibid. p254 – 255.
[99] Ibid. p255 – 256.

Wheelwright

Wheelwrights made wheels for carts. The spokes were made out of turned wood, as were the hubs. The outer ring was usually wood, sometimes covered with iron. Ready-made pairs of wheels could be found in English towns. Most were created as a flat cone, or "dished". This worked well to counteract the inevitable swaying that resulted from the cart driving over irregular surfaces and was first seen in diagrams from the 15th century onwards.[100] To make the wheels, the wheelwright would turn the hubs and spokes. There were usually 6 to 12 spokes, which were attached to the hub and tire using mortise-and-tenon joints.

Figure 24 A Wheelwright's shop. The wheelwright in the foreground is drilling the center of the hub. (From Singer, 1956)

Woodblock Cutters

With the invention of the printing press, the art of woodblock cutting became widely known. Woodblock cutting produced the illustrations for most of the early books, although it was later supplemented by metal plates. There are three types of woodcuts. The first is "in relief", where the design is raised above the surface of the background. The second is "intaglio", where the design is cut into the surface. The third is lithography.[101] The woodblocks would be carved according to the carving techniques

[100] Ibid. p552.
[101] Hind. 1963. pl – 2.

listed above in the section on joining. They would then be inked and inserted into the printing press, where the design would be transferred to the paper.

Stone

Stone was used in the fifteenth century mainly in building. It was quarried by digging into hillsides and river banks. First the topsoil was removed. Then the sedimentary rocks were chipped away with a crowbar or pickaxe. Next the large pieces of desired stone were broken into more workable pieces using the plug and feather technique.[102] This technique involved drilling a series of holes in the stone, along the line where you wished to break it. Half-circular rods of soft iron called "feathers" were placed in the hole. A steel wedge called a plug was then inserted between the feathers and driven into the hole with a mallet. As the worker moved down the line driving the plugs into the stone, the pressure created in the holes created a crack between the holes, eventually cracking the length of the stone.[103] The large stones would then be shaped at the quarry before being shipped to the building site.[104]

Limestone and chalk were burned to get quicklime for use in mortar. Mortar also included the bits of sedimentary rock removed in the quarrying process. Sand was used as the aggregate, a material added to mortar to increase its strength.[105]

In order to build a wall the foundation first had to be laid. A trench was dug and filled in with rubble, broken brick or clay. The stones were laid on top of this and stacked

[102] Parsons. 1991. p4-6
[103] Merrill. 1891. p323-325
[104] Parsons. 1991. p4-6
[105] Ibid. p1

on top of one another with the mortar in between. Once the wall reached chest height a scaffolding was built by carpenters and work continued from there.[106]

Sometimes instead of quarrying the stones old stones would be removed from demolished buildings.[107]

Alabaster and Marble

Alabaster and marble were stones used decoratively during this period. Alabaster is very soft and easily carved. It began to be used for effigies and tombs in the 15th century. It was quarried in large, workable masses called pillars. The pillars were usually separated by coarsestone and foulstone, which could be dug away by hand.[108]

Marble was quarried in great slabs and used for effigies, tombs and architectural pieces like columns and shafts.[109]

Both materials could be carved at or away from the quarry. Evidence is found that shows both cases were in use, so it may have been a matter of preference or convenience on a case-to-case basis. [110]

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[106] Ibid. p1
[107] Ibid. p21
[108] Ramsay. 1991. p31-32
[109] Blair. 1991. p42, 48-51
[110] Ramsay. 1991 p32, 42

Agriculture and Animal Husbandry

Animal Husbandry

The usual draft animal of the medieval period was the ox, preferred to the faster horse because horses required better and more expensive care and feed.[111] The donkey and mule were used for riding only, and were far less numerous than horses.[112] All draft animals were smaller then—the average modern horse stands 17 hands at the shoulder (a 'hand' is four inches, thus 17 hands is 68 inches), while a medieval horse stood only around 13 hands (52 inches).[113] The medieval farmer also kept sheep and goats for wool, meat, and milk, and cattle for meat, milk, and the all-important horn.[114]

Plowing

Northern Europe's heavy soil required that the plow, invented in the Mediterranean, be adapted. The share, the blade that makes a horizontal cut in the soil, was supplemented by the coulter, a second blade that makes a vertical cut. This allows heavy sod to be cut more easily. The moldboard, set behind the blades, is a concave curved surface that turns the cut soil to the side, sparing the plowman's wrists. Plows were primarily pulled by teams of four oxen, goaded by a driver walking backwards before them, with a plowman in the rear guiding the plow.[115]

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[111] Singer. 1956. p91.
[112] Clark. 1995. p77
[113] Ibid. p170
[114] Singer. 1956. p110
[115] Ibid. p87-91

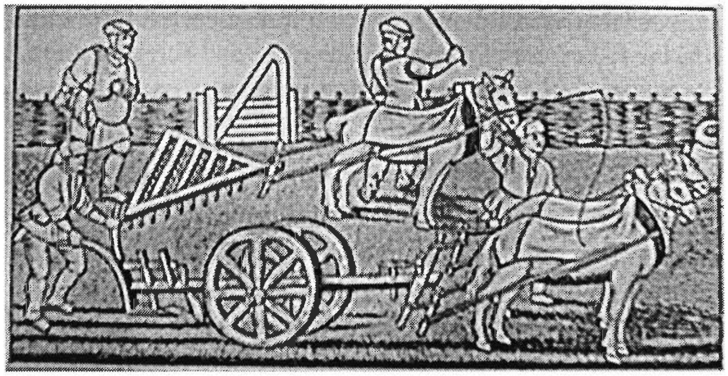

Figure 25 Wheeled plow and triangular harrow. (From Singer, 1956)

To further break up the clods of soil turned up by the plow, and also to cover the seeds in the furrows, a horse or another yoke of oxen would tow the harrow, a square, or in later years, triangular wooden frame with teeth.[116] Fields were plowed long and narrow, since turning a plow in sod is difficult. Fields were either flat, when plowed with the 'one-way' plow, which despite its name enabled the plowman to turn the sod either way, or in pronounced ridges and furrows, which form when the sod is consistently turned in the same direction. Because ridge-and-furrow plowing allows for better drainage in non-porous soils, fields were sometimes plowed this way on purpose.[117]

Harvesting

Grain was harvested with the balanced sickle, a long, crescent-shaped knife whose handle was molded to fit the hand of the worker, and the scythe, a curved blade on a long handle. Workers would gather together a handful of stalks, then cut them with the sickle. The scythe, wielded in long sweeps, speeded harvesting by allowing workers to fell more grain at a stroke.[118]

[116] Ibid. p94
[117] Ibid. p92-93
[118] Ibid. p95-96

Once cut, the grain was threshed and winnowed. Threshing separated the seeds themselves from the stalks and husks. It was done by spreading the grain out on flat ground or a barn floor and beating it with jointed flails, allowing horses or oxen to tread over it, or having them tow a threshing board studded with bits of flint. Winnowing separated the seed husks from the seeds, and was first done with winnowing fans. Before this came to mean an actual fan which produced a draft, a winnowing fan was a specially shaped basket in which the grain was shaken to let the wind carry the chaff away.[119]

Crops

The primary grain crops of 15th century Europe were legumes, wheat, oats, barley, rye, millet, and buckwheat newly introduced from the Middle East. They also grew turnips, cress, radishes, carrots, and parsnips, and rapes (oilseed plants). The crops of the time bore little resemblance to their modern equivalents, since it was just in the 1400s that horticulture began to come into its own. During that time the carrot became more popular as gardeners were able to reduce its woodiness by selective breeding. In Italy the artichoke was produced from the thistle, and the cantaloupe rediscovered.[120] Europe also produced copious amounts of grapes for winemaking,[121] and began to grow hops, a twining vine whose flowers when dried were (and are) used in brewing to give beer its characteristic bitter taste, and coincidentally, prevent bacterial growth.[122]

[119] Ibid. p97-98
[120] Ibid. p124-125
[121] Ibid. p138
[122] Ibid. p141

Transportation

Draft

By the 15th century, the modern system of horse harnessing was in place. The nailed iron horseshoe protected the horse's hooves from Europe's damp weather and kept wear from heavy draft work to a minimum.[123] For draft work, a rigid, padded collar that rested on the horse's shoulders allowed the animal to pull without putting pressure on its windpipe. The horse could then be harnessed to a cart or plow, either by shafts or the whippletree (modern form, whiffletree or swingletree). Shafts are simply poles that ran from connection points on the collar at the shoulders to the frame of the cart. The whippletree is a piece of wood attached perpendicularly to the drawpole of a cart, to which the horses are then harnessed in file. Any number of horses might be harnessed together this way, with the attachment points of the whippletree arranged to distribute the pull evenly.[124]

Riding

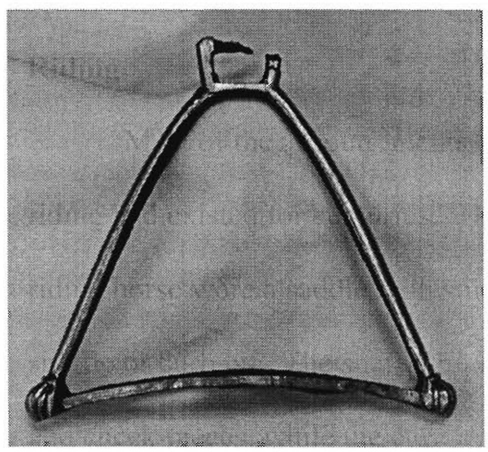

Figure 26 A stirrup dated to the 12th or 13th century. (From Higgins Armory Collection, 1567.1)

Most of the accoutrements of 15th century riding had existed for centuries. The medieval riding horse wore a saddle with stirrups, and a snaffle or curb bit. The snaffle bit had a mouthpiece and cheek pieces, while the curb bit had an extended mouthpiece which pressed up against the top of the

[123] Clark. 1995. p75-76
[124] Gans. 1998. /whippletree.html

horse's mouth when the reins were pulled, forcing the horse to raise its head. This slowed the animal quickly, since horses run with their heads down. The curb bit was popular in the 1400s, since knights on horseback needed great control over their mounts' actions.[125] Riders wore prick or rowel spurs, which increasingly lengthened as a fashion trend. Prick spurs were triangular or conical, while rowel spurs were spiked wheels.[126]

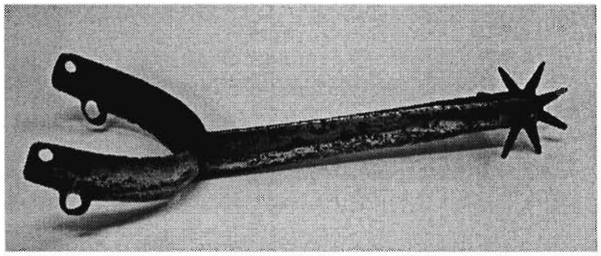

Figure 27 A rowel spur from the late15th /early 16th century. (From Higgins Armory Collection, 932.1)

Carts

The carts used in the 1400s were quite simplistic—essentially a ladder supported by two or four wheels. The harnessing shafts were merely extension of the 'ladder' frame.[127] Wheels consisted of a rim with spokes running radially inward to the axle. The rim may or may not have been protected by nailed iron plates; carts with such wheels were often banned from towns, since they tended to damage the roads.[128] A development of the 15th century was the dished wheel, whose spokes formed a flattened cone inward toward the body of the cart. These wheels were strong against the swaying motion produced by a heavily loaded cart.[129]

Primitive suspension by chains or straps existed, but though the principle of the spring was understood, it was not used in suspension. The major development in land

[125] Clark. 1995. p43-44
[126] Ibid. 1995. p129-130.
[127] Singer. 1956. p547
[128] Ibid. p533

transportation was the moveable forecarriage, or turning-train. The front axle was made one with the shafts, and attached to the chassis of the wagon at a pivot. By allowing the front of a four-wheeled cart to turn independently, steering was greatly improved.[130]

Roads

Figure 28 A paveur laying paving stones. (From Singer, 1956)

By the 1400s, most of the superior Roman roads had been cannibalized for building material. The responsibility for upkeep of roads in a given area, whether classical or modern, fell to the either the landholder,[131] with whom it was seldom a popular duty, or to the Church.[132] Medieval roads were built on sand or earth foundations, and covered with gravel, cobblestones, or blocks cemented together with mortar, a mixture of sand, lime, and river mud.[133]

Ships

"The ships of the Middle Ages are far harder to understand than those of classical times. A whole new nomenclature appears, difficult to correlate reliably with particular types of vessel. Illustrations are mostly poor—so bad in most cases as to suggest that the artist had little first-hand knowledge of the shapes they depicted."[134]

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[129] Ibid. p552
[130] Ibid. p548
[131] Singer. 1956. p524-525
[132] McNeil. 1990. p432
[133] Singer. 1956. p526.
[134] Ibid. p582

The 1400s saw the adoption by Europe of more advanced sailing technology from the Mediterranean. Formerly, European ships had triangular hulls, a single mast carrying a square sail, and a rudder which was essentially just another oar.[135] Hulls became rounded and larger, with raised fighting and storage platforms called castles built on deck.[136]

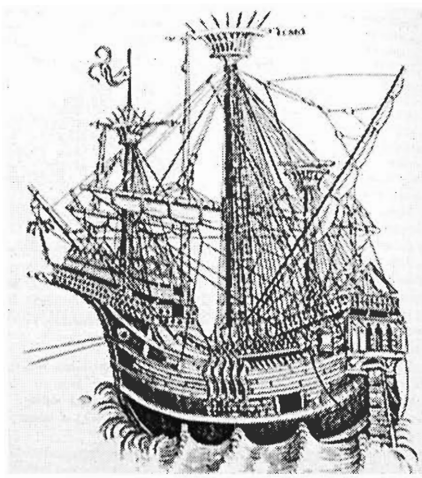

Figure 29 A full-rigged, triple-masted ship. (From Singer, 1956)

Multiple masts came into use. At first, a second mast to the fore carried a second square sail, necessitating in later designs a third mast to the aft to balance the force produced on the rudder. This mizzenmast carried a triangular lateen sail (from the French *latine*, or Latin). This form of rigging is essentially modern. The two large square sails catch more wind to propel a heavier ship, and the triangular aft sail allows the vessel to tack into the wind.[137]

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[135] Ibid. p580
[136] Ibid. p583
[137] Singer. 1956. pp586-587

The final major development in shipbuilding of the 15th century was the stern-post rudder. The rudder surface itself was underwater so that it would not be moved by the wind, and was attached to a post which ran vertically up the stern and was in turn attached to the wheel or the tiller through a hole cut in the stern, allowing the steersman greater control.[138] The first ship to incorporate all these design modifications was the carrack, followed quickly by the larger galleon as shipwrights began to build for transatlantic voyages.[139]

Figure 30 A clear example of the stern-post rudder. (From Singer, 1956)

[138] Ibid. 1956. p586-587
[139] Birdsall. 1979. p130

Textiles

Figure 31 Detail of fabric covering a section of brigandine. (From Higgins Armory Collection, 809.2)

Textiles have always been an important part of people's lives. In the fifteenth century many people depended upon textiles for many things other than clothing. The large industry of textile production affected other industries such as mining and power production. Burlap sacks were used to carry heavy industrial burdens and devices such as the rag and chain pump used bundles of rags to pump water out of mines. Interestingly enough, textile production reached its peak during the 14th and 15th centuries. With the invention of the spinning wheel and more complicated looms the quality of textiles and their patterning exceeded anything found before. In fact, many of the technologies designed in this period are still in use in the textiles industry today. A loom in modern times is really only a motorized version of the looms worked by hand in the fifteenth century. [140]

Textiles were made from four types of fibers - animal coats such as sheep's wool, vegetable-bast fibers like flax, silk and vegetable-seed hair such as cotton. The four types were usually prepared in different manners, although several types of materials shared some of the techniques used.

[140] Lynette Hart. From an interview. 5 Dec 01

Processing Raw Materials

Wool

Wool is produced from the coat of an animal, especially that of the sheep. By 1454 there were some 51 different grades, or types, of English wool. The grades varied in type of animal and quality of production and finished product. At the end of the 15th century the quality of continental wool improved, especially in Spain.[141]

Before spinning, the wool is removed from the animal and prepared in a rather lengthy process. There are eight steps in the process, even before the raw material is carded or combed!

First the damaged portions were removed and the remaining material was sorted into grades of fine, medium, or coarse. Also, wool taken from young sheep was separated from that of old sheep and wool taken from live sheep was separated from wool taken from carcasses. Next it was washed in lye to remove the natural grease from the coat. Then it was dried in the sun. The dried wool was spread on a board and cleaned. Burrs and any remaining dirt or impurities were removed by hand. After removal of larger impurities, the wool was washed and dried again. Finally it was beaten with sticks to loosen it and force out foreign matter before it was finally combed, carded or bowed. [142]

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[141] Singer. 1956 p192
[142] Ibid. p193

Combing, carding and bowing both served to untangle the wool fibers and loosen them to prepare them for spinning. Carding involved the use of two wooden paddles, called cards, each one having a handle and being covered on one face with leather. Metal teeth came through the leather at an angle. A small chunk of wool was pulled apart between the two cards. It would work down into the teeth of one card and be pulled apart by the teeth of the other. When a piece of wool was finished, the combs were worked in the opposite direction, pulling the wool off in a spongy lump. Carded wool was usually soft and rather fluffy. [143]

Figure 32 Bowing wool. (From Singer, 1956)

Bowing produced a type of wool that was very much like carding. The bow was a wooden frame with a string of cord or gut stretched across it. The wool was laid on a bench. The string of the bow was plucked and then worked in the wool while it was still vibrating. The vibrations loosened the fibers and separated tangles. [144]

Combing produced a very different type of wool from carding or bowing. To comb wool it was sprayed with water and soaked in oil and laid out on a flat surface. The comb was heated and pulled through the wool until it all adhered to the comb. The wool could then be pulled off the comb in long, parallel fibers. This produced a firm thread and

[143] Ibid. p193-194
[144] Ibid. p195

a cloth with a harder surface. Waste from combing was used to produce cheaper, coarse garments.[145]

Flax and Hemp

Flax and hemp were used to produce linen. Use of these vegetable fibers was widespread in the Middle Ages. Once the plants were threshed the seed capsules would be removed by hand or by comb. The stalk fibers would be removed from the woody tissues through a process known as retting. Retting involved placing the stalks in a bath of water warmed by the sun. The stalks were weighted down and remained in the water until the fibers had loosened from the bark. The loosened fibers would then be dried in the sun, and then the woody tissues would be broken.[146]

Figure 33 Preparing flax. The woman on the left is beating the flax over a board. The other woman is using a flax breaker. (From Singer, 1956)

In the 14th century a flax breaker was invented that was still in use in the 15th century. The flax breaker was a simple lever-type mechanism consisting of two boards lain so their edges faced up. A third board fitted into the space between them in the same manner. The two outside boards were fixed in position, and the middle board was hinged to the other two. This centerboard could then be raised and lowered into the space

[145] Ibid. p194
[146] Ibid. p195-196

between the other two by a handle attached to its end. The flax was laid across the two fixed boards and the other board was brought down on it, breaking the harder material surrounding the fibers. The machine was operated with two hands. One hand lowered the lever while the other held and turned the flax material. [147]

After breaking, the tissues were beaten. For this they would be laid across a bench or flat surface so they hung over the edge. The tissues were then beaten with the edge of a board, taking great care not to strike the flax on the surface but where it hung in the air.[148]

Finally the flax would be drawn through the teeth of a comb to remove the last of the bark and produce the final strands. The waste fibers from flax were used to make sackcloth. [149]

<u>Silk</u>

Silk is well known to have originated in China. Silk production also began to develop in France and England nearing the end of the fifteenth century. Silk is the material made from the cocoon filaments of moths. It was fairly tricky to produce at every stage. Even obtaining the cocoons in order to create the silk thread was difficult. The eggs of the silk moth had to be dipped in a salt-water bath at a highly regulated temperature. The moths, when they hatched, were reared very carefully, receiving constant attention and round-the-clock feedings. The spinning caterpillars would be separated from the breeding caterpillars. Fully mature spinning caterpillars were placed on woven straw racks and very gently heated. When the caterpillars finally emerged from

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[147] Ibid. p196
[148] Ibid. p196
[149] Ibid. p196-197

their cocoons, the cocoons were harvested and those that were too tangled were discarded. [150]

The viable cocoons were then wound into silk thread by a process called reeling - they were immersed in boiling water and stirred with rods. The ends of the silk filaments would stick to the rods, which were then wound on a frame with a crank. Only three silk filaments could be wound at any one time. As the filaments were being reeled, they had to be watched constantly. New filaments had to be attached and broken filaments mended by hand. A perfect thread diameter was very difficult to achieve, since the filaments grew thinner near the center of the cocoon. Silk from perforated or tangled cocoons would be spun like wool or cotton. [151]

Cotton

Cotton is obtained from the fluffy seed material of a stalked plant. In the fifteenth century cotton was often imported in Europe, arriving in large bales. The cotton would then be spread on wickerwork or a wire frame and beaten. It would be carded or bowed in the same fashion as wool, then spun into a yarn. This yarn was boiled in the lye of wood-ashes, sometimes with lime. In Germany the wastes were felted by a fuller and made into rain-capes. [152]

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[150] Ibid. p198
[151] Ibid. p198-199
[152] Ibid. p200

Spinning and Throwing

Spinning

The process of spinning was the same for flax, wool and cotton. Spinning is the act of imparting a twist to the fibers, causing them to grip each other more tightly and lay together to form one continuous strand. It is the process that takes the fibers from raw material into being thread or yarn.[153]

Spinning was originally performed using a distaff and spindle. The distaff was a rod on which the prepared fibers were arranged. The spindle was another rod with a round weight, or whorl, attached to it. Using a spindle and distaff, the spinster would pull the fibers out to form a thread and attach it to the spindle. Then, they would set the spindle spinning and pull the fibers out slowly. As they pulled the fibers out the spinning action of the spindle would twist them together, forming a single strong thread. Once the thread had become long enough that the spindle reached the ground, it would be wound on the spindle and the process would start again. [154]

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[153] Ibid. p200
[154] Ibid. p201-202

The distaff started as a short rod that was held in the hand, but later it was much longer and could be mounted either in a belt or on a bench. Sometimes the longer distaffs would be held in the crook of the arm instead. Also, later advances brought about distaffs with a wire cage or frame on which the fibers could be wrapped or secured. [155]

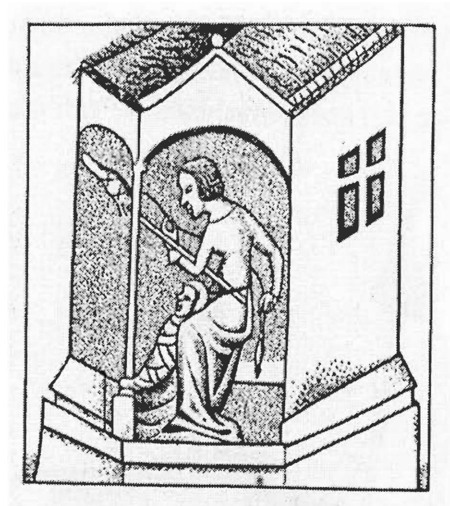

Figure 34Woman using a spindle and long distaff. The distaff is secured in her belt. (From Singer, 1956)

Spinning using the rod and distaff began in very early times and continued into the fifteenth century, even though the spinning wheel had already been invented by then. This was due to a strong prejudice against thread spun on a spinning wheel. Many textile guilds prohibited the use of spinning wheels, or limited the use of thread spun on a wheel to certain types of cloth. Part way into the fifteenth century, though, this prejudice waned. The spinning wheel soon became the primary method of spinning fibers and actually remained popular until well into the 19th century.[156]

The spinning wheel was actually comprised of two wheels - one very large wheel and one small wheel connected to a horizontal spindle. A cable joined the two wheels. When the large wheel was spun the small wheel would rotate faster, minimizing the work done by the operator. [157]

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[155] Ibid. p202
[156] Ibid. p202
[157] Ibid. p203

The prepared fibers would be mounted on the spindle. The operator would use her right hand to turn the wheel while using her left hand to draw out the fibers. The fibers would be drawn out at a 45-degree angle to the axis of the spindle. As the large wheel was turned, the small wheel would turn the spindle. The fibers would move off the edge of the spindle and, because of the angle at which they were held, would twist once. It was in this fashion that the spinster would draw out the thread while turning the wheel and causing the twist in the fibers. Once her arm was fully extended, she would hold the thread at a 90-degree angle to the spindle and turn the wheel backward to wind it on. Thus, spinning was still a two step process - spinning the thread and winding it on. [158]

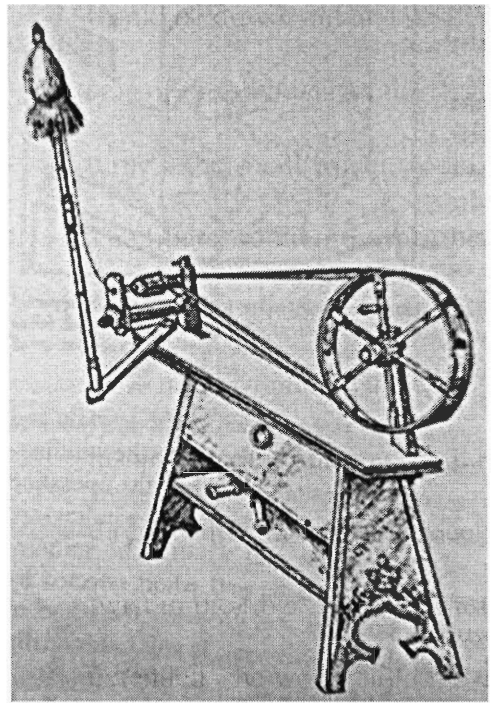

Figure 35 Spinning wheel with flyer. (From Singer, 1956)

