THE EVOLUTION OF MATERIALS IN ARMS AND ARMORS: ANTIQUITY ERA

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ABSTRACT

This project was a study of the development of armors from 8th century BC to 4th century AD. The project was mainly focused on the evolution of armors in Europe, for which a wealth of information was present and the use of armors was extensive. To fulfill the breadth of the project, we also broaden our research to some large cultures in the regions of West Asia. The designs, metalworking techniques, materials, and improvements of armors were the emphasis of this project. Fabrication of a replica of an armor was also undertaken using only the technique allowed by the most simplest of tools in order to simulate the ancients' way of armor making. A database in the form of a website was created containing all the information relating to this project.

ACKNOWLEDGEMENTS

We would like express special thanks to our advisors, Professor Diana A. Lados and Mr. Tom H. Thomsen, for their continuous and valuable critiques, advice, and support throughout this long-term project. We would also like to thank Mr. Fay Butler, who generously provided us with hours of instruction and plenty of equipment. Without his generosity and experience, making the real pieces of armor, which is one of our main objectives in this project, would not be possible. We would also thank the staffs of Higgins Armory Museum, who provided us with great source of information.

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I. INTRODUCTION

The purpose of this project is to create a resource for those interested in the study of armors from the 8th century BC to the 4th century AD, a period known as antiquity. This resource will show the differences between armors separated by time and region. An online database containing this information will also be produce in order to allow the greater public access to this information. It is our hope that this information will further advocate the true and accurate portrayal of the human history.

Time has shown humans to have a keen ability to create objects of destruction with the ability to harm both themselves and other species. To protect themselves against these objects, they came up with tools; tools that have come