The flyer was a simple U-shaped device that eliminated the two-step process. The flyer's origin is unknown, but it first appears in an illustration around 1480. The illustration shows a rather advanced flyer system, suggesting that the flyer had been around for a while before then. [159]

The flyer actually consisted of several main parts. A hollow spindle was mounted horizontally between two arms so that it could spin freely. A spool attached to the spindle also moved independently. Both the spindle and the spool had their own separate drive

[158] Ibid. p203
[159] Ibid. p203-204

gear. The rope from the large spinning wheel looped twice - once around the spool drive and once around the spindle drive. [160]

The fibers were pulled out and passed through a hole into the center of the hollow spindle. It then came out another hole partway down the shaft of the spindle. From here it passed over the flyer, held in place by hooks called "hecks" that were part of the flyer. It was then secured to the spool. When the large wheel was spun it would spin the spindle. As the spindle spun the thread would pass over the flyer and twist. Then, because the spool was spinning faster than the spindle, the spool would draw the thread out and wind it on. Generally as the spool became more full it began to wind even faster, causing the thread produced at the end of the spool to have less twists in it. To alleviate this the thread could be held out by the operator or moved to a different heck on the flyer, which was designed for this purpose. The flyer turned spinning thread into a one step process, since now the spinning and winding-on were simultaneous.[161]

Throwing

Silk was spun somewhat differently than other materials. Since the silk fiber is in one very long strand, or filament, in its raw form, the fibers didn't have to be drawn out the way wool, cotton or flax was. To spin, or "throw", silk several filaments merely had to be twisted together. This increased their strength and imparted some uniformity to their thickness. Early silk throwing used a contraption very much like a spinning wheel. The filaments would be wound in groups of three on the spindle and mounted on a machine which had a set of spokes joined with rope. The rope created a nearly round frame onto

[160] Ibid. p204
[161] Ibid. p204

which the silk could be thrown. When the frame was turned the silk filaments would slip off the spindle and twist together.[162]

The history of the throwing mill is very uncertain, due mainly to the amount of secrecy surrounding it. Very few records were kept regarding its origin or design. Most of what we know about fifteenth-century throwing mills has been pieced together from the rare illustrations of them. From what the illustrations show, fifteenth-century throwing mills were the same as in the seventeenth century, when detail about them was finally made public.[163]

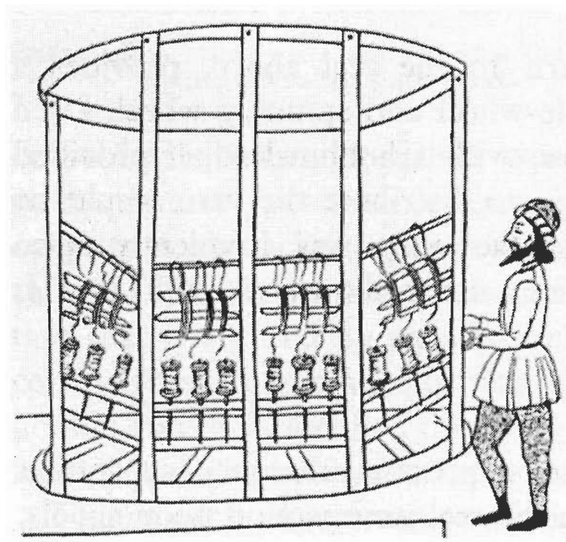

Figure 36 Illustration of a throwing mill. (From Singer, 1956)

Throwing mills consisted of two concentric wooden frames of about 16 feet in diameter. The outside frame was fixed in position and was mounted with two rows of vertical spindles. Above the spindles were horizontally mounted reels. Attached to the spindles were a series of S-shaped wire pieces, each mounted to its own dome-shaped piece. The interior frame rotated around its center. As it rotated it would rub against the outside spindles and reels, causing them to turn. As they turned the silk filaments were passed through eyelets on the ends of the metal S pieces, which would also be spinning. The spinning action of the S pieces would twist the filaments together,

[162] Ibid. p205-206
[163] Ibid. p206-207

while they were drawn up onto the reels. The center frame was spun using an undershot water wheel.[164]

After twisting, the reels of silk thread were placed in bags and boiled in soapy water to remove a gummy coating, which could impede the dyeing process. They were rinsed out and hung to dry, then bleached in the fumes of burning sulfur before being ready for dyeing and weaving. The silk throwing mills were incredibly efficient - requiring only two people two run them and doing the work of hundreds of hand-throwers.[165]

Reeling Winding and Warping

Reeling

Reeling is the process of removing the spun threads from the spindle, which is actually a more difficult task than it sounds. The threads couldn't just be slid off the spindle - they had to be wound from the spindle to an intermediate frame. In Graeco-Roman times the thread was removed by hand and wound into balls. This practice lasted into medieval times, as indicated by illustrations showing balls of thread. [166]

[164] Ibid. p207
[165] Ibid. p207
[166] Ibid. p208

In the Middle Ages, though, the cross reel was preferred for reeling the threads. The cross reel was a wooden frame. Two parallel sticks were joined by one perpendicular. The thread was wrapped around this frame in an X pattern. [167]

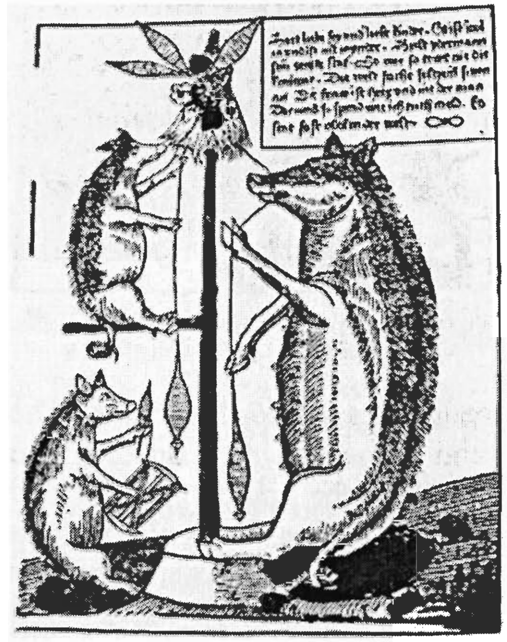

Figure 37 Illustration of spinning and winding. The pig in the lower left corner is using a cross reel. (From Singer, 1956)

About the same time the spinning wheel entered Europe, the rotary wheel was developed. This was essentially, a cross reel mounted to a frame. A handle attached to the reel allowed it to be spun, pulling the thread from the spindle. [168]

Thread could be reeled in two methods. One was to reel the thread into a hank, which was an organized bundle. This hank could be dyed or bleached at this point. Also, the thread could be wound directly from the spindle to a shuttle for use in weaving.[169]

<u>Winding</u>

Winding was the process of moving the thread from the hank or spindle onto a spool. The spool winder from the 14th century was essentially a horizontal spindle driven by a pulley wheel system. Actually, the spinning wheel itself was often used for this very purpose. [170]

[167] Ibid. p208
[168] Ibid. p208
[169] Ibid. p208-209
[170] Ibid. Pg 209

Thread wound in this manner could also be wound into conical balls of thread called cops. These cops were used for warp threads. [171]

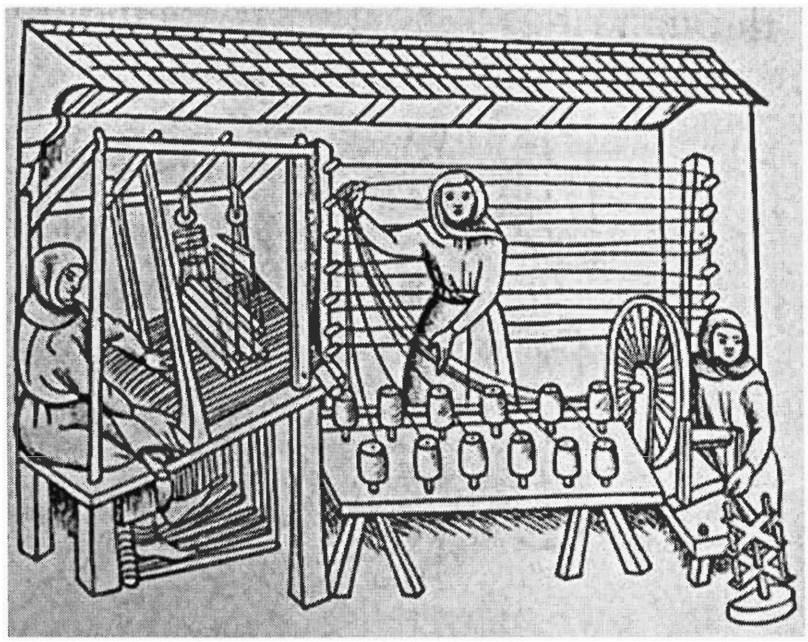

Figure 38 Nuns making cloth. The nun on the right is winding, the nun in the middle is preparing the warp, the nun on the left is weaving. (From Singer, 1956)

Weaving

For the sake of simplicity, I will discuss the weaving and warping procedures according to the type of loom one used. First we will discuss vertical looms, which were very simple. Then horizontal looms will be explained, followed by smaller frame looms.

Vertical Looms

The earliest type of loom produced was the warp-weighted vertical loom. This simple loom was frameless and had two beams. Warp preparation for these looms was fairly simple. A starting band was made on a smaller loom with long weft threads. The

[171] ibid. Pg 209

border would then be transferred to the cloth beam with the long weft threads used as the warp. The warp was wound around the bottom beam and stretched over the top, where small clay or stone weights applied the tension. The entire loom was then propped against a wall. The weaver worked standing up by passing the shuttle manually between the threads of the warp and beat the cloth up toward the top beam using a blunt piece of wood.[172] There is little evidence that these looms were still in use during the fifteenth century, but some archeological findings indicate that these looms were used in rural areas.

Another early vertical loom was the upright two-beamed. This was much like the warp-weighted loom, except that wrapping the warp threads around the warp beam provided the tension in them. Another difference was that the warp and cloth beams had been switched, meaning that now the cloth would be beaten down towards the bottom beam. This made it possible for the weaver to work in a seated position. This was the only real change, though. The method of weaving was still the same as with the warp weighted loom. Use of this loom in medieval Europe is uncertain. Archeologists have found some evidence of its use, but not a lot. [173]

Horizontal Looms

The looms widely used during the fifteenth century would all have been horizontal. There were many different varieties. One was the foot-operated counter-balance treadle loom, of which written evidence can be found. Basically, this loom

[172] Crowfoot. p21
[173]Crowfoot. p21-22.

consisted of two horizontally mounted beams. The cloth beam was at the front of the loom, next to the weaver. The warp beam was at the other end.

The process of warping this type of loom usually took at least a full day and required several workers. The tension in the threads was of utmost importance and had to be as even and strong as possible without breaking the threads. For this reason the warp was treated with size, which acted to temporarily strengthen the warp threads so they would not break during warping or weaving.[174] Size was made by boiling the skin of a rabbit in water, or from the wastes of corn milling.[175]

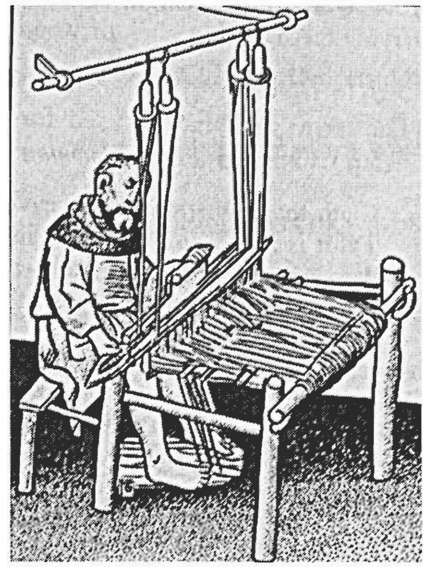

Figure 39 Man weaving at a counter-balance treadle loom. (From Singer, 1956)

Once the warp threads had been treated they were prepared for insertion in the loom on a frame. This frame had a series of pegs on two long posts. The warp thread was tied to one of the pegs and wrapped, in a zigzag fashion on the pegs until the bottom of the frame was reached. At the bottom of the frame were two pegs fixed close to each other. The threads would be wrapped around and between the two pegs, causing the threads to cross very evenly over each other. Once the required amount of wrappings had been achieved, the crossed end of the thread was transferred to a set of dowels. One dowel went through the loop, while the other maintained the cross in the threads. This would help when warping the loom to keep all the threads in order. [176]

[174] Lynette Hart. From an interview. 5 Dec 01
[175] Singer. 1956 p 209
[176] Lynette Hart. From an interview. 5 Dec 01

This set of dowels was then laid horizontally in the frame of the loom itself, so that the loop faced the warp beam and the loose ends faced the cloth beam. The loops were then secured to another dowel, which was attached by rope to the warp beam. The purpose of attaching the warp to this dowel instead of the warp beam itself was to allow as much of the warp to be woven as possible. As the end of the warp was reached the small dowel extended from the warp beam, bringing the end of the warp down to where the weaving actually took place. This same dowel setup was used on the cloth beam as well for the same reasons. [177]

The free ends of the warp were then fed through the eyes of the heddles before being attached, in small clusters, to the cloth dowel with a knot. During this last portion the warp had to be pulled as tight and as possible as evenly as possible. Once the warp was tied to the dowel and the tension was right it was ready for weaving.[178]

When the weaver pressed the pedals of the loom a string attached to the pedal would lower a specific heddle. A heddle was a device made of two strips of wood with strings almost like the teeth of a comb stretched between them. Each string was actually a

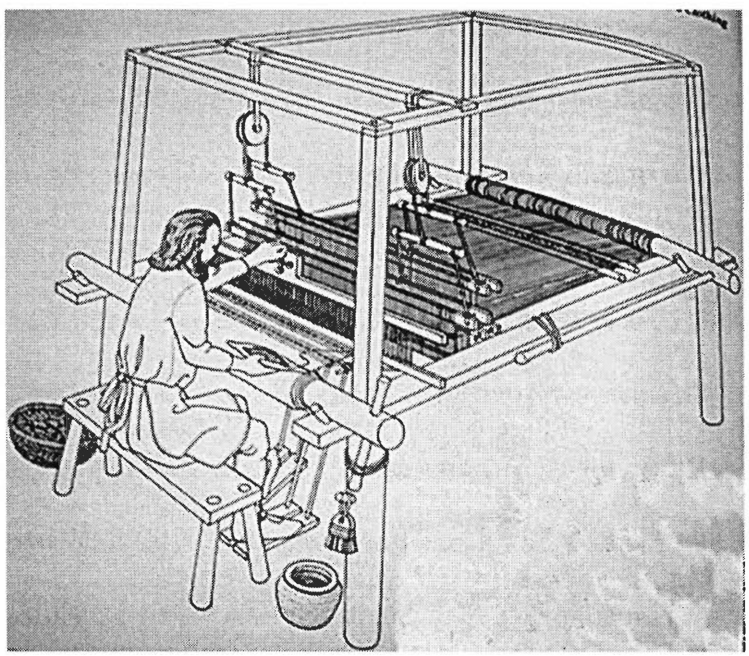

Figure 40 Man weaving at counter-balance treadle loom. This loom has four shedding mechanisms. (From Crowfoot, 2001)

[177] Ibid.
[178] Ibid.

string loop with one section tied off to create an eye. Certain warp threads were chosen to pass through these eyes depending on the desired pattern. When the pedal pulled the heddle down, the warp threads that passed through the eyes of the heddle would be pulled down as well. This heddle would also be attached to another heddle by means of a pulley. Different threads were passed through the eyes of this second heddle. When the first heddle was pulled down the pulley caused the other heddle to go up, raising the warp threads in the eyes of that heddle. This opened a horizontal space in the warp threads called a shed. When this pedal was released and another pedal pressed it lifted either the other heddle or another heddle entirely, moving another group of threads and opening a space known as the counter-shed.[179]

The shuttle would be passed through the shed or countershed from hand to hand trailing the weft thread behind it. Then, the cloth would be beaten down using a tool called a reed. The reed was attached to a frame above the loom, near the pulley system, with a hinge. It was a wooden frame, much like the heddle, fitted with teeth made from reeds. The threads passed through the reed during warping. In order to beat the cloth down the operator of the loom would merely pull back on the reed, swinging it toward them and pressing the weft threads into place with the teeth. [180]

Woven cloth would be wound on a cloth beam as it was produced. The warp wound out from a beam at the other end of the loom. Different patterns of weave could be produced by variations in the shed and countershed. Also, more shedding mechanisms could be added to the machine, giving many variations of the shed on one loom. A loom

[179] Lynette Hart. From an interview. 5 Dec 01
[180] Ibid.

with two shedding mechanisms produced a plain or tabby woven cloth. Looms with four shedding mechanisms produced diamond, twill and herringbone patterns.[181]

The counter-balance treadle loom could be very large -- so large, in fact, that two people would be needed to weave on it. They would each stand on one side of the loom and throw the shuttle to each other through the shed. Another type was the draw loom. It was very complicated, being designed to raise individual warp threads to provide more complex designs using an intricate pulley system. One person would sit at the loom and weave as normal, while a small child would sit in a frame above the loom and pull individual pulley strings, raising individual warp threads in turn. There were also damask looms, velvet looms and the low-warp tapestry loom. [182]

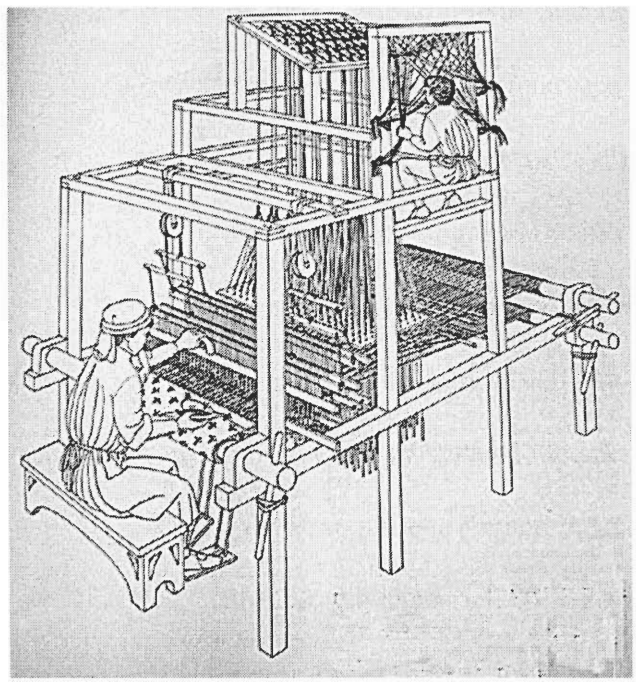

Figure 41 Draw loom. Used to make more complicted designs. (From Crowfoot, 2001)

Small Looms

Smaller looms were also produced to provide braid-work and small sections of cloth. These were usually fairly simple and often improvised. The required parts were the shedder, beater and a pole or two. [183]

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[181] Singer. 1956 p212-213
[182] Crowfoot. p23-24

The shedder worked in much the same way as the heddle and pulley system of larger looms. Shedders were small, square tablets usually made of horn, wood or hide. They had holes at their corners through which the warp was threaded. Adjusting the position of these pieces caused a shed or counter-shed to open. The beater was a small piece of bone or wood and even, sometimes, a needle used to push the weft threads more firmly into place.[184]

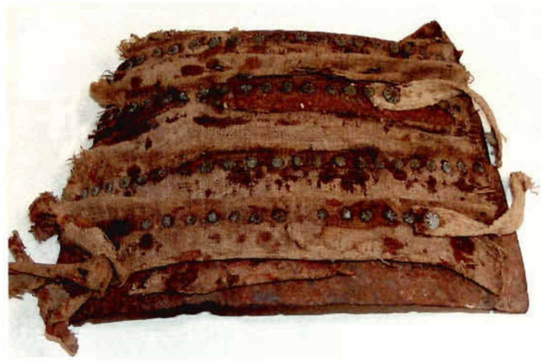

Figure 42 Fabric covering a section of brigandine. (From Higgins Armory Collection, 809.2)

The makeup of the frame of this simple loom is most interesting. Sometimes the threads of the warp would be fixed to a beam or rod or other point and then tied around the weaver's waist. Another style using two poles was popular during the 14th century. A warp spreader was often used to maintain evenness.[185]

Tabby woven braids were produced using heddle frame looms. These looms were quite small - small enough for one to sit and hold it on their lap. These looms used the heddle alone instead of with a shedding device. Usually the loom itself was of the tension warp or box frame variety.[186]

[183] Ibid. p24
[184] Ibid. p24
[185] Ibid. p24
[186] Ibid. p25

Finishing

Finishing includes the processes of treating the cloth after it was woven. Although each type of cloth had a different finishing process, they all began the same way. After the weaving was finished the cloth would be laid out and workers would use tweezers to remove bits of extraneous material or any knots or weaving errors from the cloth.[187]

Wool and cotton

From there wool and cotton would be fulled or scoured. Fulling is a trampling process used to thicken the cloth and close gaps in the weave. It was performed using one of several alkaline detergents made from plant ashes and stale urine or fuller's earth or the juice of certain plants. Fuller's earth was a type of fine hydrated aluminum silicate. The cloth would be trampled underfoot in a vat of one of the substances named above, being periodically removed and rearranged for evenness. After a sufficient time being trampled it was removed and washed in a vat or a stream, then beaten with sticks. [188]

Scouring is a similar process to fulling that achieved the same results but was used for lighter fabrics. The cloth would be washed for two hours in hot water and worked with soap or a mixture of urine and lye water until it foamed. It was then rinsed in cold water and wrung out before being placed in a pit of fullers earth and boiling water for half an hour. It would then be rinsed again and hung to dry. [189]

[187] Singer. 1956. p214
[188] Ibid. p215
[189] Ibid. p214-215

Figure 43 Monks finishing wool. In the right foreground imperfections are removed with tweezers, in the background the cloth is being tented. (From Singer, 1956)

Then it was stretched to dry on a frame or a tenter. The tenter was made of two horizontal rails on vertical posts. The cloth would be stretched across this frame. Next it would be brushed and cropped. Brushing was performed to raise the fibre-ends and give the cloth a soft finish. This was performed using teasels made of thistles or the skin of a hedgehog set in a wooden frame with a handle.[190]

After each raising the cloth would be cropped. This was accomplished using

Figure 44 Raising cloth. (From Singer, 1956)

Figure 45Cropping cloth. (From Singer, 1956)

large, flat metal shears. The cloth would be stretched on a bench and attached to small metal hooks to hold it in place. The shearer would put his left wrist through the grip and hold the sides of the blades. The blades would be opened and closed with the fingers of

[190] Ibid. p216-217

the left hand as the shears were moved over the cloth being held directly on top of it. After each section was finished it would be unhooked and a new section would be prepared. [191]

Cotton and wool were bleached in the fumes of burning sulphur. A hemispherical cage was used. The cloth would be stretched over the cage and the sulphur burned inside. When it was removed from the cage it would be laid on grass in the sun. The dew would keep the cloth moist during the drying process. When it was finished it would be rubbed with fine fuller's earth to increase its whiteness.[192]

Linen Finishing

Linen cloth had a different finishing process. After the debris had been picked out of the fabric it would be beaten with clubs to improve the surface texture before it was fulled. The next step for any cloth would be bleaching. Linen was bleached differently from wool and cotton. It would be boiled in lye made from ashes then spread out on drying fields. The drying fields were open areas with pegs in the ground. The linen would be attached to the pegs and left in the sun. Thin linens stayed out for eight weeks, thicker linens for up to 16 weeks. The cloth would be regularly sprinkled with water depending on the weather. After it was finished drying it would be scoured with running water. [193]

Pressing

After bleaching the cloth would be pressed to provide a smooth finish. This was accomplished using a screw press, which consisted of two horizontal plates. The top plate

[191] Ibid. p217
[192] Ibid. p218

could be screwed down to apply even pressure. The cloth would be folded, sprinkled with water and placed on the bottom plate. The screws would be turned, pressing the two plates together. Linen wasn't pressed. The surface of the linen was smoothed by rubbing it with rods or smooth stones.[194]

Figure 46 Dyeing cloth. (From Singer, 1956)

Dyeing

Dyeing was a process that could be performed before or after weaving. For intricate designs and patterns the individual hanks of thread would be dyed before being wound. For most cloths, though, the dyeing took place after the finishing and bleaching and was a process designed to make the cloth all one even shade.

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[193] Ibid. p217-218
[194] Ibid. p218-219

The actual methods of dyeing cloth are not entirely clear since most of the methods were treated as trade secrets. Most of what we know about dyeing cloths has been taken from pictures and woodcuts. We do have some recipes, though, for the dyes themselves. [195]

Figure 47 Another illustration of cloth being dyed. (From Singer, 1956)

Most dyes were not colorfast unless another chemical agent called a mordant was also used. Common mordants were usually ammonium alum, potash alum or a mixture of those chemicals. Dyeing was performed with heat. The dyes were boiled in large vats and the cloth was placed in the vat and stirred for a long time. [196]

Common dyestuffs were woad, which produced a dark blue, weld, which made yellow, verdigris, for green shades, and brasil or madder for red. Lye, alum glass and black soap were used as facilitators in the dyeing process. [197] Some recipes for dyes have been found in a primary source dated at around 1450-75. This source describes the processes for making a variety of colors. For green, woad, lye, weld, verdigris and black soap were boiled with the cloth. Yellow linen was made with weld and lye. Red linen was made using alum glass and brasil with water. Madder was also used for red cloths. Blacks used iron sulfide or an extract of galls or by dying a cloth with a variety of dark colors. Blues came from indigotin, the active ingredient in woad, obtained from fermentation or

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[195] Ibid. p364
[196] Ibid. p365-366
[197] Ibid. p364-369

bacterial reduction. Purple was produced using an excretion of mollusks boiled and mixed with liquor. Of course another method was dying a cloth first red, then blue. [198]

Leather Working

Leather working is the process of preparing the hide of an animal for use. There were two types of preparation used in the Middle Ages- tanning and tawing. Tanning refers to the process of preparing the skins with vegetable tannin. Vegetable tanning used various plant matters such as bark and leaves and produces a leather which is stiffer and better for carving and tooling.[199]

Tawing refers to using an alum-based mixture. Tawing produces leather which is, at first, quite stiff, but could be worked over a blunt edge to produce a softer, more supple type of leather which is snow white and suitable for clothing and indoor use.[200] Tawed leather could not be tooled or carved, though, because of its softness.[201]

Leather could also be oil tanned, or 'chamoised'. This uses the oxidation of oils applied to the leather. Brain or buck tanning are forms of oil chamoising, using the oils from other parts of the animal to cure the skin. Chamoised leather is flexible and absorbent.[202]

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198 Porkington. 1855
199 http://www.personal.utulsa.edu/~marc-carlson/leather/pl.html#pl1. 1996.
200 Singer. 1956. P 154-155
201 http://www.personal.utulsa.edu/~marc-carlson/leather/pl.html#pl1. 1996.
202 Ibid.

Leather production, in general, preserved the innermost layer of the animal hide. All of the processes produced a final product with variations on one theme of desired traits. Desired traits in leather are strength, flexibility and water resistance. [203]

Jewelry Making

The majority of jewelry made in the fifteenth century was made from gold and silver and made by Goldsmiths. Despite their name, the goldsmiths worked both with gold and silver and most of their material was recycled from old plate or coin.[204] Often it was the customers which accumulated their own supply of gems for the goldsmith to work with.[205]

Gem Polishing

Gems were commonly not cut, just simply polished.[206] The gem was temporarily fixed to a long piece of wood and rubbed on a stationary piece of hard sandstone.[207]

Gem Cutting and Shaping

The shaping of gems was done by mounting a gem on a slab to hold it in place against the edge of a cutting wheel, which was mounted on the spindle of a lathe drill. During this period gem cuts were a rarity.[208]

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203 Singer. 1956. p 153-155
204 Campbell. 1991. p107-8
205 Campbell. 1991. p117
206 Campbell. 1991. p135.
207 Theophilus. 1979. p189
208 Campbell. 1991. p136

Specifically for the diamond, there were three main varieties of cuts: the hog-back (oblong with gable-shaped facets), the rosette (angular hog-backs fitted together in a rosette shape), and the lozenge cut (a diaper of diamond-shaped facets).[209]

Gem Setting[210]

Gems appeared mostly decorating items owned by the wealthy such as brooches, chalices, and clothing. Most gems were set in the same way with the exception of the pearl.

Pearls were usually pierced and sewn onto clothing or mounted on work done by a goldsmith. If it was mounted, it was held in place be means of a short metal "tang" (superfluous metal piece) usually as part of a cluster.

Other gems, such as rubies and sapphires, had three main settings: the collar setting, the four-pronged claw setting, and the petal-shaped setting.

Horn Processing

Horn is often referred to as "the plastic of the Middle Ages". This is because horn is very soft and malleable after heating, and can actually be softened and molded like most plastics. Also this refers to the commonality of horn use. Horn was used in everything from combs to windowpanes due to the fact that it was fairly durable and cheap. [211]

[209] Campbell. 1991. p137
[210] Campbell. 1991. p139-140
[211] Carlson. http://www.personal.utulsa.edu/~marc-carlson/horn/horn2.html. 2001.

Before the horn could be processed and used the inner core had to be cleared out. This was often performed by scooping the insides out with a split wooden stick. Wood was used because metal could damage the inside of the horn, rendering the innermost layers useless. Before scooping the insides the horns could also be soaked. This made removal of the core easier, and was a favorite method for some horners of the period due to the ability to soak large batches of horn at one time. Another option was allowing the horn to sit in a dry place. Over time the core would harden and shrink, separating from the horn on its own. [212]

After removing the core, the membranes inside the horn must also be cleared out, since they would rot over time and damage the horn. One way horners did this was using various levels of gravel. First, large rocks would be placed in the horn and the horn would be shaken vigorously. This would be repeated with finer and finer pebbles until the horn was being shaken with sand inside. [213]

While the finer details of horn-working may be less clear, it is generally agreed that the cleaned horn was worked largely by heating. Either wet or dry heat could be applied. Typically, a horn would be boiled for many hours or heated over a fire in order to soften it, after which it would be cut and flattened between plates of wood or metal. Some sources mention coating the plates with tallow or grease. Other sources recommend boiling the horn in water with wood ash in it. This would create a solution of lye which softened the horn more than boiling in plain water or heating over a fire. After initial

[212] Ibid.
[213] Ibid.

flattening the plates of horn could be reheated in order to further mold it or to separate it into thinner layers. [214]

Horn could also be worked cold. Cold working of horn includes carving and cutting.[215] A piece of horn work could use both methods- heating to mold it into the desired shape, then carving and cutting to achieve a desired shape or design.

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[214] Ibid.
[215] Ibid.

Glass Production

There is little known about the process of glass making before the 13th century. However, by the 13th century glass production was widespread in Europe. This is indicated in the writings of Theophilus in the 12th century. Medieval glass painters got their supply of glass merchants who got the glass directly from a glass-house. In the south, production of glass flourished in places that were established in Roman times. Venice was one such location. In the North, the glass-houses were usually located in the woods where fuel for the kiln was readily available. Also available were the raw materials for the glass itself, sand (silica) and beech wood (potash). The beech wood reduced the sand's melting point to make it easier to work with.[216] The beech wood was burned and its ashes were added to sand in a ratio of 2:3. Also added to the mixture were water and cleaned earth and stone. The materials were put into the top portion of the kiln and stirred with a long handled iron ladle.[217] By constantly mixing and raking the ingredients, waste gasses could escape.[218] When the mixture was hot enough it was stirred constantly with the ladle to prevent it from melting.

Glass Blowing

Containers

Using a hollow iron pipe, molten glass could be picked up and rolled to shape and cooled slightly. While the glass was still warm, the glassblower would blow into the pipe

[216] Brown. 1991. p42
[217] Theophilus. 1979. p67
[218] http://www.regia.org/glass.htm

to form a bubble in the glass and then reheat it. This process was repeated until the glass took on a shape that was desirable.[219]

Window glass

During the Middle Ages, window glass could be form by either of two processes. The first is the "crown glass" method. This involved the blowing of the glass into a cylindrical shape that was opened at the bottom. The open end was heated at the mouth of the furnace. The blowing iron was rotated quickly until the bottle flared out to form a flat disc by the power of centrifugal force. Glass at the center (the "crown") of the newly formed disc was very thick and only used in windows where light could be admitted but transparence was not needed. The second process involved the creation of the glass cylinder as well. However, the glass was cut down the side and the glass was flattened while it was still in a soft state.[220]

Painted Glass

Glass painters were usually paid by wealthy patrons for their work and the designs of the painted glass were subject to the specifications of the benefactor. The glass painters used life-size designs made on tables for their work. Basic measurements and cut lines for the glass were made directly on the table because paper was expensive. The glass was laid over the table and designs were cut into the appropriate shapes. This was done by cracking the glass with a hot iron and its edges were trimmed with a grozing iron. The iron had a hook on each end and left a "nibbled" edge on the glass. Once the

[219] http://www.glassplusinc.com/history_of_glass.htm

glass was cut the process of paint could begin. Very few colors were available until the introduction of yellow enamel in the 14th century and certain carnation and sanguine colors that were introduced in the 15th century. The paint was applied to the inner surface of the glass with brushes, made from animal hair or fur, as well as needles, sticks or the ends of the brushes. Painting on the backside of the glass was common for shading or special effects. Once the window was properly painted the glass was heated in a kiln. This was done so the paint would last. [221]

Clay Production

Clay was used mainly for containers such as pitchers and vases in the early Middle Ages. By the fifteenth century, clay was still used to make containers but it was also used to make roofing tiles and bricks in a more widespread area. Clay was generally molded into the desired shape and fired in a kiln. Kilns varied widely in their appearance but accomplished the same thing. In Northern Europe, kilns were very small, round or oval in shape, and either horizontal or vertical. In the south, such as Italy, kilns were more rectangular and made from bricks. Peasants generally at this time still used open hearths to fire their pottery.[222]

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[220] McNeil.
[221] Theophilus. 1979. p70
[222] Singer. 1956. p295

Thrown Pottery

Figure 48 A kick wheel. (From Singer, 1956)

Clay used for thrown pottery was washed and formed either in a lump or in long strips or spirals. The ball of clay was put on a potter's wheel, centered, and thrown to the desired shape. Generally two types of wheels were used. The first was the kick wheel, which was moved by the feet so that both hands could be used to mould the piece. The second type of wheel was turned by a handle. This was more inefficient because the potter had to use one hand to turn the wheel with the stick and use the other hand to mould the piece. After the clay was thrown, it was taken off the wheel with a knife or string and left to dry until it was leather-hard. After the piece was dried slightly, it was replaced on the wheel, re-centered and turned.[223]

Figure 49 A potter's wheel with a handle. (From Singer, 1956)

Additions to Pottery

<u>Lips</u>

A spout found on a pitcher that was formed by pinching the rim of the container.[224]

[223] Ibid. p262-3
[224] Ibid. p290

Handles

The handles were made by hand and attached to the piece when it was in its leather-hard stage before firing. The handles were made of strips or rods of clay and fixed on by wetting the junction point with slurry and working the handle and body together by using their fingers while the clay was still soft. The handle junctions could also be strengthened by jabbing a pointed stick through the clay.[225]

Legs

Legs were added to the base of a container by pinching and molding a thick rim of clay left on the base-angle.[226]

Molded Clay

Molded clay was prepared by weathering it through the winter, and occasionally turning it. The clay was then kneaded, often with bare feet, and shaped by pushing it into a wooden frame. The clay was dried for one month and fired in a rectangular kiln.[227]

Glazing

Glaze was added to pottery when it was at its leather hard stage of drying. The glaze was made from a lead compound mixed with gum. Colors were achieved by adding different types of powered metals to the glaze. For example, adding copper to the

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[225] Ibid. p291
[226] Ibid. p291
[227] Ibid. p304

glaze produced a blue-green color.[228] The glaze was applied to the vessel on both the inside and outside with a brush and fired. However, cooking pots were rarely glazed.[229]

Armor

By the beginning of the 15th century, plate armor was the most popular form of armor worn by the knight, although other forms of armor were worn. Suits of armor were made most commonly in Italy and Germany out of iron or steel, although the two countries' styles differed slightly. By the end of the 15th century, however, the innovations in missile technology such as the English longbow (which could punch an arrow through plate armor) and handguns began the decline of such armor (except as for fashion) as the knight encountered more weapons designed to pierce or crush plate armor. Some examples of such weapons would be the Swiss halberds and the French glaives, as well as longbows and handguns.[230]

Types of Armor

Plate

The most popular form of armor used by those who could afford it was plate. This type of armor consisted of steel plates covering as much of the body as possible. This form of armor was sometimes combined with mail or brigandine. The individual

[228] Ibid. p300
[229] Blair. p201

pieces of plate were either attached to each other, or attached to an arming doublet with points (laces).

Figure 50 Effigy of Dietrich Von Berlichingen. There are many effigies in European churches and cathedrals depicting knights in full plate armor. (From Mann, 1935)

Mail

Form of armor consisting of many steel rings linked together. The rings were either riveted or welded shut for the most part. In this period, a shirt of mail could be worn under plate or attached to plate by rivets. Sections of mail could also be sewn to the arming doublet in lieu of wearing an entire shirt.

Brigandine

Form of armor consisting of steel plates riveted in between two layers of cloth. The rivets either formed decorative patterns, were arranged horizontally in lines, or formed groups of three (most popular).[231]

Leather

Boiled leather, or thick leather was formed into tunics or helmets to provide a bit of extra protection for common soldiers. Leather helmets were sometimes reinforced with steel ribs.[232]

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[230] Edge. 1988. p96 – 97.
[231] Ibid. p115 - 120

Cloth-based Armor

Used by retainers and commoners in the infantry. This form of armor usually consisted of layers of linen stuffed with tow or other soft material.[233] It was believed the softer the material the armor was stuffed with, the better it could stop weapons.

The German Style of Plate

There are several differences between the evolution of German "gothic" plate and the Italian plate. In Germany, the basinet and kettle hat (see glossary for definitions) remained popular pieces of armor to protect the head. Nuremberg, Augsburg, Landshut, and Innsbruck became the major armor-making cities in Germany during the medieval period but especially during the 15th century. Prior to 1420, the armor tended to be covered in cloth or clothing, but around 1420 it became popular to allow the "white" (steel) harness to show, although knights still wore heraldic garments.

Figure 51 A German armorer and his apprentice at work. Note the pieces of armor hanging in the right corner. (From Mann, 1935)

Around 1420, the famous "Kastenbrust" cuirass became popular. It was a boxy breastplate which sloped down to the waist sharply. It was decorated with flutes in the typical "gothic" style.[234] These flutes were not purely decorative, however. They could occasionally turn aside the point of a weapon.[235] The back plate to the Kastenbrust was attached with straps and a waist belt. The breastplate was attached to

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[232] Ibid. p128 – 129.
[233] Ibid. p128 – 129.
[234] Ibid. p988, 101.

the arming doublet with points, and a hauberk of mail was sometimes worn underneath for extra protection.[236] Laminated plate spaudlers covered the upper shoulders and arms. The spaudlers were domed plates for the shoulders with lames down the arm. Gutter-shaped upper and lower cannons were attached to each other with straps and laced to the arming doublet. Until 1430, gauntlets consisted of a simple hourglass-shape that was in use from the 14th century. However, the mitten gauntlet gradually became popular. Expensive armors had fully articulated finger pieces, and vambraces were enlarged to cover the forearm as well as the hand. The mitten gauntlet did not have separate fingers, but was sometimes articulated around the fingers through the use of laminations. During the beginning of the century, cuisses had articulated plates at the side and top of the thigh and were articulated to the poleyn by a single lame. The poleyn had small fan-shaped wings and was strapped over the greaves. Fluting was applied to the cuisses but not the greaves. The armor was completed with sabatons of articulated lames ending in a pointed toe cap.

[235] Houston. 1996. p200.
[236] Mann. 1935. p78.

In 1450, a new style of breastplate appeared that was made in two sections. The upper section covered the ribcage area, while the lower section overlapped the upper section and protected the abdomen and waist. The two sections were attached via a system of sliding rivets or straps.[237] The spaudlers were now riveted to the upper canon, and pauldrons were developed. The main plate became enlarged and now wrapped around the front and back of the breastplate. The long-tailed sallet with a bevor became the characteristic helm of Germany during the last half of the century.[238]

Figure 52 The armour of Archduke Sigismund of Tyrol. Note the fluting on the armor that typifies the German Gothic style. The armor also is equipped with a sallet and detachable sabbatons, which were in fashion during the 15th century. (From Edge, 1988)

From 1460 on, the trend in Germany was to produce graceful lines with a lot of fluting and decoration. The waist was accentuated, the fauld barely covered the hips, and was often accompanied by spade-shaped tassets. The back plate consisted of an upper and lower plate with three accompanying lames. By 1470, the pauldrons had enlarged to form wing-like projections down the back. Gard-braces, which were external plates attached to the front of the pauldron, appeared. Expensive armors had enclosed canons and an enlarged couter by this time. The cuisses began extending upward towards the waist by

[237] Edge. 1988. p100.
[238] Mann. 1935. p80.

increasing the number of laminations. By 1480, the cuisses extended fully to the hip, eliminating the need for tassets. The sabatons had become so long they had to have a toe that could be removed for fighting on foot.[239]

The Italian Style of Plate

During the 15th century, Milan was the most famous center for armor-making. Besides producing exclusively Italian-styled armor for export, armorers sometimes made variations or mixed German and Italian styles in a suit. The Italian style of armor was more popular than the German because the lines were plainer and more rounded. Another difference was that the left side of the armor tended to be better defended than the right side and the vambraces defended the arms better than those of German make. A hauberk of mail was often worn underneath the plate to cover the gaps in the armor. The basinet was rarely seen after 1420, and the kettle hat was virtually non-existent. Instead, the sallet, barbuta, and armet were the helms of choice in Italian armor. From the turn of the century to 1420, the "white" armor was still being developed. The harness consisted of a globular breastplate reaching to the waist overlapped by a fauld with three lames. The back piece was made of upper and lower plates and attached to a culet.

In 1425, the lames of the fauld were cut into an arch, and around 1430 were divided to form rudimentary tassets. By 1420, the cuisse tip became concave and the upper edge was turned in. The cuisses still retained their hinged side pieces as well. The cuirass was hinged on the left side and fastened by straps on the right. Until 1420, the shoulders were covered solely by mail. Then laminated pauldrons became popular in

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[239] Edge. 1988. p100 – 105.

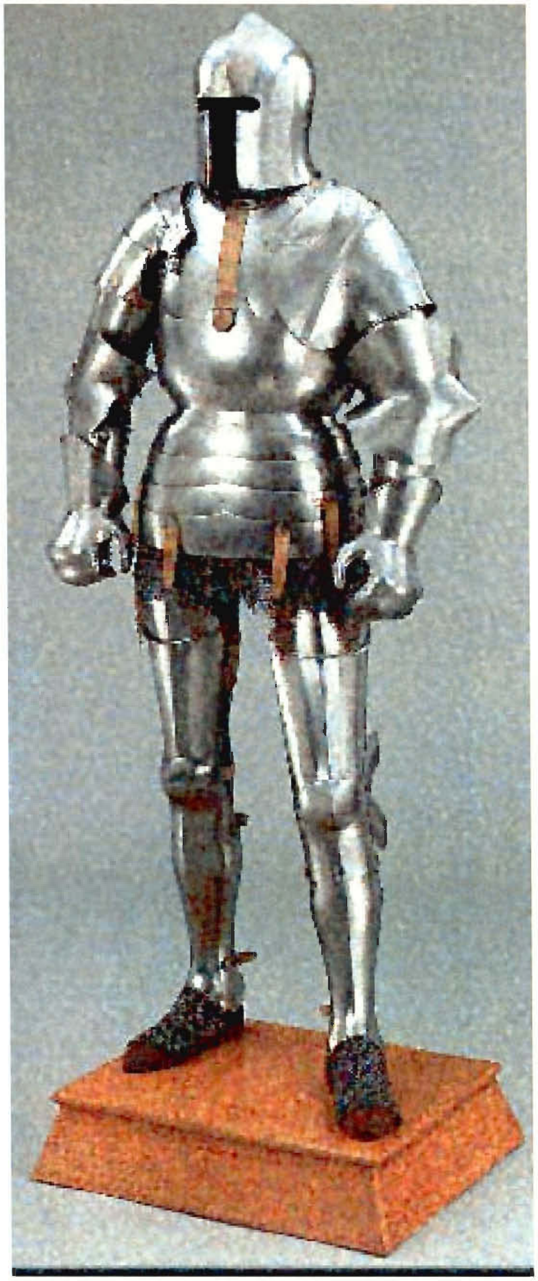

Figure 53 An armour belinging to a member of the Von Match Family. This set is equipped with an Italian-style barbuta, and mail covering the feet. (From Edge, 1988)

Italian armor. Gard-braces were attached to the pauldrons. They were at first circles, but then began to follow the contours of the pauldrons and were attached by means of staples or pins. The upper edge of the pauldrons were flanged to protect the wearer's neck. The armor was completed by mail-covered shoes.

By 1430, the upper cannon almost encircled the arm. The right couter had a side wing that was enlarged to protect the tendons at the elbow joint. The lower canons were hinged and strapped together. An additional top plate was inserted into the cuisse which had a strong convex top. The poleyn was articulated to the cuisse with a single lame, and had a fringe of mail attached to the bottom lame. The side wings were enlarged to protect the tendons of the knee.

After 1440, they became rounded and the edges spread out to overlap on the wearer's back. After 1450, the lame below the poleyn became pointed and mail was sometimes riveted below. Some suits of armor were never intended to be worn with greaves but instead the lower leg was encased in mail.[240]

Brigandine

Brigandine is a style of armor that became very popular in Spain, especially in the armor-making cities of Burgos and Seville. By the mid 15th century, brigandine was extremely popular with all classes of soldier. This is because it is lighter and more flexible than plate, as well as being less expensive, and was the common form of armor for the poorer knight. The typical coat of brigandine reached to the hips, and the sleeves were separate pieces attached by points. The coats sometimes included L-shaped plates to protect the lungs, and was closed down the front using straps or laces. The outer layer of cloth was usually a decorative material, such as silk, satin, or velvet, while the inner material was usually cheaper cloth.[241]

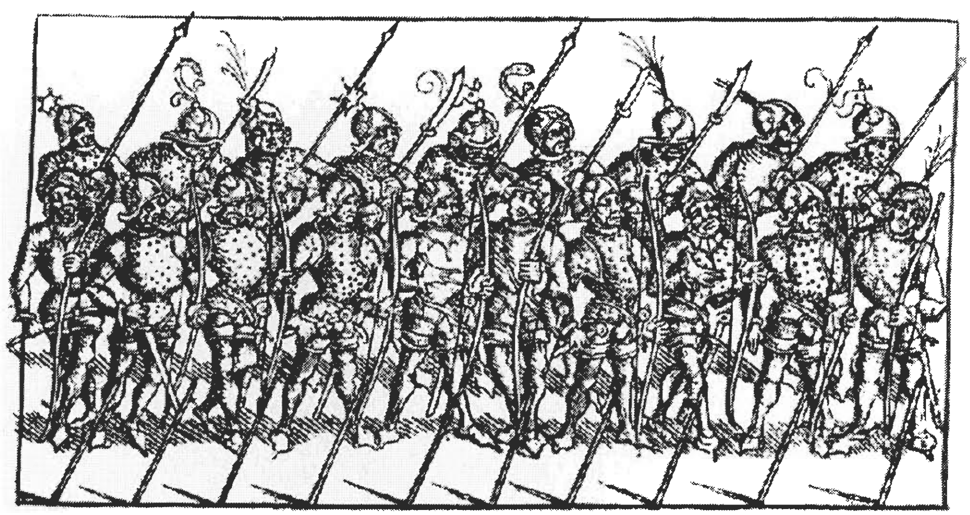

Figure 54 Burgundian Infantrymen. Note the brigandine, which is shown by the grouping of studs in the chest area. Brigandine was a cheaper form of armor than full plate and popular with the more common class of professional soldiers. The front row carries longbows, and the back row weilds pikes. This was a common mixture of troops used in what is known as a pike square. (From Edge, 1988)

[240] Ibid. p105 – 109.

Other Forms of Armor

During the 15th century, there was no time when every country in Europe was at peace. This meant that commoners were often drafted to serve in the infantry for their lords. The most common form of armor during the first half of the 15th century was the aketon (aka jaquette), which was a long sleeved jacket with deep skirts that was made out of layers of linen stuffed with tow or other soft material. This was often accompanied with open-faced basinets and later sallets.[242] During the second half of the 15th century, the skirts of the aketon were shortened to just below the hip. The common infantryman didn't usually wear leg armor, but sometimes had gussets of mail strapped to hose. During the end of the century, professional soldiers began to be issued "standard" equipment by their employers. This was aided by the tendency during the last part of the 15th century to mass-produce breastplates (in the German fashion) for infantry and retainers. These breastplates were designed to be worn without a back plate and were strapped over the aketon or brigandine.

Shields

During the 15th century, shields were mostly obsolete for use by the mounted knights except in the joust. Infantrymen sometimes carried small shields called bucklers, and archers used large rectangular-shaped shields called pavises, which could be propped up to provide cover.[243]

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[241] Ibid. p115 – 121.
[242] Ibid. p129.

Horse Armor

Horses also had plate armor. It covered the head (with ear-guards, eye-shields, and nose defense). The neck was covered with laminated plates while the hindquarters and forelegs were shielded with welded plates. The saddles had ridges jutting up in front and behind to steady the knight while riding.

Decoration Techniques for Armor and Weapons:[244]

Blueing

The surface of the steel was heated until it glowed, then quenched quickly. This produced a blue tinge to the steel. The hotter the steel got before it was quenched, the deeper the blue tinge.

Etching

Acid is applied to the armor in a design and allowed to eat away at the surface of the metal. It is then neutralized by a base and washed in water.

Gilding

There were two ways to gild something. The first way was to roughen the surface with a file and burnish thin sheets of gold onto it. The second way was similar to goldschmelz (see below) except that there was a larger proportion of mercury in the amalgam.

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[243] Ibid. p121 – 122.
[244] Blair. 1962. p45.

Goldschmelz

This technique was first used in Germany during the late 15th century. First, the steel was etched and the background coppered. Then the etching was filled with an amalgam of gold and mercury. The work was heated until the mercury evaporated, leaving a thin crust of gold. The work was then polished until the surface of the gold was even with the surface of the steel, and blued.

Inlaid Metal

First the surface was carved, then softer metal (such as silver or gold) was hammered into the grooves. Finally, the excess metal was scraped away. This technique was very rare because of its expense.

Inlaying

Other materials (i.e. bone, horn, soft metals) were hammered into grooves in the steel carved to fit it.

Pointelle

Designs made of a series of dots were picked out on the surface.[245]

Silvering

Silver was applied the same way gold was gilded on.

Glossary of Armor Terms:[246]

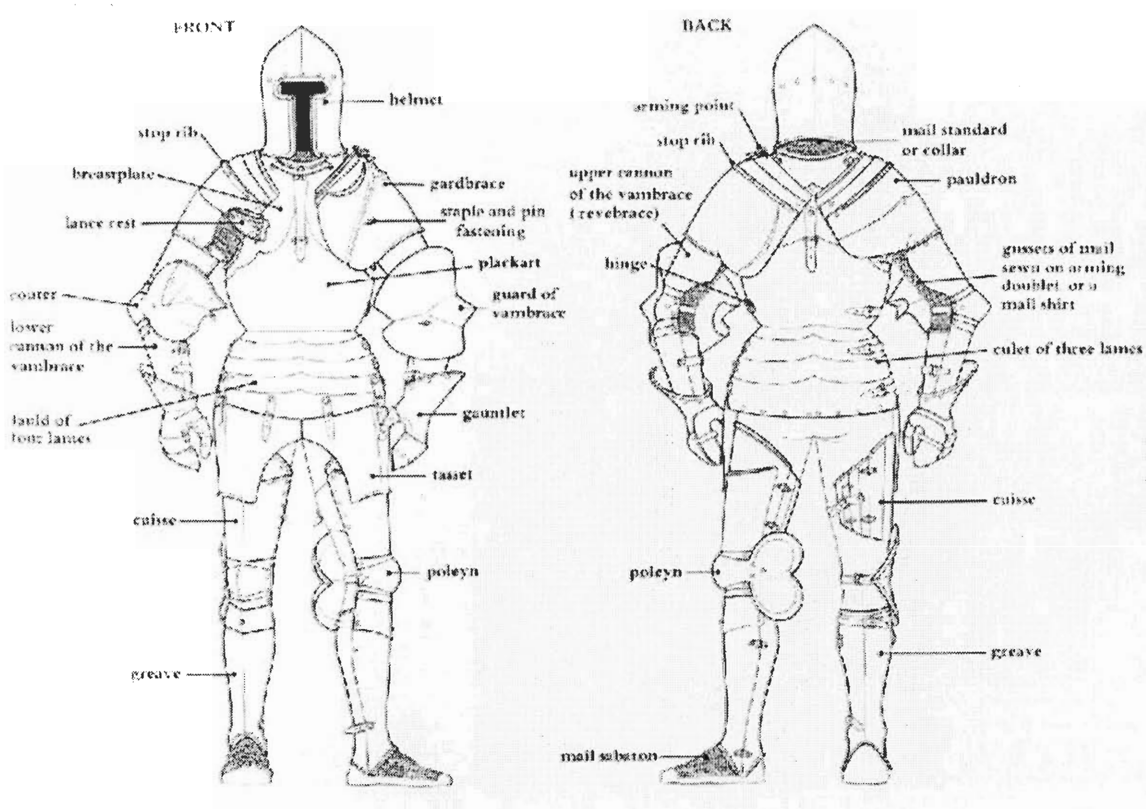

Figure 55 Diagram of a suit of armor based on the Von Match armor seen earlier. (From Edge, 1988)

<u>Aketon</u>

A padded and quilted jacket usually made of linen that was worn under or instead of plate or mail.

<u>Armet</u>

15th century Italian helmet. It consisted of a skull (or dome-shaped plate covering the top of the head), two side pieces covering the cheek and riveted to the skull, and a visor.

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[245] Edge. 1988. p183 – 189.
[246] Ibid. p183 – 189. Definitions are modified from the glossary given in this book. Additions to the definitions are footnoted.

Arming Doublet

A quilted cloth garment that was worn underneath armor. No examples have been preserved, but it is assumed to be made out of quilted linen padded with wool, tow, or other similar material. It was long-sleeved with a collar and reached to the hips. The armor was attached with waxed twine and leather ties, and sections of mail could be sewn to it to protect the places where the plate had gaps.[247]

Aventail

A section of mail attached to the bottom of a helmet and covering the shoulders.

Back Plate

Plate armor protecting the back from the neck to the waist. Worn with a breastplate.

Barbut (aka barbute, barbuta)

An open-faced helmet from Italy with a T-shaped opening for the face.

Basinet

An open-faced helmet that has a globular or conical skull and could sometimes be worn with an aventail. Rarely seen after 1420.[248]

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[247] Ibid. p115.
[248] Ibid. p105.

Bevor

Plate armor made to defend the neck and chin. It enclosed the neck and extended down to the upper portion of the chest and shoulders, as well as extending up to the wearer's nose. Usually worn with a sallet during this period.

Breastplate

Plate armor protecting the chest to the waist. See also cuirass.

Cannon

Plate armor for the upper and lower arm. It could be either gutter-shaped or enclosed.

Chausses

Mail protection for the legs. They could either be mail hose or strips of mail laced around the front of the leg. This style was more popular in Italian armor than German, and some suits of armor were made to be worn with chausses instead of plate greaves.[249]

Couter

Armor for the elbow. Sometimes had attached laminations above and below.

Cuirass

A back plate and breastplate designed to be worn together.

Cuisses

Plate armor for the thighs. Could have attached laminations on the tops and the sides. By 1480, the cuisses extended to the hip, eliminating the need for tassets.[250]

Fauld

Armor attached to the bottom of a breastplate to protect the abdomen.

Gard Brace

A reinforcing plate attached to the pauldron. At first it was a round plate, but during the second half of the 15th century gradually began to conform to the shape of the pauldron. It covered the lower part of the pauldron.

Gauntlet

Armor for the hand. It could either be shaped like a mitten, or a glove with laminations for each finger.

Greave

Armor for the shin. Originally gutter-shaped but later was made of two plates enclosing the lower leg.

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[249] Ibid. p105 – 109
[250] Ibid. p104.

Gusset

Section of mail sewn to the arming doublet to cover the parts which were not protected by plate armor.

Hauberk

A shirt made of mail, usually reaching somewhere between the waist and the knees.

Hunskull

Nickname for the German basinet with a pointed visor (from the German *Hundsgugel*, or dog head)

Kastenbrust

A certain type of breastplate that was popular in Germany between 1420 and 1450. It was equipped with a lance rest on the right, a hooped fauld made out of laminations, and was decorated with flutes. Considered the typical "gothic" breastplate.[251]

Kettle Hat

Open-faced helmet shaped like a bowl with a brim. Worn only by common infantry.[252]

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[251] Ibid. p101.
[252] Ibid. p105.

Lame (or lamination)

A narrow strip of plate used to provide articulation.

Pauldron

Laminated plate armor for the shoulder. Covered the front and rear of the shoulder, as well as the armpit.

Poleyn

Cup-shaped plate armor for the knee with a side wing to protect the tendons in the knee.

Sabaton

Plate armor for the foot consisting of a number of laminations. Shaped like the popular pointed-toe shoe of the 15th century.

Sallet

A rounded bowl-shaped helmet with a keel-shaped center ridge, slit for eyes or a visor, and a long pointed tail. The tail reached to the shoulder and the visor reached low enough to cover the nose.[253] Kin to the basinet. The head and jaw were often bandaged to cushion the weight.[254]

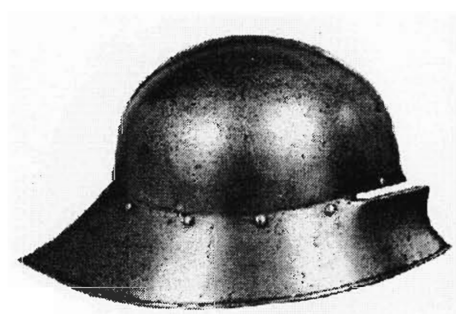

Figure 56 A German-style sallet. (From Edge, 1988)

[253] Ibid. p100
[254] Mann. 1935. p84.

Spaudler

Light laminated armor covering the shoulder and the top of the arm. Popular in Germany.

Tasset

Armor covering the top of the thigh. Hung by straps to cover the gap between the cuisses and the breastplate.

Vambrace

Armor for the lower arm.

Visor

Protection for the face that is attached to the helmet using hinges.

Weapons

During the 15th century, there were relatively few advances in melee weapons, but the handgun and cannon were slowly being improved. Long-hafted weapons, such as pikes, halberds, and bills became the standard infantry weapon during the latter half of the century, epitomized by the Swiss pike square. There are 5 broad categories of weapons of this period. Swords, daggers, hafted weapons (from maces to pikes), missile weapons, and artillery (aka siege weapons). Siege weapons will be discussed in another section along with fortification.

Swords

During the 15th century, the sword was the typical weapon for the mounted knight, and a typical sidearm for the infantry. The hand-and-a-half sword (aka the "bastard sword") was the most popular weapon for a knight because it could be gripped either with one hand or two, depending on the circumstances. Infantry were often equipped with shortened versions (referred to as short swords).

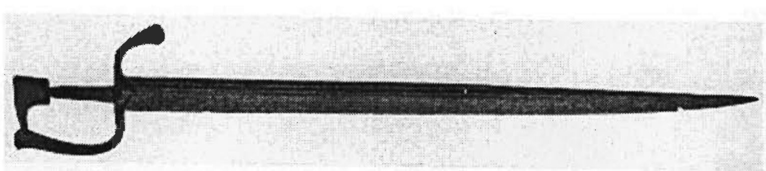

Figure 57 A short sword, the blade single-edged. (From Blair, 1962)

There was no one stereotypical style of sword construction. Any hilt design could be combined with any pommel, blade, and quillons. Most swords were straight and double-edged, had straight or slightly curved cross guards, and a pommel, although some short swords which were used by footmen had a single edge. Swords were sometimes lightened by being hollow-ground or ground to give a central ridge with a parallel sided blade.[255] Because swords were beginning to be used for thrusting as well as cutting, the point of the sword was tapered and made thinner. During the latter half of the century, a sword called the estoc, which was designed to only thrust, appeared.[256] Another form of sword, called the cinquedea, was fashionable in Italy with all classes of people.

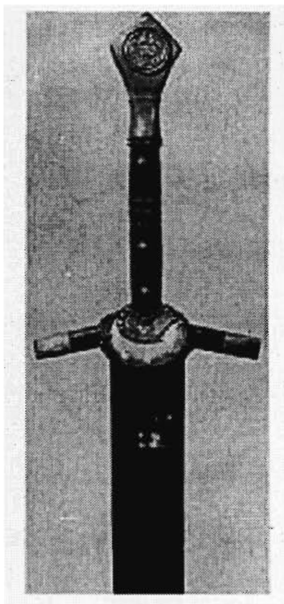

Figure 58 Hand-and-a-half sword hilt of Emperor Friedrich III (From Blair, 1962)

The hilt was usually made of wood wrapped in leather, cord, or wire. However, sometimes more costly materials were used. Certain hilts consisted of two metal plates riveted to the tang of the blade and could be wrapped or left plain. The blade was usually double-sided and curved to a point at the end. Some blades had "ricassos", which was an unsharpened length near the cross guards where the hand or index finger grasped when fighting in close-quarters. These areas began to be

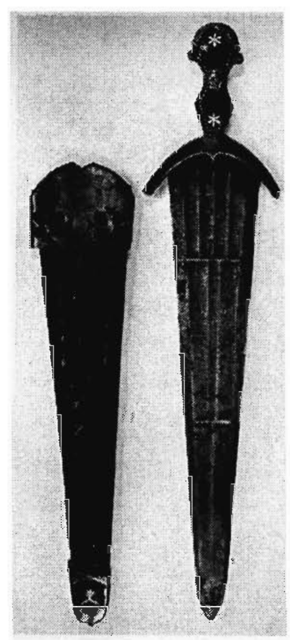

Figure 59 Cinquedea and scabbard. These short swords were popular in Italy. (From Blair, 1962)

255 Ibid. p124.
256 Blair. 1962. p1.

guarded with curved projections from the quillons during the fifteenth century to protect the wielder's fingers.

A pommel helped balance the sword and made it less unwieldy. It was most often made out of metal, although it could be made out of crystal or a precious stone as well. There were several varieties of pommel styles. The wheel-shape pommel consisted of a flat disc with chamfers around it. Variations on this style were polygonal or rectangular. The triangular shaped pommel had many variations. The sides of the triangle could be convex, creating a lozenge shape, which could be developed into a flat pear-shape. Another variation was a flat triangle with a truncated apex and convex sides. The conical pommel was a cone with a truncated apex. This style was especially popular during the last quarter of the century. Variations of this style were either fig or pear-shaped. Finally, the globular or ovoid pommels were seen, but were rather rare before the 16th century.[257]

The cross guard (aka quillons) protected the wielder's hand. It was either straight, or curved slightly to the point of the blade. Because the sword was developing into a thrusting weapon, it was common for the wielder to place a finger or two over the quillons to aid in balance and control. One variation curved one quillon toward the pommel to form a rudimentary knuckle guard while the other quillon curved down to the blade, forming an S-shape. Later, two loops were added looping from the quillons to the blade to guard the wielder's fingers. In Scandinavia, a variation twisted the ends of the quillons around until they crossed, then twisted them together.[258] Écussons, which were

[257] Ibid. p3.
[258] Ibid. p3.

triangular sections extending from the quillons down the center of the blade to strengthen it, also saw widespread adoption during the early 15th century.

It is difficult to be completely accurate in identifying a sword in the modern era. Important sword-making centers exported their wares in vast quantities, sometimes without the hilts. A number of other centers (for instance, Solingen in Germany) produced imitations of the best foreign masters, including makers mark, so it is difficult to tell a forgery from the actual thing.[259] The hilt might also be re-done, or not original.

Daggers and Sheath Knives

Almost everyone in the Middle Ages carried some form of dagger or sheath knife. The difference between the two is that a sheath knife was intended for eating but could be used as a weapon, and a dagger was primarily a weapon.[260] A knight's sword was balanced by a dagger of some sort. The most common forms of dagger were the anlace, ballock-knife, baselard, and rondel dagger. These daggers were also sometimes referred to as a "misericorde" or "mercy dagger", because these daggers were used to deliver the *coup-de-grace* to a knight *in extremis*.

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[259] Ibid. p1.
[260] Ibid. p13.

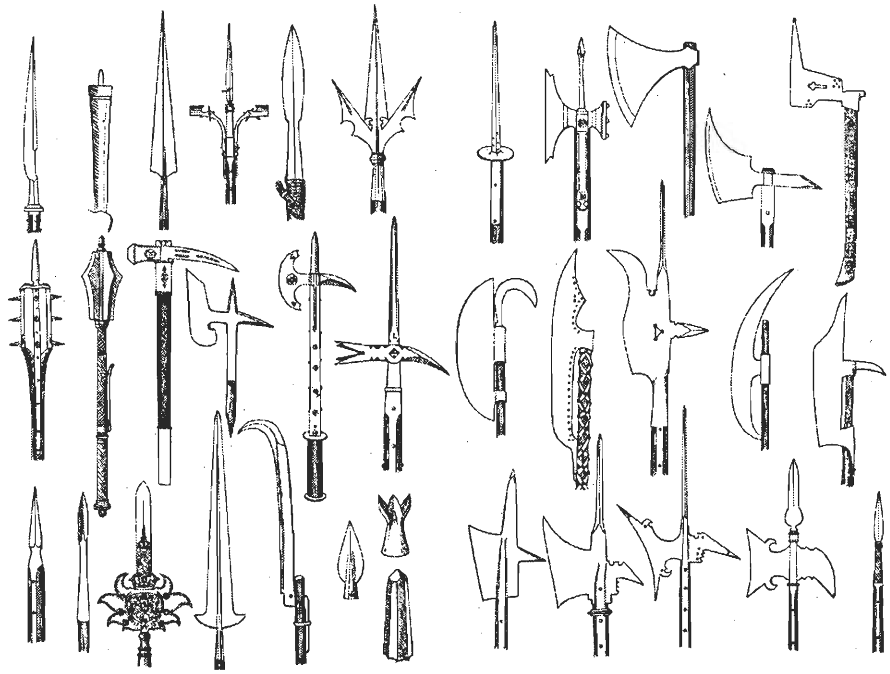

Figure 60 Collection of hafted weapon heads. Bold-faced labels are dated from the 15th century. Others are either pre- or post-period. Top Row from Left to Right: **"Voulge Francais" Glaive**; Plancon-a-picot; **Langdebeave**; Linstock; Boar-spear; Corseque; **Ahlspeiss**; **Polaxe**; Danish Axe; Moraxt; Miners' Axe. Center Row from Left to Right: Holywater Sprinkler; **Mace**; Horseman's Hammer; **Throwing Axe**; Horseman's Axe; Lucerne Hammer; Lochaber Axe; Bardiche; Bill; Guisarme; Halberd. Bottom Row from Left to Right: boarding pike; lance; parade partisan; partisan; **war-scythe**; **3 lance heads**; **"Sempach" Halberd**; Swiss Halberd; Italian Halberd; Halberd; **English pike**. (From Blair, 1962)

Hafted Weapons

During the 15th century, hafted weapons became more popular. There are a few different sub-types. The first is the weapon that is mounted on a short metal or wooden staff, such as the one-handed axe, maul, or mace. Maces were usually used as a sidearm in addition to swords, and delivered crushing rather than slashing blows. A relative of the mace is the flail, which was derived from the agricultural tool of the same name. The next sub-category is the long slashing or bashing weapons, such as the poll-axe, war hammer, and the halberd. These were long metal or wooden shafts with an affixed head. The shaft was reinforced with steel strips riveted along its length, and a circular rondelle of steel was riveted on to prevent any weapons from sliding down its length.[261] These weapons were used to slash or bash opponents. The third sub-category of hafted weapons are the spears. The term spear was used in the Middle Ages for any staff weapon used for thrusting.[262] This included the pike, lance, and the ahlspiess. These weapons usually ranged from 6 feet to 14 feet in length and were mostly used for pure thrusting.

Missile Weapons

There were three main types of missile weapons which were in use during the 15th century. They were the bow, the crossbow, and the hand gun. Bows and crossbows were not replaced by hand guns until the last half of the century because of the unreliability of guns. They were also somewhat slower and less accurate than trained bowmen. However, the dwindling supply of trained archers and the slowly increasing reliability of hand guns heralded the beginning of the end for bows and crossbows.

Bows were primarily made from basic, wych elm, hazel, ash, and yew.[263] The string of the bow was made from animal gut or twine, and was commonly waxed. Bows could be tipped with horn, ivory, or bone tippets as well. Arrows had forked, barbed, or chisel-shaped heads and feathers on the other end to improve their accuracy and distance. The bow was commonly used as a support unit and kept behind the front lines. It was sometimes supplemented with men wielding hafted weapons.

[261] Ibid. p21 – 29.
[262] Ibid. p29.
[263] Ibid. p33.

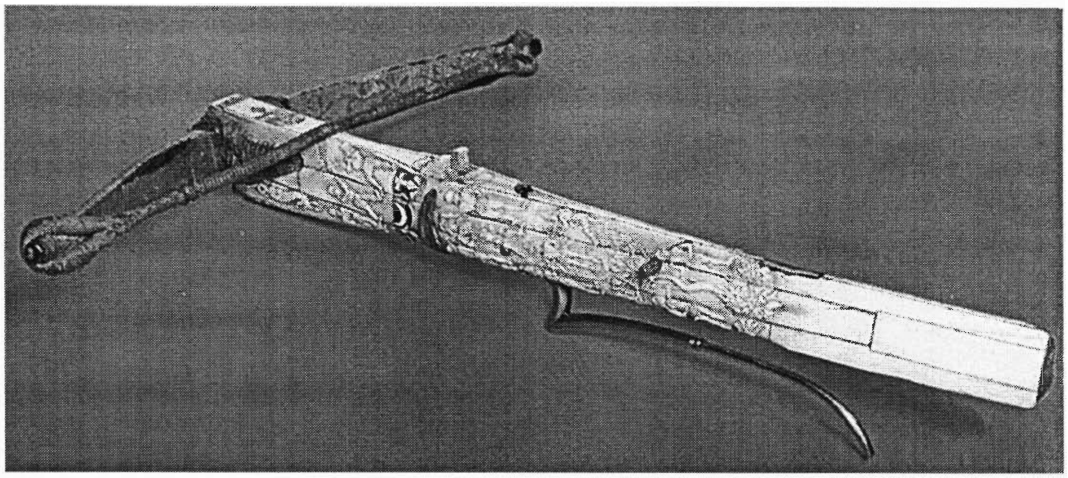

Figure 61 A Bavarian Crossbow, circa 1450-1470. (From Edge, 1988)

Crossbows are a more advanced form of the bow. A crossbow consists of a bow mounted perpendicularly to a stock, with a trigger mechanism to hold the string taut. It is loaded with crossbow quarrels, which were miniature versions of arrows. There were several mechanisms used to pull the string taut. The first system required the user to pull the string back by hand and hook it around a hook which was connected to a trigger mechanism. The second system used a ratchet or lever to slowly pull the string back. The third main system used a crank to winch the string back.

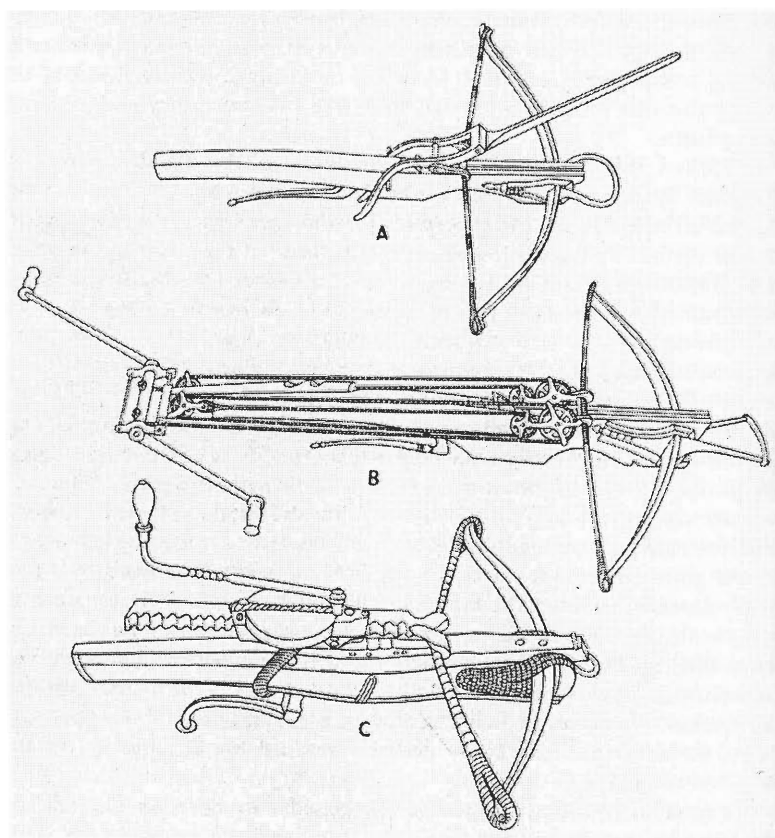

Figure 62 three styles of crossbow. (A) winches the string back using a goat's-foot lever. (B) winches the string back using a crank-and-pulley system, and (C) winches the string back using a ratchet system (From Singer, 1956)

Handguns slowly became more popular throughout the 15th century. They consisted of an iron or steel barrel with a touch hole through which the powder was ignited. To fire, the stock was tucked under the arm. They had a range of about 200 feet and could either fire lead or cast iron shot, but lead was known to pierce armor better. During the beginning of the 15th century, it was similar to a small cannon mounted on a 14 foot handle. However, during the early 15th century, the handle was shortened, the barrel was fastened on top, and the touch hole was moved to the side of the barrel to protect the powder from the elements. A small cup called the pan was placed underneath the touch hole to contain the powder. The powder was ignited either with a hot wire or a slowly smoldering rope.[264] Later, the barrel had a hook at the bottom so it could be steadied against the top of a wall.[265] During the 1420s, the serpentine was invented. This was an S-shaped piece of metal pivoted on the side of the barrel. It would hold a section of smoldering rope on the topmost portion, and was lowered into the pan by depressing the lower portion of the S-curve. During the last quarter of the century, it was attached to a spring and stop mechanism, as well as a trigger.

Figure 63 An iron hand gun circa 1500. The left-hand side is a solid cylinder that was tucked under the armpit to hold the hand gun steady. The hole for the powder can be seen, and on the bottom right is a lip so the gun can be steadied against a wall. (From Edge, 1988)

The formula for black powder that was commonly used during that period consisted of four parts saltpeter, one (or 3) part(s) carbon, and one (or 3) part(s) sulfur.[266] However, due to the impurities present in the available components, it was impossible to

[264] Morrison. 1963. p179.
[265] Ibid. p180.
[266] Morrison and Edge differ on their formula for gunpowder. Morrison says it was made from 3 parts each sulfur and carbon, Edge says 1 part each.

produce a homogenous mixture. This could cause the same amount of gunpowder to either fizzle or explode stronger than normal, in bad cases. Because of this unreliability, and because the weapons themselves were inaccurate, handguns played a small part in warfare until the end of the 15th century, although every major army had them.[267]

Glossary of Terms

Ahlspiess (aka *lance a pousser*)

German thrusting spear used by foot soldiers. Its head was a long quadrangular spike attached to a long shaft with a rondelle at the base to protect the wielder.

Anlace

Slender, sharply pointed thrusting blade.

Axe

Virtually indistinguishable from the axes used as tools. A hafted weapon with a crescent-shaped head.

Ballock-knife *(aka "kidney dagger")*

Normally worn by civilians. Its guard was formed by 2 rounded lobes.

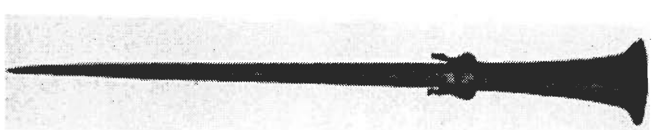

Figure 64 Ballock-Knife. (From Blair, 1962)

267 Morrison. 1963. p184.

Bardiche

Pollaxe with a long, slightly curved blade.

Baselard

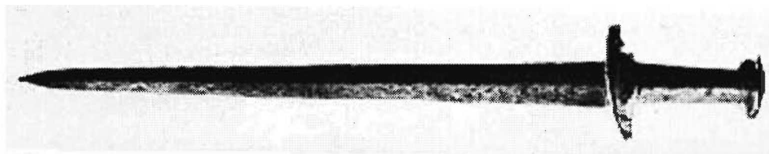

Figure 65 Baselard (From Blair, 1962)

Dagger with an I-shaped hilt. Its blade was often as thick as a short sword's and was carried almost exclusively by foot soldiers and civilians.[268]

Bastard sword

Contemporary term used to describe a hand-and-a-half sword, or a sword that could be wielded by either one or two hands.

Bill

Adapted from the farming implement of the same name, this long-hafted weapon was popular with foot-soldiers. Its head was long with a single cutting edge. It was divided at the top into a single spike with a curved hook and sometimes has pointed lugs at the top of the socket.[269]

Bow

Wooden staff bent into a crescent shape with a string held in tension. Used to fire missile weapons (arrows)

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[268] Blair. 1963. p13.
[269] Ibid. p24.

Cinquedea

An Italian civilian sword so named because it was supposedly "five fingers" wide at the top. It varied between dagger length and longsword length, had a broad, flat, double-edged triangle blade, and a grip formed of two plates riveted to each face of the tang of the blade. It also had arched quillons slightly wider than the base of the blade, and a cup-shaped pommel that fitted over the end of the hilt.[270]

Crossbow

Bow set perpendicularly to a shaft where the string is held in tension by mechanical means.

Dagger

Small form of a sword. Usually a double-edged blade.

Ear-dagger

Dagger with a pommel formed by two disc-shaped pieces, splayed outwards. The guard was formed by spool-shaped molding. Popular in Spain and Venice.

Écusson

Small triangular extension of the quillons extending up the blade of a sword from each side to strengthen it.[271]

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[270] Ibid. p4.
[271] Ibid. p3.

Estoc

Thrusting sword with a triangular or square cross-section. It was used as a subsidiary cavalry weapon and for fighting on foot in the lists.[272]

Flail

Adapted from the farming implement. It was originally a club hinged to a long staff, but the military form had a metal ball that had spikes, which was attached via a chain to a haft.

Gisarme

Long-hafted weapon with a long crescent-shaped blade. The upper end projects like a spike.

Glaive

Long-hafted weapon with a cleaver-like blade attached to the shaft. Usually has a rondel to protect the hand.

Halberd

Axe balanced by a short fluke on the rear attached to a long spike.

Hand gun

A gun held in the hand or hands, in contrast to artillery which relies on a free-standing carriage.

Lance

Denoted a horseman's spear, but the term was coined in the 16th century. It is a 14 foot shaft of tough wood (i.e. ash) with a small steel leaf or lozenge-shaped head. A jousting lance was fitted with a steel hand defense.

Mace

Short club-like weapon. Its globular head was separated into flanges and occasionally spiked and attached to short haft.

Matchlock

Simple ignition system for early firearms. A pivoted arm is activated by the trigger to lower a smoldering match into the gunpowder-filled pan at the side of the gun barrel.

Maul

Large hammer with a head of iron or lead. Looked like a croquet mallet.

Misericorde

"Knightly" dagger. Often used to deliver the final blow to a knight *in extremis*.

Partisan

Spear with a long triangular 2-edged blade with upturned lugs at the bottom.

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[272] Ibid. p2.

Pike

Long small-headed spear primarily used in defense against cavalry.

Pollaxe

Long-hafted weapon with an axe head balanced by a fluke or hammerhead.

Rondel dagger

"Knightly" weapon. Its grip is cylindrical with a disc-shaped pommel and guards.

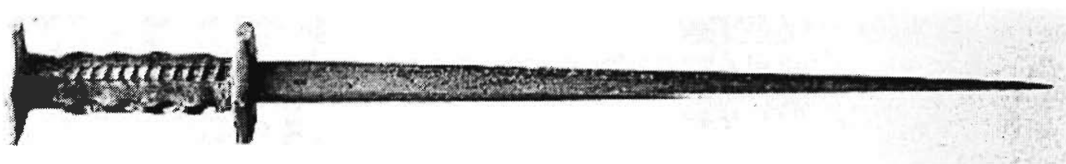

Figure 66 Rondel Dagger (From Blair, 1962)

Spear

Generic term for any staff weapon used for thrusting.

War hammer

Short-hafted hammer.

Siege Weapons and Fortifications

During the 15th century, the gradually increasing use of the cannon in sieges began to take its toll on fortification-building. The castle had become relatively obsolete because of the power of the cannon. Very few castles were built in the 15th century, and other siege weapons were gradually replaced by the cannon.

Fortifications

The castle seems to have been the primary means of fortification during the 15th century, even though many castles were being allowed to decay. Other fortifications that existed were fortified manor homes, forts, blockhouses, towers, fortified cities, and defended batteries. The castle in England dwindled greatly during the 15th century, while the castle in France flourished.[273] However, they were very expensive to build and not as comfortable to live in as a manor house.

There were four main causes for fortification, all of which occurred in various forms throughout the century. The first is a danger from a foreign enemy. The Hundred Years War caused England and France to fortify as much as they could. The second was danger from civil war. The War of the Roses in England was such a civil war. The third was a danger from an uprising of discontented peasants. The Hussite rebellion in the Germanic states resulted in several castles being destroyed. The fourth was a danger from fights between small factions or families. There were many such ongoing feuds during this period.[274]

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[273] Thompson. 1987. p3.
[274] Oman. 1926. p11.

The castle is defined best by Thompson, who describes the castle as "a fortified residence in which the fortifications predominate over the domestic aspect of the structure, and the occupant usually controls a large territory around it."[275] There

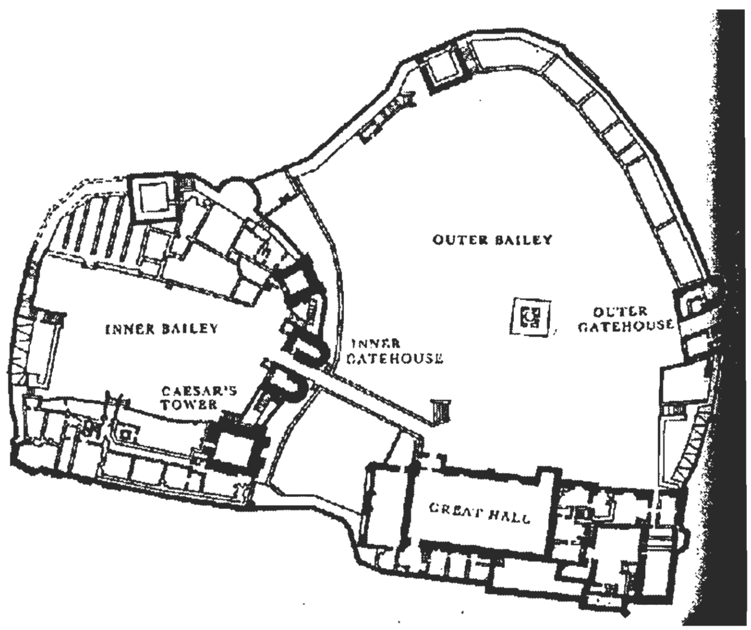

Figure 67 Diagram of Chester Castle in 1769. This shows the layout main areas inside the castle grounds, including the inner and outer gatehouses. (From Hogg, 1975)

are many places which are called "castles" but which are merely fortified manor homes. There are also two primary categories of castle – "royal" and "baronial".[276] Royal castles were commanded by the king, who ordered them to be built in strategically important places, such as in major towns, trade routes, and along the perimeter of his realm. Baronial castles were build by a lord who could afford it, and who looked for the strongest point in his land to fortify. Such castles were built on cliffs, lakes, and marshes for best defense. However, as mentioned before, very few castles were built during this period.

The primary defensive features of the castle during this period are the portcullis groove, arrow slits around the perimeter of the gatehouse, a wet or dry moat, the fortified gatehouse, and the curtain wall with wall-walk, parapets, towers, and machicolations. Each feature will be discussed by itself.

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275 Thompson. 1987. p1.
276 Oman. 1926. p12.

The portcullis was a wood (usually oak) grid suspended in the entrance to the gatehouse that was plated with iron and had spikes on the bottom, and which could be hauled up and down using a winch. It could be dropped very quickly, and its function was to trap attackers between it and the gate. Defenders could then kill the attackers with very little risk by firing arrows through arrow slits that lined the gate house or pouring and dropping things down the murder-holes in the ceiling of the gateway.[277]

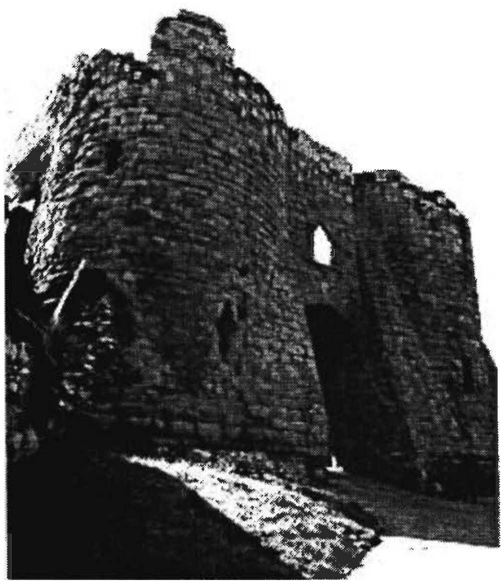

Figure 68 The Burgess Gate, Denbigh Castle. This photograph gives one the idea of the sturdiness of the gatehouse. (From Hogg, 1975)

The gatehouse had superseded the keep as the main defense of the castle by the beginning of the 15th century, and was sometimes used as an extra barracks for reserve soldiers. It was attached to the curtain wall, and consisted of either two or four towers with a passageway between them. The gateway was bounded on one side by a portcullis and on the other by a heavy gate. There usually was no access to the interior of the towers from the gate level, and the entryway was lined with arrow slits and murder holes. The entryway also sometimes extended at an angle to further hinder the attackers. Some castles also had a second wall with a space between and another gate offset from the first, so if the attackers managed to push through the first gate they would have to run the gauntlet between the two walls to get to the next gate, while being bombarded with

277 Koch. 1978. p160 – 161.

missiles from above[278]. Because of the thickness of the curtain walls of castles during this period, the gatehouse was a popular target during a siege.

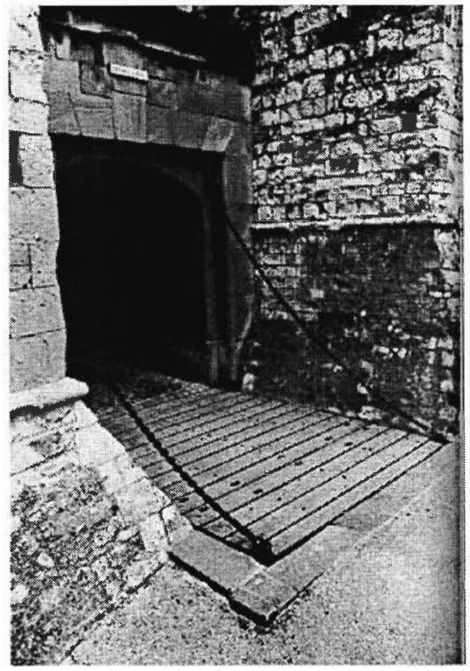

Figure 69 Dover Castle; A drawbridge at Palace Gate. The drawbridge could be drawn up to give attackers one more obsticle to navigate when attempting to invade the castle. (From Hogg, 1975)

The moat (or motte) was merely a ditch dug around the perimeter of the curtain wall and sometimes filled with stagnant water. It was yet another obstacle for the attacker to overcome. The moat was usually dug so that there was as little space as possible between it and the base of the curtain wall, to prevent the attacker from gaining a foothold. This pit was spanned by a drawbridge at the gatehouse that could be winched up.

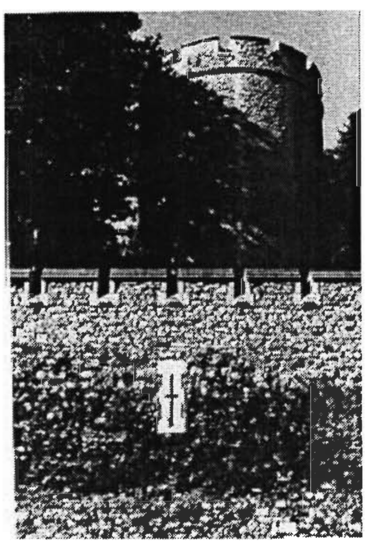

Figure 70 Tower of London; part of the curtain wall showing arrow loops and crenellation. (From Hogg, 1975)

Towers were spaced periodically around the curtain wall to strengthen it. Although they were originally square, by this time they were rounded to prevent mining and to provide extra protection against siege weapons.[279] Their bases were usually built a bit thicker than their tops (or parapets) to provide a sturdier foundation. Towers that were built out from the curtain wall (called flanking towers) helped the defenders fend off the siege weapons of the attackers because the archers and gunners no longer had to lean out of the protection of the walls to get a clear shot.

[278] Hogg. 1975. p21.
[279] Hogg. 1975. p15.

The curtain wall surrounded the castle on all sides and was usually 30 to 60 feet high. Walls began to be thickened to defend against the cannon. The few castles built during the 15th century were short, squat, and had walls up to 70 feet thick.[280] Such castles also began integrating artillery into their battlements. Some castles had a second wall inside the first which channeled attackers in between the two. To prevent mining, the foundations of walls were dug into the earth before they were built, and walls tended to have broader bases than tops to create a sturdier foundation. During a siege, bricks would be taken out of the top and a protective walkway made out of wood called a horde would be erected on top of walls that didn't have machicolations (see below). This enabled soldiers with missile weapons to lean out over the edge of the wall and fire at the foot without coming under enemy fire.[281]

Machicolations were more permanent versions of the horde. They were spaced stone buttresses that surrounded a parapet of a tower to allow missiles to be shot toward the base of the walls.[282]

Other forms of fortification used the same principles the castle used. Towns were surrounded by a curtain wall and had gatehouses spaced evenly around the wall. Manor houses sometimes had a rudimentary defense system, but for the most part manor defenses were purely for show. The fort and the defended battery were both military fortifications and tended to be used to garrison large numbers of soldiers and guard important strategic areas. They used towers, the portcullis, artillery-holes, the gate house, and the curtain wall for their defenses.

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[280] Ibid. p31.
[281] Ibid. p15.

The Siege

During a siege, there were four ways the army could assault a castle. The first was to go over the walls with an assault. The second was to go through the walls using bombardment by siege weapons. The third was to go under the walls through mining. (This technique was rarely used during this period because of the increasing thickness of the curtain walls.) The fourth was to establish a total blockade to try to starve the defenders out.[283] The army would camp on the outside of the walls, and usually the siege weapons that were made out of wood were built on the spot.

If the army chose to mine the walls of the castle, the procedure was simple. A group of miners would start digging a tunnel, using common picks and shovels, some distance away from the wall and out of sight, then would extend the tunnel under the wall, shoring it up with timbers. When the tunnel reached under enough of the wall, the miners would set the supporting timbers on fire using wood soaked in oil or petroleum. Without the supports, the heavy wall would fall into the resulting cavern, causing a breach the army could take advantage of. Mining could only be countered by digging a counter-mine and killing the miners before they had a chance to set the supports on fire, then filling in the mine again.[284]

If the enemy chose to bombard the walls, the cannon was the primary siege weapon in the 15th century, although it is agreed that its predecessors were also used, albeit in a secondary role.[285] The cannon will be discussed on its own in a following section. The trebuchet was the secondary bombardment siege weapon of choice, it

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[282] Ibid. p21.
[283] Wise. 1976. p164.
[284] Ibid. p168 – 169.
[285] Ibid. p164.

seemed, and the catapult and ballista were virtually non-existent during this period and will not be discussed. However, by the end of the century advances in artillery technology made the trebuchet almost obsolete.

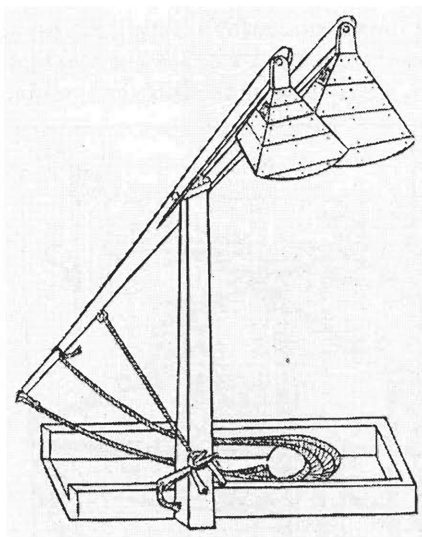

Figure 71 A double-counterpoise sling-trebuchet. (From Singer, 1956)

The trebuchet consisted of a frame with a large crossbar. An arm was pivoted on this crossbar. One end was attached to some sort of weight system, and the other had a sling on a track. The slinged end was pulled down, a missile (usually a large boulder) was placed in the sling, and the weight would be released, flinging the missile. This principle was called counterpoise.[286] Sometimes a movable weight was attached to the beam instead of being allowed to hang from the end of the beam. This machine was called a tripantum.

If the commander decided to go over the wall in an assault, there were several siege weapons the army could use. These machines were designed to provide protection against all sorts of assault long enough for the army to either go over or through the walls.

The first sort of machine was the "cat" (also called tortoise, penthouse, rat, and sow). It consisted of a sturdy wooden frame affixed to wheels. It was enclosed on the sides and the top and moved with manpower. The top was covered with green hides to resist attempts to set it on fire. The moat would be crossed by filling it in with brush and earth, or on beams or a makeshift bridge. A ram was the most common way the cat was used to breach a wall or gate.

The ram was a large timber suspended from the roof of the cat by chains. It sometimes had a metal head or point attached to the front of it. It was swung repeatedly into the walls or gate to try to batter it down. Defenders would drop rocks, boiling water, or Greek fire on a cat to try to destroy it. They would also lower mattresses or beams to try to soften the ram's blows, or attempt to hook it with chains and haul it up at an angle to make it useless.[287] Because of the thickness of the walls, the gate was the primary target for the battering ram.[288]

Another option was to attempt to go over the walls using the escalade or the belfry tower. The escalade was a scaling ladder with hooks on the top to hook over the crenellations of the walls and hold them in place.[289] This was a risky maneuver because the ladders could be pushed away from the edge of the wall causing whoever was climbing them to plummet to the ground.

The belfry tower was a huge fortified wheeled tower made of wood that was slightly taller than the wall. It was usually fortified on the front and the sides and covered with green skins to resist attempts to set it on fire. Stairs or a ladder were affixed to the back to allow soldiers to climb it. It would be wheeled to the wall by soldiers or horses, but because it was so heavy a path had to be smoothed before the assault and the moat had to be filled in. If the belfry was taller than the walls, a drawbridge would be lowered to meet the wall. Sometimes a ram was installed on a lower story to undermine the walls if an over-the-top assault failed. The disadvantage of this tower was that it was slow and ponderous, giving the defenders plenty of time to try to either shoot the people or horses

[286] Ibid. p165 – 166.
[287] Wise. 1976. p69 – 170.
[288] Koch. 1978. p148 – 149.
[289] Wise. 1976. p174.

moving it, or try to set it on fire[290]. To do this, the most common weapon was called Greek Fire.

Greek fire was a semi-viscous liquid that was probably made out of petroleum and oil. Other materials were added to give it different properties. Pitch was added to make it burn longer, sulfur made it stick to things, and quicklime caused it to ignite on contact with water.[291]

Artillery

The 15th century saw the increased use of cannons as siege weapons, and the gradual replacement of the former siege weapons such as the catapult and trebuchet. The cannon made medieval castles almost obsolete because of its sheer destructive power. However, because of its inaccuracy and unreliability, it was rarely used in field battles before the end of the century. In 1497 during the Battle of Fornova, Charles VII became the first leader to use cannons in an open field battle. However, only 10 of the 35,000 men killed were killed by cannon fire.

290 Ibid. p174 – 176.
291 Ibid. p176 – 177.

Cannons were made by the blacksmith. The most common method for constructing a cannon was similar to the technique used to make barrels. First, heated

Figure 72 A siege in the late 15th century, one of the earliest pictures of canon being used against fortification. (From Hogg, 1975)

strips of iron (usually made from excess metal left over from horseshoes) were wound around a thick wooden pole and allowed to cool. The blacksmith then pounded the cracks out with a hammer and wound more rings of heated iron and pounded them smooth. Cannons were usually made of several such layers. Then the blacksmith heated the entire thing until the wood burned off. He plugged the back of the cannon with a large chunk of iron (called the breech). Cannons were attached to heavy beds of wooden beams with large wooden stakes driven in behind the bed before firing to prevent kickback. The hole in the top of the breech contained priming powder, which was ignited with a smoldering rope or hot wire.

By the middle of the 15th century, cannons were also being cast in molds using bronze or later iron. These cast barrels proved easier to load and less prone to explode.[292] By the end of the century, cannons were mounted on carts that were pulled by horses, rather than oxen. They also required huge baggage trains to haul the shot and powder. Also during the middle of the century, a new technique for mixing gunpowder was created. First, the gunpowder was mixed wet, then dried into cakes. Then it was crumbled and passed through sieves to produce an even granular size. This technique was called "corning".[293]

These cannons usually had a bore of about 15 – 18 in, and ranged from 12 – 18 feet long. They could either fire stone or iron shot. While stone was cheaper and required less powder, it was also lighter and less effective against fortifications. Around 1470, trunnions (which were 2 lateral lugs protruding from the barrel at the balance point) enabled range adjustments by allowing the gunners to elevate and lower the barrel more easily.[294]

The biggest cannon of that era was made for King James of Scotland and was 13 feet long and weighed 5 tons. It fired a 1100 lb ball nearly a mile and needed 105 lbs of powder to ignite it.[295] However, the cannon was very unreliable. It took a long time to load, and had a tendency to either shoot the breech off or explode, either maiming or killing the gunners.[296] A strange variety of multi-barreled cannon called the ribaldequin was invented during the latter half of the century. Its barrels were clamped together on a

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[292] Morrison. 1963. p176.
[293] Hogg. 1975. p37.
[294] Edge. 1988. p133.
[295] Morrison. 1963. p175.
[296] Edge. 1988. p134.

wooden base and could be discharged individually or all together. It was sometimes used to command breaches.[297]

Leather Products

Writing Surfaces

Parchment

Parchment is an early form of writing material made from sheepskin. The skin would be soaked in a lime solution, then spread on a frame and scraped with a curved knife on one side. After scraping it would be dried, wet again, and scrubbed with pumice. It would then be dried, wet another time, stretched and rubbed with chalk to give it a white color which better held the ink.[298]

Vellum

Vellum is often taken to mean writing material made from calfskin. Often, though, it just referred to the quality of the final product, since discerning whether a piece of vellum or parchment was made from calf or sheepskin was difficult at best. Vellum was of higher quality than parchment. It was made in much the same way as the parchment, except that it was scraped on both sides with a curved knife. [299]

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[297] Ibid. p134.
[298] http://orb.rhodes.edu/encyclop/culture/books/medbook1. 1997.
[299] Ibid.

Household Goods

Various Items

The various items in the household for which leather could be used were generally tooled and carved into the desired designs, then sewn or otherwise assembled as needed. Satchels, book covers and carrying cases were often made from leather. Leather could also be used as tapestries and attached to boxes or molded into bottles. [300]

The raw hide of an animal could be used to cover door panels. It would be shaved of its hair and attached to the wood with cheese glue while still damp. [301]

Medieval furniture often used a mix of wood and leather. Using sections of leather made the finished product lighter, overall, and could be decorated and gilted quite beauftifully. Leather was often used in litters, coaches, sedan chairs, mural panels, screens and chairs. Coffers also made furniture out of wood, then covered it in leather, attaching it with attractive tacks. Murals, hangings and leather "tapestries" were often painted and embossed and had rather lovely designs applied with colored varnish.[302]

Industrial Use

Leather was often used in the Middle Ages to polish other items. This included, but was not limited to, the polishing of semi-precious gemstones.[303]

A bellows could be made using the whole skin of a ram, removed in one piece. The skin would be dried and treated and turned right side out. The ankles would be

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[300] http://www.personal.utulsa.edu/~marc-carlson/leather/plwt.html. 2001.
[301] Theophilus. 1979. p26
[302] Singer. 1956. p173-174
[303] Theophilus. 1979. p189

closed off. The ram's skin would be attached to the metal pipe leading into the forge and the neck would have a pressing apparatus attached. The ram skin could then be squeezed to force air into the forge.[304]

Clothing

Leather was often used in clothing, shoes and armor. Special methods of hardening included boiling the leather briefly and applying hot wax. Hammering was also used to make hard shoe bottoms. [305]

Clothing

During the 15th century, clothing was a way for those who could afford it to show precicely how wealthy they were. The cut and fashion of the actual garments themselves did not differ between the nobility and the peasantry. The chief difference was the expense of the material and the extent of ornamentation. Richer clothing was gilded and bejeweled, or was made of costly fabrics imported from as far away as the Orient, or had many costly linings. The more expensive the clothing was, the more it showed off the wearer's wealth. Because of the expense of clothing, it was often mentioned in wills and legacies. In Bohemia, it was customary for the elderly to leave their cloak or coat to their grandchildren.[306] During the second half of the fifteenth century, the Burgundian courts were considered the epitome of fashion, and decadence in clothing was the norm.

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[304] Ibid. p83
[305] http://www.personal.utulsa.edu/~marc-carlson/leather/hl.html. 2001.

Construction

At the beginning of the fifteenth century, the making of clothing was divided up into many guilds, each making a specific product. Tailors made new clothing for men and women, while second-hand dealers repaired and altered old clothing. Coat-makers made only coats, while furriers worked with furs, smockers made smocks, and hosiers made stockings. Shoemakers made new shoes while cobblers repaired old ones. Hatters worked in felt or fur hats, cap-makers made caps, beret-makers made berets, wreath makers made wreathes and circlets for the hair, and veil-makers made veils, wimples, hoods, and head scarves for women. Each guild had its own niche in the clothing business, and there were other guilds not mentioned above.[307]

Figure 73 A shoemaker's shop. (From Singer, 1956)

The actual construction of clothing changed somewhat over the course of the 15^{th} century. Gores, which were triangular pieces of fabric used to enlarge seams, became widely used in the construction of hose and sleeves. Sleeves moved from a square-shoulder to a more rounded shoulder with the addition of gores. Sleeves became looser-fitting, and were eventually slashed to allow the shirt or chemise to show through. Men's jackets became tighter-fitting and changed from knee-length to hip-height and emphasized the waist in an extreme fashion. Padding emphasized the shoulders and chests for men, while women's bodices grew tighter than in previous

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[306] Wagner. p14.
[307] Ibid. p13.

centuries. Women's dresses began being laced up the front, rather than the back or sides.

During the fifteenth century, there were four basic layers of clothing that people of both sexes wore. The first, and innermost, was the shirt (or chemise). Then over this they wore a tunic or dress. Over this, they wore an overtunic or similar garment, and added the final layer, the cloak or coat.[308]

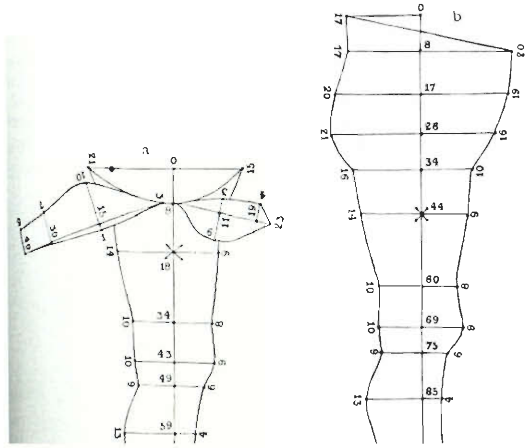

Figure 74 Pattern showing how hose were constructed. (From Kohler, 1963)

Men's Clothing

During the 15th century, the innermost layer in both sexes was a shirt. This was usually made of linen, although silk was sometimes used. The next layer in masculine fashion was the tunic or doublet. This outer garment was usually made out of linen or woolen cloth, but could be made out of richer material.[309] In most accounts, the tunic was usually a knee-length garment with long sleeves that was belted at the waist. However, in the cases where a doublet or similar garment was worn, the skirts only came to

Figure 75 Men's court costumes in the late 15th century. They are wearing doublets and hose, with long sabbatons. (From Houston, 1996)

[308] Ibid. p15
[309] Houston. 1996. p178.

just below the waist.[310] The sleeves came in many shapes ranging from tight to the arms to long, sack-like sleeves or sleeves ending in a long tippet hanging from the wrist. The hose were form-fitting pants tied to the tunic by means of laces called "points". They had a seam in the back and "feet" or a stirrup-like strip of cloth that slipped under the arch of the foot. According to Houston, the material that was used for the closest fit was woolen cloth.[311] Sometimes hose had thickened soles so they could be used without shoes.[312]

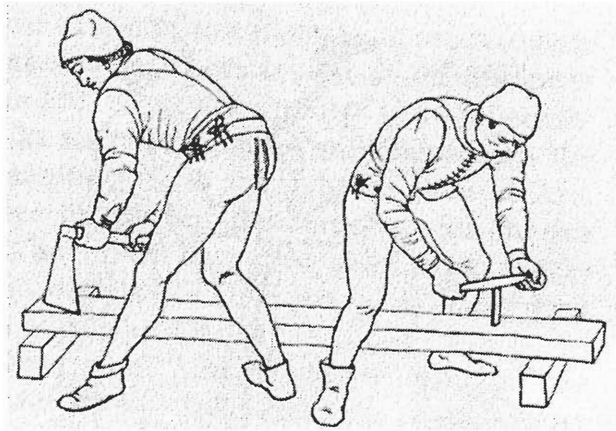

Figure 76 Carpenters at work. This picture shows how hose and tunics were attached by means of laces. (From Houston, 1996)

The doublet was a vest or jacket-like garment worn at any length from the waist to the mid-thigh. It was usually worn just below the waist, but could have skirts slitted up the sides and the front. It was also fitted around the chest and usually padded or slashed as fashion of the period dictated. It was made of many materials such as velvet, silk, leather, and cloth, and seems to have evolved from a padded garment worn under armor. There is a reference that the doublet in Germany was often used under mail, and so was made out of either leather or coarse cloth and was unadorned. The doublet was also called a jupe, jupon, gipon, paltok, gambeson or pourpoint.[313]

The next layer out was the overtunic. In male fashion this usually was either a tabard, smock, or houppelande. These fashions were usually sleeveless, but in the case of

[310] Kohler. 1963. p166
[311] Houston. 1996. p181 – 182.
[312] Wagner, 1963. p13.
[313] Kohler. 1963. p179.

the houppelande sometimes had full or half-sleeves as fashion dictated. Another similar garment was the robe, which resembled the houppelande in that it was open at the front, had sleeves, and was belted at the waist. Over these layers was sometimes worn the cloak or jacket.

Women's Clothing

Figure 77 Women's court costumes in the late 15th century. The woman is wearing a henin-style headdress. Her dress is so long that it has to be lifted to show the underskirt underneath, a fashion that was popular in the late 15th century. (From Houston, 1996)

Feminine fashion usually followed male fashion. For the most part, women wore long floor-length dresses. Underneath the dress, the chemise (or chemisette) was worn. It could have fitted or flowing sleeves and was usually made out of linen or silk, but the materials used became finer as fashion allowed the chemise to begin showing during the latter half of the 15th century.[314]

The typical dress consisted of a fitted bodice, an overskirt, and an underskirt. The bodice had a rounded neckline and high waist during the first half of the century, but the square neckline came into fashion around the middle of the century. The skirts were attached to the bodice and sometimes the stitching was covered with a girdle of fabric called a stomacher.[315] The overskirt was the outermost layer of skirts. It was occasionally slitted either up the center or on the sides to allow the underskirt or chemise to show through. The underskirt was a

[314] Houston. 1996. p187, 189 – 190.
[315] Ibid. p174 – 176.

separate piece of cloth attached underneath the skirts of the overskirt. It was made of decorative cloth as fashion made the overskirt longer than floor length so they had to be lifted to walk, allowing the underskirt to be seen.[316]

Figure 78 A picture of a surcot. (From Kohler, 1963)

Over a simple dress, a robe or surcot was often worn. The robe was a simple garment that extended from neck to floor and was belted just below the breast. The surcot resembled the dress, except it was sleeveless and the holes where the arms fit through were greatly exaggerated.

For most of the century, it was fashionable for women to keep their hair covered with elaborate headdresses. The most popular headdress was the henin, which was a cone-shaped headdress with a veil over it. It was held in place by a small circle of wire (called a frontlet) on the forehead to counterbalance it. Variations on this style appeared throughout the 15th century. Two of the most popular were called the "butterfly" and the "horns".[317] A simpler headdress was the wimple, which was a headdress consisting of a veil covering the hair and wrapping around the chin and neck. It could be secured with a circlet or another headdress.[318]

[316] Kohler. 1963. p170 – 171.
[317] Asser. 1966. p63.
[318] Houston. 1996. p161 – 162.

Clothing for Both Sexes

The outermost garments were shared by both men and women. Several varieties of headdress were also shared by both sexes, and children's clothing usually consisted of a miniature version of the adults' clothing.

Figure 79 Court costumes. The man in the center is wearing a houppelande and a baldric with bells hanging from it, a popular fashion in Germany during the 15th century. The women on either side are wearing the feminine versions of the houppelande. (From Houston, 1996)

The houppelande was extremely popular during the first half of the century. The male version was loose and flowing with long, wide sleeves and was opened in the front and fastened with a belt or a girdle. In feminine fashion, the houppelande had a closer fit around the chest than the male version did.[319] The cloak was another outer garment, and was a sleeveless garment that hung over the shoulders and could hang anywhere from the mid-back to the ankles. It was usually fastened at the neck by a chain, clasp, or pin.

Both men and women wore long belts called girdles that hung low around the hips. The poorer varieties were made out of cord or leather. The richer varieties were usually made out of metals (usually either silver or gold as a base) and were for the most

[319] Ibid. p186.

part decorative. The richer girdles also had jewels inset into them, and in the Germanic areas, it was fashionable to hang little bells from the girdle.[320]

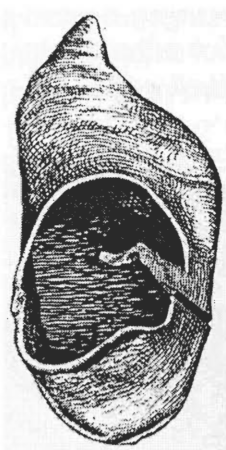
Figure 80 pointed leather shoe (from Singer, 1956)

Covering the feet was a variety of footwear. Shoes were made out of either leather or oiled cloth. There were boots, sandals, broad-toed shoes, and shoes with long toes that were sometimes so long that the wearer had to tie them to the tunic, girdle, or knees by means of either ribbons or small metal chains. These long-toed shoes (known as sabbatons) were popular during the first half of the century, but were gradually replaced with broad-toed shoes during the second half of the century.[321] Wooden pattens could be strapped over the shoes to protect them from the elements.[322]

Certain styles of headdresses were shared by both sexes as well. The turban-styled headdress, the hood, and the capuchon were the most popular. The turban-style headdress consisted of a cloth wound around the head, or a padded roll holding a wrapped strip of cloth to the head. This style was often decorated with fur, jewels, or gilt pins. The hood was a simple head covering that covered the crown of the head down to the shoulders with an opening for the face. The top of the hood often ended in a long tassel called a tippet or liripipe, which was wrapped around the neck or left to hang. The capuchon (or chaperon) was a variation on the hood. The


Figure 81 Man wearing a cappuchon. The edges are snipped, according to the fashion of the day. (From Houston, 1996)

[320] Ibid. p162
[321] Ibid. p186.
[322] Wagner. 1963. p15.

crown of the head was stuck through the opening that the face would have gone through, and the edges that formerly encircled the shoulders were snipped. It was sometimes held in place by a padded roll. The part that formerly covered the crown of the head ended in a long tassel called a tipped, which was either wrapped around the shoulders or left to hang. During the course of the 15th century, the capuchon was heavily modified and soon lost all resemblance to the hood.[323]

Ornamentation

As mentioned previously, ornamentation on clothing was a mark of wealth. Costly fabrics, such as velvets, satin, gold tissues, and patterned silks, were popular mediums. These fabrics were usually trimmed, often with furs (such as ermine), or with other ornamentation such as brocade or lace. Fabrics were sometimes embroidered in a regular pattern over the entire length. These designs usually consisted of leaves and fruit, although fleur-de-lis were also popular among the nobility.[324]

Embroidery was a primary way of decorating clothing. Some surviving embroideries were worked with gold or silver gilt threads mixed with colored silks, or silk thread on a linen background. Embroidery designs were created by artists, and applied by professional needleworkers. However, despite efforts to the contrary, quality of embroidery decreased as the needleworkers created shortcuts. One such shortcut was called "appliqué". Embroiderers would sew their design onto a separate piece of fabric,

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[323] Houston. 1996. p 164 – 165.
[324] Ibid. p213 – 214.

then apply the design to the ground fabric, which would usually be one of the more costly fabrics such as velvet, and stitch it to the fabric using couching and stem stitch.[325]

Occasionally silk cord known as brocade would be stitched on the edges of designs to add a raised surface. Fur was also a very popular trim and lining.[326] Gems would also be used to adorn clothing and headdresses, and would be attached to the clothing using a metal fixture that wrapped around the gem much like the fastenings used to hold gems in jewelry in place.

Jewelry

Jewelry in the fifteenth century was worn by both of the sexes. The upper class had the money to purchase gold and silver jewelry and a variety of gems and glass beads. The poorer population was limited to less expensive materials such as bone. The majority of surviving period jewelry can be divided into either brooches or rings.[327]

Finger-ring

The finger-ring required very little metal to make and was very popular. It could be plain or decorated in such ways as engraving or being set with gems. Some finger rings were engraved in such a manner that they could be used as seals.[328]

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[325] Blair. 1991. p344 – 345.
[326] Houston. 1996. p 162.
[327] Blair. 1991. p140
[328] Ibid. p140

Collars

Collars were long chains of gold or silver worn around the neck. They were used as decoration, portable forms of bullion, or as gifts.[329]

Brooches

The most common form of brooch was the ring-brooch. It could be made into many shapes aside from the aforementioned "ring". Those shapes included animals such as deer or swans or in the shape of a heart. The brooch could also be set with gems.[330]

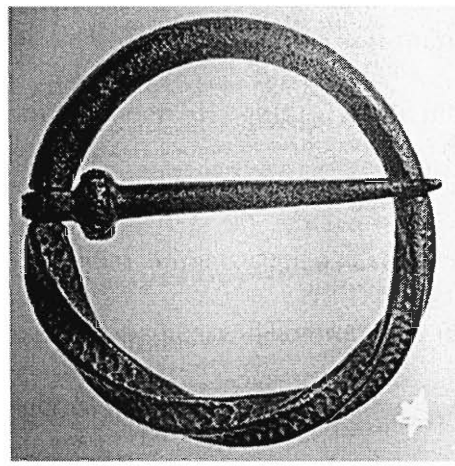

Figure 82 A ring brooch. (From Murdoch, 1991)

Architecture

Houses

The chief room of any medieval house was the hall. Many centuries before the period we are discussing, and still for some peasants, the hall was the only room of the house. In these times, the central hearth was in the middle of the hall and smoke escaped through a hole in the roof. In the 12th century the practice of adding other rooms to the

[329] Ibid. p141
[330] Ibid. p142

house began. The ground hall, a variation on the hall in which the hall composes the ground floor of the house, became popular in the 14th and 15th century. [331]

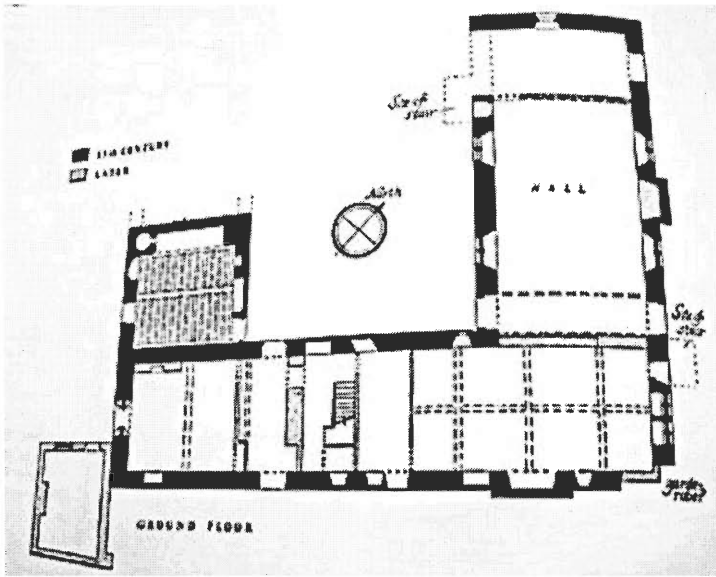

Figure 83 Floor plan of a manor house. Notice that most of the floor is dominated by the great hall. (From Wood, 1983)

Stone Houses/Manors

Stone houses and manors were the houses of the wealthy in the 15th century. While peasant houses weren't exactly mud huts, they still weren't the elaborate, many-roomed structures made of stone.

The stone house still focused on the great hall, although rarely an aisled hall could still be found. The aisled hall had a series of intermediate arches along its length for support and to avoid the use of large timbers that were hard to obtain around the 12th century.[332] The great hall used a roof construction that required no posts, using trussed timbers for support.[333] The central hearth was declining in the 15th century, being replaced by wall fireplaces. As a result the ceilings, which were once kept high to help make the room

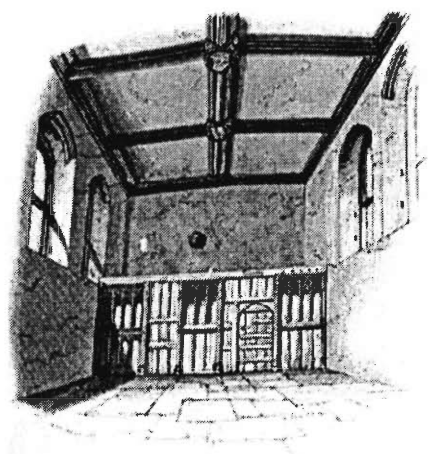

Figure 84 Interior of a great hall. Paneling on far wall was common for the period. (From Wood, 1983)

[331] Wood. 1983. p56-62
[332] Ibid. p35
[333] Ibid. p49

less smoky, were made lower to keep in the warmth. The great hall would have windows -- in fact the bay window became very popular in the 15^{th} century, probably due to the decline of the oriel, which I will discuss later. The exterior doors were set into small entranceways, pushed back from the great hall itself. This was done to prevent drafts from entering the hall. [334]

The private bedroom and sitting room of the owner of the manor and his family was called the solar, or great chamber. This was located on the second floor of the house. Centuries earlier the entire family would sleep in the great chamber and the servants would sleep on the floor of the great hall, but in the 15^{th} century individual bedrooms became more common for both owners and servants. These small bedrooms and the bed were shared by several people. Personal servants slept in the master's bedroom on a truckle bed that pulled out from under the master's bed. [335]

Many medieval manors also had a cellar, which would be totally or partly underground. These were usually vaulted and supported by a combination of vaults, ribs and columns. Their main use was storage. Sometimes a cellar would be built under the great chamber. This was sometimes used as a parlor.[336]

The oriel is an interesting architectural feature, mainly because of the evolution it underwent. Originally the oriel was a window which jutted out from the house. Over time it grew, first to include a small room under it for storage then to become a whole room and eventually a whole section of the house. The oriel was always considered a private area for the family who owned the house. Eventually, this tiny window area grew to

[334] Ibid. p56-62
[335] Ibid. p67-79
[336] Ibid. p81-94

become a fair sized chamber known as the withdrawing room, which was a parlor for the family of the house only.[337]

The great brick gatehouse was also a 15th-century development. They usually had a tower-type main room. Sometimes there were two towers with an arch between them. This could be separate from the house, but was usually attached. [338]

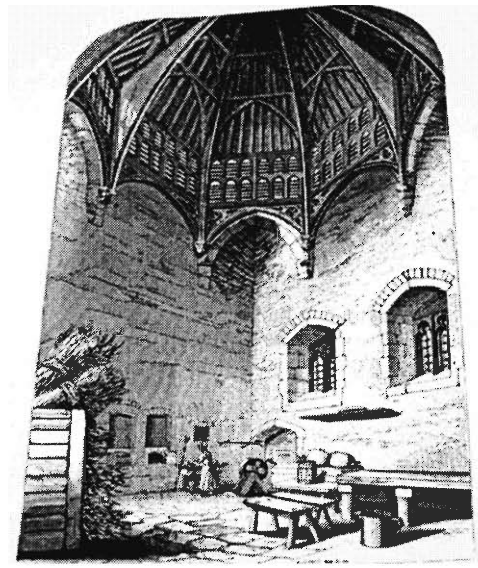

Figure 85 Interior of a kitchen. The ceiling is high to allow smoke from the multiple hearths to disperse. (From Wood, 1983)

The kitchen was square or oblong in shape, although some interesting specimens take on other shapes. There was a great fireplace in this room, accompanied by other small fireplaces. The opening in the roof, which was waning in the great hall at this time, remained in use in the kitchen.[339]

The privy or garderobe was the room in which the family members could attend to their bodily needs. The family would share one privy. Small ventilation windows were provided. The privy had a seat and from it a pipe extended to the ground level, where it emptied into a cesspool. The ends of these pipes were often decorated by rather grotesque faces with open mouths. [340]

Scattered about the house one would find a variety of small wash basins set into the walls. These were called lavers. They were often decorated with arches and

[337] Ibid. p99-116
[338] Ibid. p161-163
[339] Ibid. p250-255
[340] Ibid. p382-388

stonework. [341] Baths were much like tubs today. They often had a canopy for privacy, and wall pipes and storage tanks brought in the water. [342]

The roof of a manor would be trussed. Wind braces were added to give lateral stability to the structure. Some of the support schemes for these houses are quite interesting and complicated, but most followed the same design as in fig. 82. [343] Actual roof coverings could be made from slate, weather-boarding or from tiles.[344] Windows were used in great numbers to bring light into the house. Only the rich had glass windows, which were made in smaller panes. The common style of this time was to have the windows arched and very ornate.[345] The floor of the house was made from painted tiles. [346]

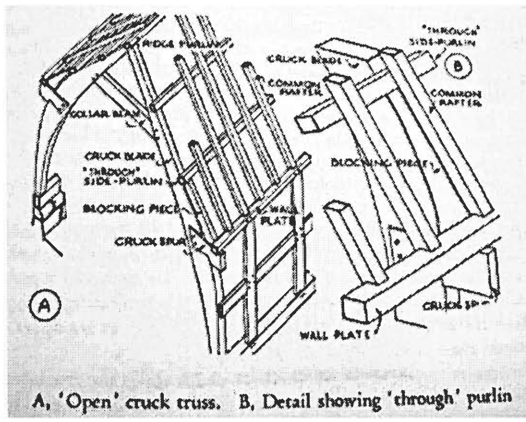

Figure 86 Diagram of a trussed roof. (From Wood, 1983)

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[341] Ibid. p369-370
[342] Ibid. p372, 374-376
[343] Ibid. p302-324
[344] Ibid. p292-299
[345] Ibid. p358-362
[346] Ibid. p392-393

Timber Houses

Figure 87 Timber homes in London. (From Wood, 1983)

Timber homes were made in a different design from stone homes. For those who lived in a city timber houses were long, the central section being the great hall with living rooms at either end to create something of a stunted H shape. The walls were made from wattle and daub and the floors were made of mortar. The central hearth persisted in this style of house, fireplaces becoming common in the 16th century.[347]

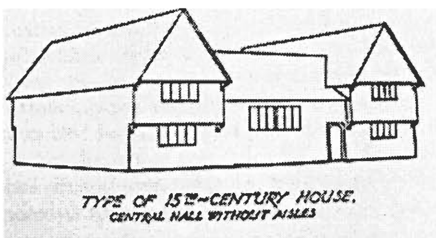

Figure 88 Typical 15th Century timber house. Features central hall. (From Wood, 1983)

Timber houses in villages were made far more simply. They usually consisted of one room, sometimes with a second story room for sleeping. The central hearth was still used. The roofs were crucked. Thatch was still used for the roof covering. The farmhouses were kept separate. [348]

Castles

Castles are not very unique, architecturally. The style is that of a stone manor, only made larger and more heavily fortified. The only difference that is worth noting may

[347] Ibid. p216-219
[348] Ibid. p216

be that the castles extended the L or H shaped plans of the manor houses in order to become a completely encircled structure.

Furnishings

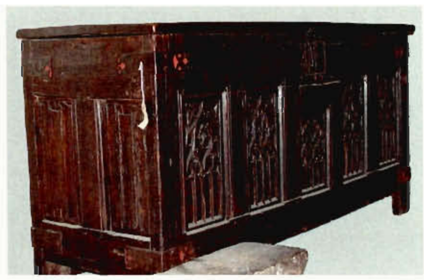

Figure 89 Carved trunk from France, dated to 15th century. (From Higgins Armory Collection, 998)

Most furnishings in the house were decorated to some extent. In wealthy households, many articles of furniture contained examples of turning or elaborate carvings. In an average house, many pieces of furniture were not permanent and tended to be moved around. Because of this, tables and chairs could be disassembled or folded if the space was needed for something else. Furniture could also be expensive and items in a poor house and a wealthy one generally differed in quantity and quality.

Figure 90 Detail of carving from fig. 89. (From Higgins Armory Collection, 998)

Chairs

The most common chair was the x-framed chair. The chair was made of two connecting x-shaped frames with a leather or cloth seat. It was easy to move and often folded. Towards the end of the 15th century, the x-chairs lost the ability to fold but remained the same otherwise.[349]

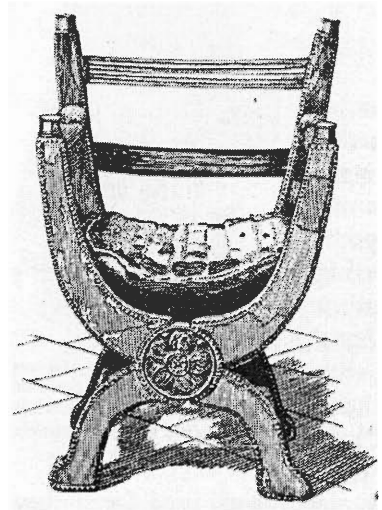

Figure 91 X chair. (From Singer, 1956)

Another type of chair found was the armchair. This chair is very similar to modern chairs, but could have three or four legs. Armchairs were a more permanent type of furniture and usually displayed turned or jointed components.[350]

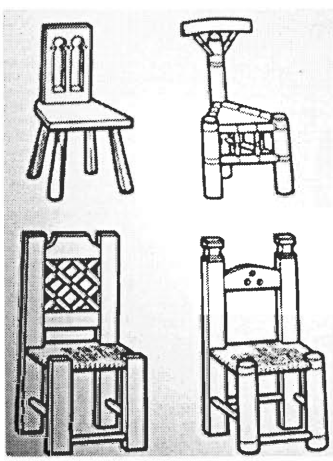

Figure 92 Types of back stools. (From Chinnery, 1979)

More common than chairs were stools. Usually made by turners and carpenters, the stool could have either three or four legs and varied in height. The back stool first appeared during the late fifteenth century and was similar to modern chairs. It literally was a square stool with a backrest.[351]

The settle, a high backed bench or wall bench, was also common. Settles were usually located around the hearth or fireplace or behind a long dining table.[352]

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[349] Chinnery, 1979. p232
[350] Ibid.
[351] Ibid. p276-7
[352] Ibid. p235

Tables

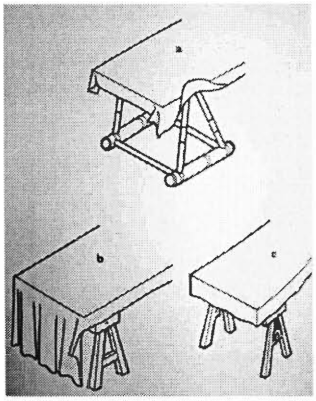

Figure 93 Trestle tables. (From Chinnery, 1979)

Tables were narrow and were made of one piece. The trestle table could easily be disassembled or turned and put aside if more space was needed.[353] The table was covered with cloth (wealthy people used linen or silk of was available and the lower class used canvas) and napkins or towels.[354]

Beds

The tester bed consisted of three pieces: the base where the bedding is laid (bed stock), the headboard, and the canopy over the bed (tester). Many testers were made only out of fabric and supported from the ceiling.[355]

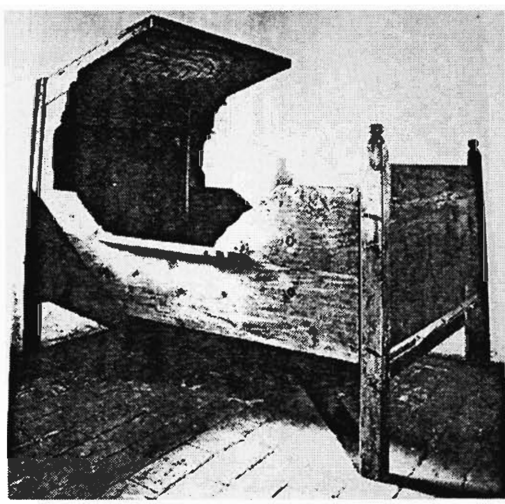

Figure 94 A tester bed. (From Windisch-Graetz, 1982)

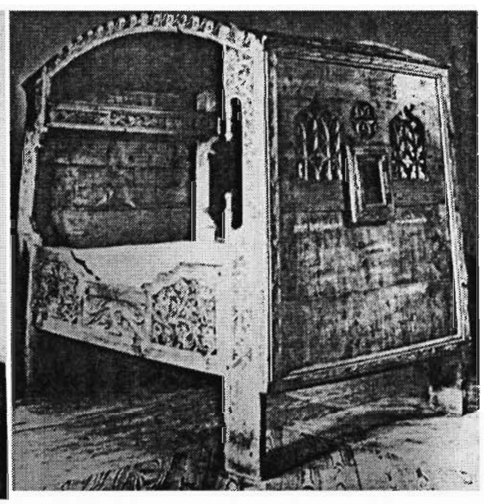

Figure 95 Another type of tester bed. (From Windisch-Graetz, 1982)

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[353] Ibid. p284
[354] Singman. 1995. p166
[355] Chinnery. 1979. p385-7

The pallet bed was used more by poorer people.[356] It consisted simply of a straw mattress placed on the floor of the house.[357]

Cupboards (Ambries)

Ambries were freestanding storage spaces for clothes, food, or dishes. Ambries varied in size and decoration, often containing turned or joined components. Press cupboards were entirely enclosed and have either one or two doors[358] while livery cupboards can have a canopy and usually only have one door[359]. The mural cupboard took care of small storage needs, such as spices. It was hung on the wall of the house supported by a wire hanger or by a nail through the back of the cupboard.[360]

Cup-boards

The cup-board was literally a board on which drinking cups were placed.[361] It took the form of an open side table without doors and often built into the house itself.[362]

Eating Utensils

People during this time ate with a knife and a spoon.[363] The knife was usually a hunting knife of sorts and the spoon could be made of wood, bronze, iron, or horn. Forks were rare and generally used for serving in the kitchen.[364]

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356 Singman. 1995. p87
357 http://dictionary.oed.com/
358 Chinnery. 1979. p323
359 Ibid. p319
360 Ibid. p329
361 Singer. 1956. p241
362 Chinnery. 1979. p312-15

Tableware

Plates, bowls, and cups were either made of turned wood or ceramics. Pewter and glass tableware were reserved for the wealthier citizens.[365]

Trunks and Chests

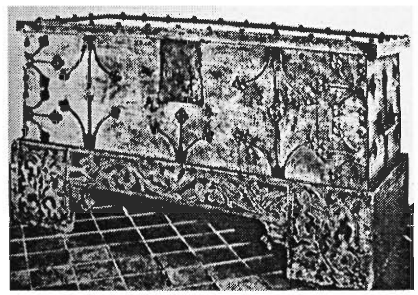

Figure 96 A trunk. (From Windisch-Graetz, 1982)

Jointed or boarded chests were used as storage spaces for mostly linen and clothing. Coffers were very similar to chest; the main difference being the coffer was made by a coffer make instead of a carpenter or jointer.[366] Coffers were used more to store valuables.

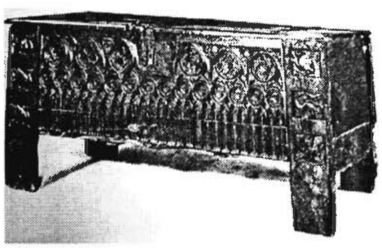

Figure 97 A carved trunk. (From Windisch-Graetz, 1982)

Chests and trunks were very common because they were inexpensive and had many different uses in the house.[367]

Tapestries and Wall hangings

Tapestries were owned by those who could afford them and used for decoration and insulation. The rich owned woven tapestries while the poor would use a painted cloth for the same purpose.[368]

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363 Singer. 1956. p125
364 Ibid. p128
365 Blair. 1991. p68
366 Chinnery. 1979. p358-60

Horn Products

Spoons

To make a horn spoon, a section of horn plate was boiled and placed in a mold. Medieval molds were usually wooden, made of two carved pieces hinged with leather and closed with an iron ring. After the horn had dried and cooled, it could be removed from the press. At this time the spoon could be cut to any shape, carved with a design and was generally sanded or polished.[369]

Combs

A plate of horn would be cleaned and smoothed and then the teeth would be cut along the grain of the horn. The horn had to be smoothed before cutting the teeth because smoothing after the teeth were cut would often break the comb.[370]

Horn Containers

A piece of horn was cut to the size needed. The inside was hollowed out and a plug was used to seal the bottom. A cover could be made using a wad of rags or a cork.[371] Horn cups were made the same way, although they could also be made by hollowing the horn and leaving a "tail" or flat piece of horn attached to the bottom. This piece could then be heated and folded over to form a flat bottom. [372] Inkwells were basically horn

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[367] Singman. 1995. p86
[368] Ibid. p85
[369] http://www.personal.utulsa.edu/~marc-carlson/horn/hspoon.html. 2001
[370] http://www.personal.utulsa.edu/~marc-carlson/horn/hcomb.html. 2001
[371] http://www.personal.utulsa.edu/~marc-carlson/horn/hcont.html. 2001
[372] http://www.personal.utulsa.edu/~marc-carlson/horn/hcup.html. 2001.

containers. Horn worked well for these kinds of containers because of its watertight qualities.

Tinder Horn

Tinder horns are made the same way as the horn containers, although a variant on the design would involve taking the horn in its original, uncut form and hollowing it, then drilling a hole in the side and using a strip of leather running through the inside of the horn to attach the horn to its plug. The leather strip could be pulled to force the plug into the mouth of the horn tighter. [373] The purpose of a tinder horn was to provide a watertight container for keeping tinder dry.

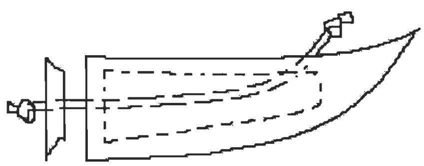

Figure 98 Diagram of a tinderhorn

Horn bow tips

Horn bow tips would be made by carving a piece of solid horn. The bow tips were used to anchor the string to the frame of the bow. They were essentially rounded end-pieces with a notch, called the nock, carved into the side.[374]

[373] http://www.personal.utulsa.edu/~marc-carlson/horn/htind.html. 2001.
[374] http://www.personal.utulsa.edu/~marc-carlson/horn/hbow.html. 2001

Horn "Glass"

Horn was once used as a substitute for glass, mainly in lanterns. To achieve this effect the lightest, thinnest and most translucent section of a horn was selected and soaked in water for a month. After this time it would be cut and shaped, then delaminated into thin layers. These layers could be coated with tallow and pressed between hot iron plates, further thinning them and making them more translucent. [375] Horn glass would then be polished with charcoal and water applied with a woolen cloth.[376]

"Gemshorn"

15th century illustrations have been noted to depict the use of small recorders made of horn. These become known as gemshorns around the 19th century. This recorder could be made by hollowing out a horn so the sides are very thin. One end is then plugged with an airtight seal with a tiny slit for a wind hole. Holes are then drilled along the side of the horn and shaped very carefully. The shape and size of the holes affected the tune and pitch of the horn. [377]

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[375] http://www.personal.utulsa.edu/~marc-carlson/horn/hlant.html. 2001.
[376] Theophilus. 1979. p189.
[377] http://www.personal.utulsa.edu/~marc-carlson/horn/hgems.html. 2001.

Glass Products

Drinking Vessels

Drinking vessels such as cups or bowls were commonly made from blown glass. The rich generally owned them. Middle-class families, if the glass was available, only used it at special occasions.[378]

Windows

Windows were prepared from large sheets of glass. Glass windows were limited to the wealthy and most commonly found in churches and cathedrals in the form of stain or painted glass. Stained or painted glass here allowed light in as well as displayed religious artwork for the people.[379]

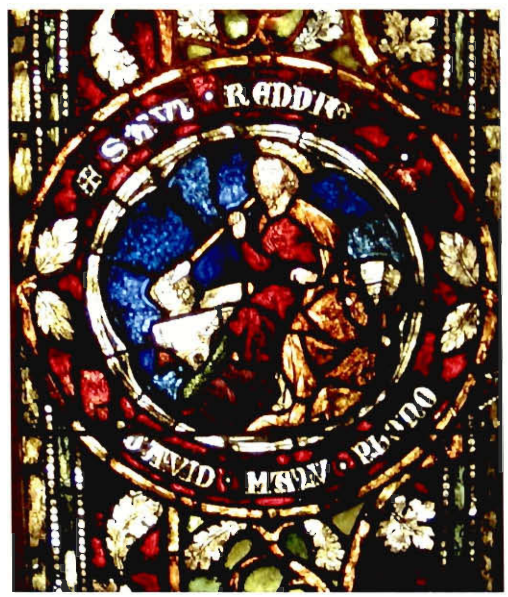

Figure 99 Replica of painted 13th century German painted window. (From Higgins Armory Collection, 2939.2)

Jewelry

Rings

Glass rings were made using molten glass and a piece of sharpened wood approximately 8 inches long with a wooden disk ¾ of the way down the length referred to as a spit. A small amount of molten glass was picked up by the tip of the spit. The spit was then driven into a woodened post so the

[378] Brown. 1991. p40
[379] Ibid. p42

hole went all the way through the glass. The glass was heated to loosen it and spin on the spit to form the ring shape.[380]

Beads

Glass beads were made in a way similar to rings. Instead of heating the glass and spinning it, the glass would be taken off the spit and cooled.[381]

Clay Products

Containers

Clay containers were made by the thrown pottery process. This included vases, bowls, pitchers, etc. Large vessels were usually made in two parts, and then fitted together. Shallow vessels, such as plates, were formed upside down by putting a ball of clay upside down on a convex mold placed on the top of the potter's wheel.[382]

Bricks

Clay bricks were made by the molded clay process. The bricks as building material in kilns and were foundation of most buildings.[383]

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[380] Theophilus. 1979. p74
[381] Ibid. p74
[382] Singer. 1956. p281
[383] Ibid. p304

Tiles

Clay tiles were also made from molded clay. They were most commonly found as roofing tiles. Roofing tiles were molded into a ^-shape or left flat.[9] Tiles were also used for floors in churches, palaces, and some large manor houses.[385]

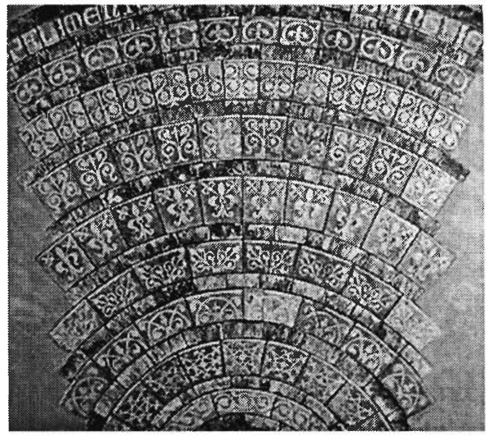

Figure 100 Painted clay tiles. (From Blair, 1991)

Lighting

Flint and Steel

Before the invention of sulfur matches, there were two methods of creating fire: friction between two pieces of wood, or striking sparks from flint and 'steel'—in reality, any ferrous metal. In Europe in the 1400s, the flint and steel method was by far the most common. One held the steel with striking edge exposed, then struck sharply downwards at an acute angle with the flint. Tiny pieces of red-hot steel would be flaked off by the flint and fall on the dried kindling. In the Middle Ages, flint, steel, and tinder consisting of flax, plant down, dry-rotted wood, charred cloth, hemp, or a type of fungus would be stored in leather purses.[386]

[384] Blair. 1991. p198

[386] Caspall. 1987. p15-16.

Candles

Candles came in two types: tallow and beeswax. Tallow candles were made with animal fat, and were cheaper and thus much more common in the 15th century. Unfortunately, tallow candles smelled bad, sagged, guttered in the wind, and formed a sooty halo around the flames. Beeswax candles burned with a steadier, brighter flame and lacked the smell of tallow.[387]

The primary method of candlemaking in the 15th century was dipping. A rush or plaited wick would be repeatedly dipped into melted tallow or wax, adding layers until the candle reached the desired thickness.[388]

Candlesticks came in two types: pricket and socket. The pricket stick consisted in the 1400s of a spike to hold the candle and usually a drip tray to catch melted tallow or wax. The socket stick, well known to the Romans and forgotten during the Dark Ages, was re-invented in the 15th century and differed from the pricket only in that it held the candle in a small cup or cone, with slots on the sides to remove the burned-down stub.[389]

For portable light, candles were carried in hand lanterns to shield the flame from drafts. The tankard style lantern of the 1400s had a flat bottom, domed roof, and handle, and did indeed look like a drinking stein. Made out of sheet bronze or iron, it had a latching door on the side to insert the candle, and window panes made out of hide, glass, mica, or most commonly, horn.[390]

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[387] Ibid. p43.
[388] Robins. 1939. p17.
[389] Caspall. 1987. p71-74.
[390] Ibid. p224-225.

Rushlights

The rushlight was a very common form of light in the 1400s. It was made from the rush, a reedy meadow plant. Picked and soaked, the rushes would be peeled, leaving only a strip of the outer skin to support the pith. They were then dried, and soaked in melted oil or fat.[391]

The rushlight would be held in a rushnip, a stand with a pair of plier-like jaws held shut by a counterweight. The rush would be angled downward and lit at the bottom. The closer it was held to horizontal, the more light it would give and the faster it would burn.[392]

Splinter Lights

Splinter lights were similar to rushlights. They were made from a resinous wood like pine, which would be split into many long, narrow strips and burned like a rushlight.

Lamps

An oil lamp has a reservoir for its fuel, in which the wick soaks. In its simplest form, the wick hangs over the side of the lamp and needs to be pulled gradually forward as it burns down. Cresset and crusie oil lamps were the only kinds used in the 1400s. The stone cresset lamp had a groove or bowl carved into it for the oil and wick would hang over the side. The crusie lamp was made of bronze, iron, or pottery, and had an ovoid or circular well with a triangular spout for the wick.[393]

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[391] Ibid. p171-173.
[392] Ibid. p.176-176.

Soap

Soap in the fifteenth century was used for a variety of applications ranging from preparing textiles to washing one's face. Usually, though, all soaps were based on lye. For industrial applications the soap would be lye made by running through wood-ash and lime. For use in the home it was mixed with some form of fat or oil. Sixteenth century recipes say that soap could be made simply by stirring hot lye with oil and letting the mixture thicken.[394] "French" soap was made of 2/3 lye and 1/3 sheep tallow. "Saracen" soap was made from 2/3 lye and 1/3 olive oil. Saracen soap was more expensive and could be scented.[395]

Instruments

Astrolabe

The astrolabe is an astronomical tool for solving problems relating to time and the position of the sun and stars in the sky. It was one of the instruments used by ship navigators to find their way. The astrolabe was first introduce to Europe by Islamic Spain and was used until the mid 1600s when more accurate and specialized instruments were made. They were mainly manufactured in Augsburg and Nuremberg, Germany and some manufacturing took place in France.[396]

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393 Robins. 1939. p87-92.
394 Singer. 1956. p356
395 Singman. 1995. p87
396 www.astrolabe.org

Clocks

The first mechanical clocks were built in monasteries in the 13^{th} century. The clocks had no glass face and no minute hand. They were originally used as small alarms to tell the person whose job it was to sound the bells to call the monks to prayer services. Eventually, larger clocks were set up in public areas for the benefit of the whole population. Though most people were unable to read the numbers or the dial, they were able to count the strokes of the bell when it sounded.[397] In the late 15th century clockmakers realized that they could use the energy stored in a coiled spring to drive some clocks, enabling them to be moved around and positioned anywhere.[398]

During this period, the water clock and the sand clock were also in common use. Again, these clocks could only measure one-hour intervals. The water clock had been in use since the Roman times but had the problem of the water freezing. Sand hourglasses, though did not freeze, were subject to moisture until glassmakers took care to make sure that the glass was properly sealed.

Glasses (spectacles)

The idea of using glass lenses to improve eyesight was described by the English monk and scientist, Roger Bacon in the 13th century. Some people in Venice and China may have worn convex spectacles for close work around this time. Concave lenses, used to help short-sighted people see long distances, appeared in the 15th century.[399]

[397] McNeil. 1990. p23
[398] Ibid. p23
[399] http://www.lineone.net/encyclopedia/technology/c--inventions2-d.html)

Printing Press

The printing press was invented in 1450 by the German Johan Gutenberg. The printing press allowed books to be printed in a large quantity. Before the printing press, books were hand written by scribes or wood-block printing was used. Wood-block printing limited the number of each book because the block had to be periodically replaced when it wore out and a new block had to be made. This would cause a difference in the actual text and the font and style of the writing and was physically demanding. [400]

The success of the printing press was due to four things; paper, the press, ink, and type. The press had long been used in making wine. The type of ink used in the press was a water-based ink used by scribes. The type itself was made by metal-casting techniques already in use, however, Gutenberg was the first to use different sizes of type in the same work. The type consisted of an alloy made from lead and tin. This was chosen because of its low melting point and its resistance to wear.[401]

Ink

There were two methods for making black ink: one based on carbon content and one by using a gallate or tannate (salts) of iron. The two ink types could be mixed together if desired.

The first method obtained carbon from soot and burnt vine-shoots. The supply from the vine-shoots was trickier to get. Too much burning would result in ashes and pale ink and too little burning would make for a tarry substance brown in color.

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[400] McNeil. 1990. p669
[401] Ibid. p670

The second method was made of a mix of crushed gall (a growth found on trees), usually oak, with iron salts. This produced a pale brown that was darkened before use.[402]

Paper

Papermaking was introduced to Europe from China in the mid to late 1300s and became widespread in its use in the next century. Paper became a cheap alternative to vellum with the rise of the textile industry at this time. Leftover or waste linen rags were used.

The rags were cut into small pieces, boiled and allowed to ferment to assist in the disintegration process. The fibers were mixed with water, making a substance with the consistency of a thin porridge. A wooden framed with a mesh of brass wires and heavier wires perpendicular to them was used as a mold for the paper. This frame was dipped into the pulp mixture and another frame was placed over the first, sandwiching the pulp. The frames were shaken to interlock the fibers and remove excess water.[403]

Writing Utensils

The main implement of writing was the quill pen. It made from a primary feather of a bird, usually a goose but sometimes a raven or swan, and the tip was sharpened. The quill, however, was very fragile and wore out quickly. It generally only held enough ink to write a few words before needing more.[404] The quills were hand carved and mended with penknives.[405]

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[402] Singer. 1956. p359-60
[403] McNeil. 1990. p673
[404] Ibid. p667
[405] http://dictionary.oed.com/

Conclusion

This project has proved to be a great learning experience for everyone involved. Not only did we learn about the various aspects of medieval material culture, but we also learned a lot about methods of researching and writing reports such as this document.

To research for the individual sections, we went to several of the area libraries, took out interlibrary loans, and researched websites for sources. The research stage took the first two terms. Each project partner was assigned several sections to research and compose. We found that many of the websites created by enthusiasts rather than professionals were not very accurate when compared to books written on the same subject. There were also many books concerning periods before or after the fifteenth century which were very informative about technologies not used during our period. They are included in the bibliography for further reading. Primary sources were very difficult to find. The books we were able to find referred to documents contained in museums and private collections which average college students would never have access to.

Charles Singer's History of Technology was a very good source for almost all of the sections in this document. This book contained a section on every major craft that was used in the period from the height of Grecian civilization to the beginning of the Renaissance. There were several other books that provided information on several sections, but none as helpful as Singer.

Three books were very useful to us as primary sources; "On Divers Arts", "De Re Metallica", and "Mechanick Exercises". "On Divers Arts" by Theophilus was composed in the thirteenth century and detailed various handicrafts. "De Re Metallica" by Agricola was printed in the 16^{th} century, and was the authority on metallurgy until the beginning of the Industrial Revolution. "Mechanick Exercises" by Moxon is an extensive study on smithing, carpentry, joinery, and bricklaying techniques and was originally published in 1678. However, there was a problem finding sources for some of the more "common" crafts, such as horn crafting and basketry. For horn, the only source that we were able to find was a website, and we were unable to find any documentation, written or web-based, on basket making techniques. We believe this is partly due to the lack of archaeological evidence.

The final step was to synthesize the individual sections into one complete document and to create the website which would be available to public browsing. It is our hope that this website will be both informative and easy to navigate. It has a menu bar on the side of the screen containing the titles of the individual sections, which should make browsing easy even if the user does not know anything about the fifteenth century. The addition of pictures and captions is intended to make the document more accessible in its written and online versions.

During the final stages of the project we sought to obtain permission to reproduce the copyrighted images in this document. This proved to be a very difficult task. Some of the images we obtained from books were copyrighted, not to the publishers, but to a separate party. It was difficult to find these copyright owners to make our requests. Some publishers required additional information to grant approval. Still others could not tell us who owned the copyrights. We have made every effort to receive permission to use the images in this document. We acknowledge that some of the images were reproduced without having been able to contact the copyrght holder. It is noted on the accompanying web page that anyone who knows of a copyright issue should contact us.

This document is merely an overview of the material culture of the fifteenth century. Future IQPs could go more in depth into specific aspects of the technology of our period, such as military technology, mechanization, or metallurgy. Another idea for a future IQP would be the relationship between technological changes and social trends during the Middle Ages. There were also several smaller topics which we could not find enough information to write about, such as basketry. If another team were to expand on this project, that could be one subject they could explore further.

During the course of this project, we learned many things about the fifteenth century, and medieval life in general. However, despite all of the interesting facets of medieval life, we have to unanimously agree that we prefer living in the current era with its emphasis on technology (and electricity, hot water, Internet and other such comforts). However, the information we discovered during this IQP has improved our appreciation of the technologies used during the modern era, which for the most part have only been refinements of those of the fifteenth century (with the notable exceptions of devices with did not exist in any form then, such as computers and aircraft).

Bibliographical Information

Primary References

Books

Agricola, Georgius. De Re Metallica. Trans. Herbert Clark and Lou Henry Hoover. New York: Dover Publications, Inc., 1950.

Wealth of knowledge. Originally dates to 1556. Illustrations were also very useful.

Asser, Joyce. Historic Hairdressing. New York: Pitman Publishing, 1966

This book has a lot of sketches of hairstyles from the 15th century. Very interesting source.

Birdsall, Derek and Carlo M. Cipolla. The Technology of Man. New York: Holt, Rinehart, and Winston, 1980.

This book provides a good sense of the interconnectedness of history, and also has excellent pictures.

Blair, Claude. Eurpean and American Arms c. 1100 – 1500. London: B.T. Batsford Ltd., 1962.

Has many pictures of weapons, and very good descriptions of the evolution of weapons throughout the centuries.

Blair, John, and Nigel Ramsay, Ed. English Medieval Industries. London: The Hambledon Press, 1991.

Very useful book. A collection essays by various authors. Each section is well covered and contains a wealth of information.

Brown, Sarah and David O'Connor. Medieval Craftsmen: Glass-Painters. Buffalo: University of Toronto Press, 1991

An excellent source from the "medieval craftsmen" series. Has wonderful illustrations and information. Any other books from this series would probably also be very useful.

Caspall, John. Making Fire and Light in the Home pre-1820. Woodbridge, England: Antique Collectors' Club, 1987.

An exhaustive treatise on lighting, with many pictures.

Chinnery, Victor. Oak Furniture. Woodbridge, England: Antique Collectors' Club, 1979.

Has many good illustrations and explanations, although most of the information dates from other time periods.

Clark, John, Ed. The Medieval Horse and Its Equipment c.1150-1450. London: HMSO, 1995.

One of the excellent "Medieval Excavations in London" series. Quite technical and in-depth.

Clifford, C.R. Period Furnishings: An Encyclopedia of Historic Decorations and Furnishings. New York: Hall Publishing Co., 1949

This book has a wealth of sketches of period furnishings in different styles, as well as some textile patterns. Also has two pictures of 15th century homes.

Crowfoot, E., F. Pritchard and K. Staniland. Textiles and Clothing, c. 1150-c.1450. Rochester, New York: Boydell Press, 2001

From the "Medieval Finds From Excavations in London" series. Excellent resource, although very technical. Most of the book is aimed at archeologists, but introductory sections have a lot of information made more accessible.

Derry, T. K. and Trevor I. Williams. A Short History of Technology from the Earliest Times to A.D. 1900. New York: Oxford University Press, 1960.

Short to the tune of 700 pages. Still shorter than Singer, of which it is essentially an abridgement. Since this book is divided by category rather than time, period information is scattered throughout.

Edge, David and John Miles Paddock. Arms and Armor of the Medieval Knight. New York: Brompton Books Corp, 1988

The definitive source on the evolution of arms and armor throughout the middle ages. The pictures are fantastic and the descriptions are easy to follow. It also includes a glossary of terms in the back.

Gille, Bertrand, ed. The History of Technologies, Vol. I. New York: Gordon and Breach Science Publishers, 1986.

A survey of the development of techniques, which is an interesting take on history.

Hay, Denys. Europe in the Fourteenth and Fifteenth Centuries. New York: Holt, Rinehart, and Winston, Inc., 1966.

Very good source for the history of Europe during the fourteenth and fifteenth centuries. The writing is very easy to understand and has lots of useful appendices.

Hind, Arthur M. An Introduction to the History of Woodcut. Vol. I. New York: Dover Publications Inc., 1963.

Two volume set that tells about the use of woodcuts and the printing press, and gives examples of very early woodblock cuts in the second volume.

Hogg, Ian V. Fortress: A History of Military Defense. New York: St. Martin's Press, 1975.

Very good details of the construction and evolution of the castle.

Houston, Mary. Medieval Costume in England and France in the 13^{th}, 14^{th}, and 15^{th} Centuries. New York: Dover Publications Inc., 1996.

A very easy read if you want to know the basics of the trends in costuming during this century. Pictures are taken from various sources and illustrate her points well.

Koch, H.W. Medieval Warfare. London: Bison Books Ltd., 1978.

Decent sections on siege weaponry and the castle.

Kohler, Carl. A History of Costume. New York: Dover Publishing, 1963

Very in-depth look at fashion throughout Europe. It gives patterns and pictures, and discusses styles in individual countries during each period.

Mann, J. G. Notes on the Evolution of Plate Armour in Germany in the 14^{th} and 15^{th} Centuries. London: Society of Antiquitaries, 1935.

This is an interpretation of the work of Sir Guy LeFey, a rather large book. It condenses LeFey's writing down into a nice, short, clear description of less than 100 pages.

McNeil, Ian, ed. An Encyclopedia of the History of Technology. London: Routledge, 1990.

Similar to Derry and Williams, though with more of a bent to mechanization.

Merrill, George Perkins. Stones for Building and Decorations. New York: John Wiley and Sons, 1891.

By no means a source dated to the 15th Century, but included some useful information about stone working in general.

Milne, Gustav. Timber Building Techniques in London c. 900 to 1400. London: The London and Middlesex Archaeological Society, 1992.

Very in-depth book detailing the structure and construction of buildings unearthed by archaeologists. The introduction does give a brief overview of building techniques that can be understood by people not versed in archaeology, however.

Morrison, Sean. Armor. New York: Thomas Y. Crowell Co., 1963

This book didn't really provide good details about armor, but it did have a very interesting section on cannons.

Moxon, Joseph. Mechanick Exercises: or the Doctrine of Handy-works. London: Printed for D. Midwinter and T. Leigh, 1703.

Very good primary source detailing carpentry, joinery, smithing, bricklaying, and a few other crafts. The old English is sometimes a bit hard to follow but it is a fascinating read.

MS Porkington 10. J. O. Halliwell, ed. Early English Miscellanies in Prose and Verse. Warton Club, 1855

Contained some interesting information about dyeing of cloth, including recipes for various colors.

Murdoch, T. Treasures & trinkets : jewellery in London from pre-Roman times to the 1930s. London : Museum of London, 1991.

Good pictures. Had some information that we did not use.

Oman, Charles. Castles. London: The Great Western Railway, 1926.

A decent book, but it mostly discussed the decline of the castle and the sociological reasons behind it rather than the actual construction of castles.

Robins, F.W. The Story of the Lamp (and the Candle). London: Oxford University Press, 1939

A very useful resource, although it has few pictures of artifacts from the 15th century.

Singer, Charles Joseph. A History of Technology. Vol 2. New York: Oxford University Press, 1956.

The Last Word on the history of technology. So much information that sorting through it took a while. If mankind ever used it, it's in this book. We love this book.

Singman, Jeffrey and McLean, Will. Daily Life in Chaucer's England. Westport, Connecticut: Greenwood Press, 1995.

Explains daily life in the 14th century. Much of the information is still applicable in the 15th century.

Theophilus. On Divers Arts. New York: Dover Publications Inc, 1979.

This source originally dates to the 12th century, but still very useful for our project. Included a lot of information about various handicrafts.

Thompson, M.W. The Decline of the Castle. Cambridge: Cambridge University Press, 1987

Again, a good read about the historical and sociological decline of the castle, but not much about its actual construction.

Wagner, Eduard, Zoroslava Drobna, Jan Durdile. Medieval Costume, Armor, and Weapons. Czechoslovakia: Andrew Dakers ltd, (No publishing date).

Decent book about costume, armor, and weapons. Mostly deals with the area around Germany, Austria, and the Czech Republic.

White, Lynn Jr. Medieval Technology and Social Change, New York: Oxford University Press, 1962.

Last section is most useful. First two sections are before 15th century. Should yield some information.

Windisch-Graetz, Franz. Furniture of the Middle Ages. vol. 1. Munchen: Mobel Europas, 1982.

Written in German, but has excellent pictures. Luckily, some of us spoke enough German to find the pictures associated with our time period and figure out what they were.

Wise, Terence. Medieval Warfare. New York: Hastings House Publishers, 1976

If it's known about medieval warfare, it's in this book. There were several excellent chapters detailing the siege and siege weaponry.

Wood, Margaret. English Medieval House. New York: Harper & Row, 1983

Very detailed resource tracing the development of the various rooms of the house. Has many good illustrations, also.

Internet Sites

Paul J. Gans. Medieval Technology Pages. 19 July 1999. New York University. http://scholar.chem.nyu.edu/technology.html

Includes many example of medieval technology, has a link to a timeline and refers to many other authors. If you follow the above link back a step to the base page, there is a link there to a course in Medieval technology and daily life. Following that link gives a lecture outline. In this lecture outline, each lecture contains several links on the same topic.

Laura Blanchard. ORB: The Online Reference Book for Medieval Studies. Carolyn Schriber. 2000. http://orb.rhodes.edu/

Mostly a search engine but also has an encyclopedia and teaching references. Not affiliated with any college or institute.

Marjorie Senechal. Smith College Museum of Ancient Inventions- Home Page. 1998. Smith College. www.smith.edu/hsc/museum/ancient_inventions/trebuchet2.html www.smith.edu/hsc/museum/ancient_inventions/keelbreaker2.html

Has a brief analysis of the trebuchet and the keelbreaker, with some good information. May also have other inventions from the 15th century.

James E. Morrison. www.astrolabes.org/HISTORY/HTML. 5 April 2001

Discusses the astrolabe in great detail, with some information regarding the 15th century uses and developments. Appears to be fairly thorough and lists resources.

Marc Carlson. *Using and working with Horn* - Horn Use in the Middle Ages. http://www.personal.utulsa.edu/~marc-carlson/horn/. 2001.

This is an excellent resource. The author provides bibliographies and notation to his work and is very thorough in his presentation. Complete reference regarding horn and leather.

The Columbia Encyclopedia, 6th ed. New York: Columbia University Press, 2001. www.bartleby.com/65/ .

The encyclopedia is always useful.

Muhlberger, Steven. "Medieval England". 1999. Orb Reference Book for Medieval Studies. http://Orb.rhodes.edu/textbooks/Muhlberger/hyw_end.html

Very good site detailing the many political events that happened during the fifteenth century.

Rick Cavasin "Leatherworking in the Middle Ages - Period Leather". http://www.personal.utulsa.edu/~marc-carlson/leather/pl.html#pl1. 1996.

A good site with lots of information and well-recorded sources.

Ben Levick and Roland Williamson. "Glass and Amber". http://www.regia.org/glass.htm May, 1999

Another useful web resource. Had some relevant information.

Ken & Sally Custer. Glass Plus Inc. "History of Glass".

http://www.glassplusinc.com/history_of_glass.htm 2000.

A glass company's website containing information on the history of glass.

Medieval and Rennesiance Book Production- Manuscript Books. Richard W. Clement.

http://orb.rhodes.edu/encyclop/culture/books/medbook1 1997.

Contact

Jenna and Robert Reed
Jlrreed@ix.netcom.com
603-598-6813

Mr. and Mrs. Reed represent the Wolfe Argent company. Wolfe Argent performs 15th century reenactments. Provided many resources and helpful hints or information.

Lynette Hart.
508-798-0997

A helpful resource in the area of textiles, expecially historical weaving. Interviewed on 5 Dec 01.

Suggested Sources for Further Reading

This section contains materials we read through but did not actually cite in the finished document.

Books

Bishop, Morriss. The Middle Ages. New York: American Heritage Press, 1970

Wealth of knowledge in a general sense, but it's all very jumbled up. Also, has no bibliography at all. Still, seems to hold a lot of useful information.

Bloch, Mark. Land and Work in Medieval Europe. Los Angeles: University of California Press, 1967

Contains some information, although it is a bit sparse. Index and notes are very useful.

Brooke, Christopher. The Structure of Medieval Society. New York: McGraw-Hill Book Company, 1971

Excellent pictures. Pp. 14-15 show three panels of daily life in three classes.

Chrimes, S. , Ross, C. and Griffiths, R. (Ed). Fifteenth Century England: 1399-1509, New York: Manchester University Press, 1972

Excellent history resource. May show some material culture information along the way, as well.

Cotterell, B. and Kamminga, J. Mechanics of Pre-Industrial Technology, New York: Cambridge University Press, 1990

A very technical treatment of everything from flint arrowheads to musical instruments. Very in depth, but it has a wealth of information.

Coulton, G. G. Life in the Middle Ages. New York: The Macmillan Company, 1931

Excellent daily life resource. A collection of short primary source information, such as poems and stories and tips for daily life.

Cutts, Rev. Edward L., B.A. Scenes and Characters of the Middle Ages. London: Virtue and Co.,Ltd.

It's really hard to tell if the illustrations in this book are actual woodcuts from the Middle Ages, or if they are sketches of images from such woodcuts, or if they are just contemporary artists' renderings. Also, this book has no bibliographical information. With those problems aside, this books still provides a wealth of information regarding military technology, as well as some interesting material about daily life and trade.

DeMolen, Richard L. (Ed). One Thousand Years : Western Europe in the Middle Ages, Boston: Houghton Mifflin Company, 1974

Tidbits are to be found in this book, but not very much. Has some promising resources.

Forbes, R. J. Man the Maker; a History of technology and Engineering. New York: Abelard-Schuman, 1958.

A more lyrical, aren't-opposable-thumbs-great? treatment. Dated, but with a section dedicated to medieval technology.

Fox, Robert. Technological Change: Methods and Themes in the History of Technology. United States: Harwood Academic, 1996.

An anthology. The article about milling may be useful.

Harpur, James. Revelations: The Medieval World. New York: Henry Holt and Company, 1995.

Has good information, although not all of it covers the 15th century. It's arranged as an introductory book and, while visually stunning, mentions many subjects briefly rather than discussing any topics in depth.

Huizinga, J. The Waning of the Middle Ages: A Study of the Forms of Life, Thought and Art in France and the Netherlands in the XIVth and the XVth Centuries, London: Edward Arnold (Publishers) Ltd., 1924

Good history book. Excellent bibliography. Could provide a lot of background material.

Jacob, E.F. The Fifteenth Century: 1399-1485, Oxford: Clarendon Press, 1961

Another excellent history resource.

Klemm, Friedrich. A History of Western Technology. Ames: Iowa State University Press, 1991.

Similar to Derry and Williams, but gives medieval technology its own section.

Lilly, S. Men, Machines, and History: a short History of Tools and Machines in Relation to Social Progress. London: Cobbett Press, 1948.

A history of technology with a more sociological leaning.

Meadowcroft, Kirk. Apes, Ivory and Jade: Essays on the Minor Arts. New York: Richard R. Smith, 1963

Includes some sparse information related to the 15th century in regards to uses of ivory.

National Gallery of Art (U.S.). Fifteenth Century Woodcuts and Metalcuts.

While this book, for some reason, has no printing information, it's still a source of excellent woodcuts and metalcuts. Each image is carefully reproduced and catalogued. This is an extensive collection, and very interesting. A lot of the images are religious in nature, but some depict daily life scenes.

Pacey, Arnold. Ideas and Idealism in the Development of Technology.

An interesting take on the subject. Has a chapter covering innovations in the late Middle Ages.

Power, Eileen. Medieval People. New York: Barnes and Noble, Inc., 1964.

Follows and explains the stories of several historical figures. Includes a very thorough notation system, which could be a very useful source on it's own.

Rice, Eugene F. Jr. The Foundations of Early Modern Europe: 1460- 1559, New York: W. W. Norton and Company, Inc., 1970

Excellent description of printing and paper production in first chapter. Also, some mention of other material items in second and third chapters on commerce and merchants. Also information on guns and cannons in warfare chapter.

Souchal, Genevieve Masterpieces of Tapestry from the Fourteenth to the Sixteenth Century. Paris: Impremerie Moderne du Lion, 1973.

A collection of images of tapestries, as well as a brief summary of each one. Some images are printed in color, while the majority are black and white. Quality of printing on some pictures is lacking, but the majority are presented well.

Staniland, Kay. Medieval Craftsmen: Embroiderers. Buffalo: University of Toronto Press, 1991.

This book is an excellent source. It is a comprehensive look at medieval embroidery, with lots of good pictures. The presentation is aimed at a high school audience and is very easy to read and understand.

Zacour, Norman. An Introduction to Medieval Institutions, Toronto: MacMillan of Canada, 1969

Chapter 4, industry, should provide some information on material culture. Unfortunately, has no bibliography.

Internet Sources

Eric Kondratieff. Forum Antiquum 13 February 2001. University of Pennsylvania School of Arts and Sciences. http://www.sas.upenn.edu/~ekondrat/medieval.html

A directory for more web sites. Has some very promising material which is well organized. Unfortunately, some of the links are unavailable. Many of them are school webpages, which are subject to change.

Author Unknown. Medieval Europe Links. Nina Lerman. 23 August 2001. Whitman College. http://www.whitman.edu/offices_departments/history/medieval.html

All links, but some appear to be interesting. Main history page (history/index.html) may also be useful.

Mike Madin. Medieval History Resources- Middle Ages. 23 August 2001. Academic Info. http://www.academicinfo.net/histmed.html

Links section, emphasis on Byzantine and Russia with woman's studies. Links to the Richard the Third Foundation, Inc. which turned up on another web page. This organization can be a credible resource.

15th Century Life Sponsored by the Richard III Society. http://www.r3.org/life/

Has articles about 15th century life and a bibliography plus access to an online library. Has no authorship information, but does have an email address for feedback which can be another way of finding such information.

Specialized Encyclopedias for Medieval Studies. 28 August 2001. Stanford University Libraries/ Academic Information Resources. http://www-sul.stanford.edu/depts/ssrg/medieval/diction.html

Large bibliography, mostly concerning the church.

James Masters. History of Games. 2001.
http://web.ukonline.co.uk/james.masters/TraditionalGames/index.htm

Nice history of common games, including the equipment used to play and time periods of invention

Russell Minors. The Grey Company Trebuchet Page. February 2000.
http://members.iinet.net.au/~rmine/gctrebs.html

Has historical pictures of trebuchets (mostly wood cuts), as well as historical references and the mechanics of building the trebuchet.

Regia Anglorum Listings. Roland Williamson. 20 March 2000. Regia Anglorum Publications. http://www.regia.org/listings.htm

Lots of pages on technology of anglo-saxon villiage. However, most of it is outside our period.

netLibrary. 2001. NetLibrary, Inc. www.netlibrary.com

This online library can be a great resource. It's essentially a collection of books online in their entirety. Books available can be quite limited and tend to be more aimed at popular consumption than research.

Medieval History. 2001. About.com, Inc. http://historymedren.about.com/mbody.htm

About.com (formerly MiningCo) provides on-site articles and link libraries for a variety of topics. Their medieval pages are very good.

Beau A.C. Harbin. NetSERF. 2001. http://www.netserf.org

A clearinghouse of medieval websites, organized by topic. Only mediocre for technology, but possibly useful for other areas. While not exclusively linked to one college, is associated with two colleges, one historical group and Amazon.com.

Dr. Patricia Backer. Technology in the Medieval Age. 14 August 2001. San Jose State University. http://www.mastep.sjsu.edu/history_of_tech/middle.htm

Lots of links and a good bibliography. Also seems to have a lot of basically good information analyzed by a good source.

SCA: Compleat Anachronist Index. http://www.pbm.com/~lindahl/ca.index.html

Contains a few interesting articles on medieval culture, such as 14th and 15th century German counted-cross embroidery, brewing, and Medieval merchants and artistans. No authorship info on the page, unless you count that weird name at the bottom. There is a contact email address, though, so you can get authorship that way.

Mark Harris. Stefan's Florilegium Archive. http://www.florilegium.org/

Has a lot of links to articles dealing with a wide variety of subjects from the uses of beeswax to heraldry. Also has a links page. Another site that is woefully short on authorship info. The authors name above is something of a guess.

JSTOR: Speculum. 2001. JSTOR. http://www.jstor.org/journals/00387134.html

Medieval research journal. It has a lot of interesting articles, however the site itself is difficult to navigate. Information from this site can be hit-or-miss but is more somewhat more reliable as a resource than other sites since it is a "scholarly" journal.

Martin Irvine and Deborah Everart.The Labyrinth Search Engine. 2001. Georgetown University. http://data.georgetown.edu/labyrinth/display.cfm

Search engine with a lot of links. Didn't get a chance to explore this site much, but it is very easy to navigate and the articles reviewed seemed well done.

Sample Images of the Webpage

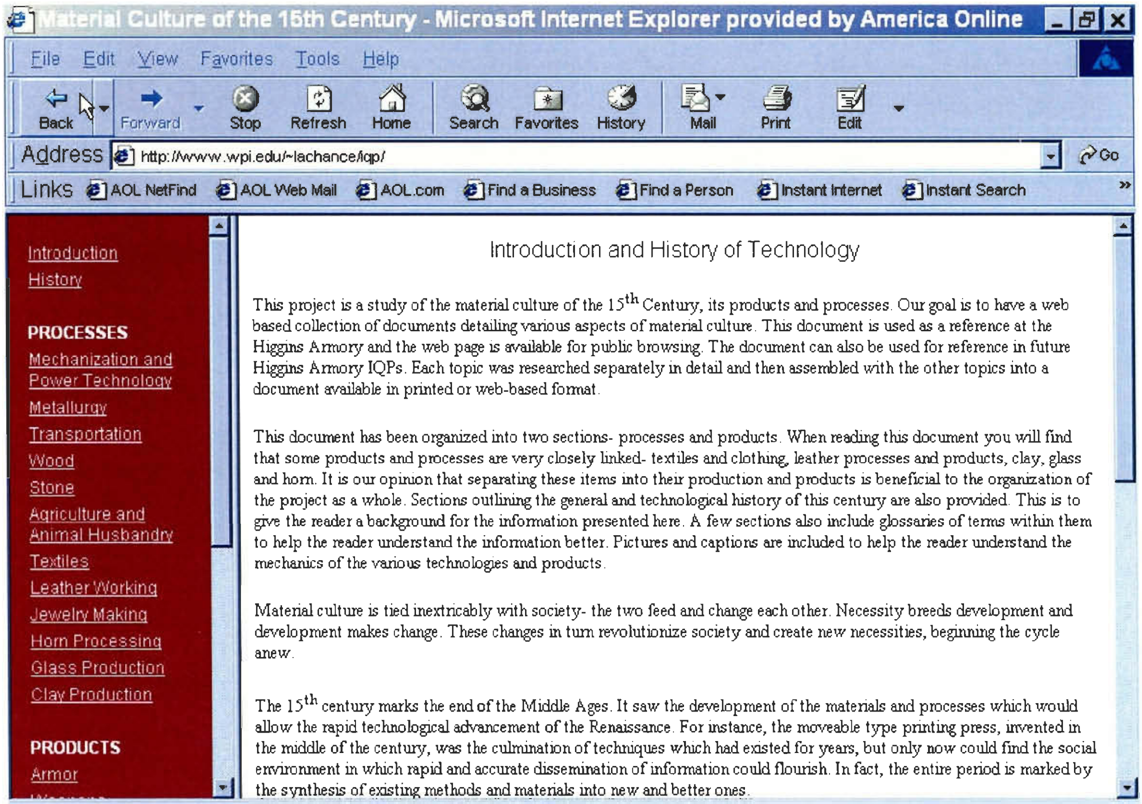
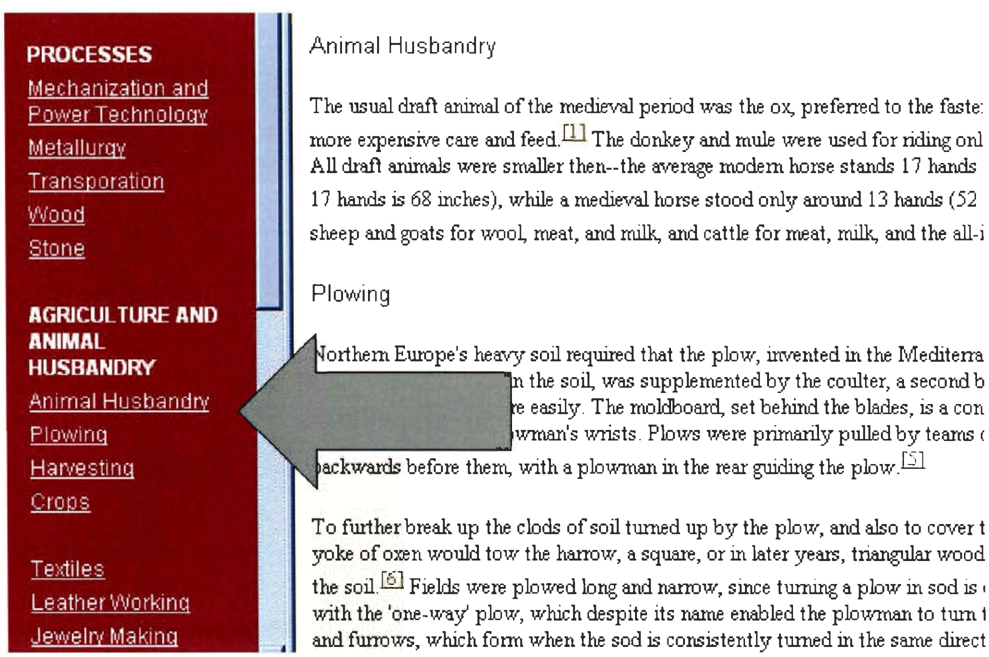


Image of a Typical Page Layout

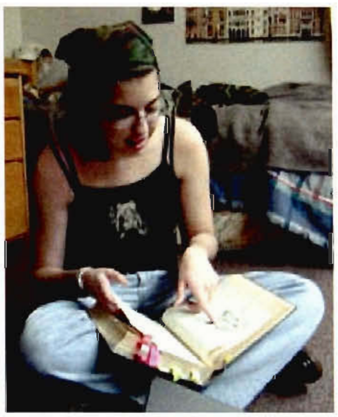


Extended Site Menu Highlighted by Arrow

Our IQP Group

JEN ZIMMERMAN

Jen is an ME/AE major, graduating in May 2003. For her sufficiency Jen composed and arranged a piece of music. Jen did a lot of driving during this project. She also wrote the sections on armor, weaponry, siege weapons and fortifications, history and clothing. She probably spent the most time of any of us in the Higgins Library and she spent a lot of "quality time" with the scanner.



CAROLYN LACHANCE

Carolyn is also an ME/AE major, also graduating in May 2003. Carolyn wrote the sections on mechanization and power technology, metallurgy, agriculture, lighting, transportation and the history of technology, which started as a separate document and became part of the introduction. She was also our goddess of programming, doing most of the HTML for the web page.

LEANNE HOFFMAN

Leanne is the lone BBI major of the group, graduating in May 2003. She wrote the sections on glass, jewelry, clay, the section on sanitation, which was not used, furnishings and instruments. She was also our main contact with the publisher, handling the issue of copyrights, and drew up the outline for the project. She is keeper of the "No!" list.

LAUREN BEAUMONT

Lauren is the third ME/AE major in the group, graduating with everyone else in May 2003. She completed her sufficiency in German. She wrote the sections on textiles, horn, leather, stone, architecture and soap. She also compiled and formatted much of the final paper, especially the illustrations. She used to drive the group around until her car became no more.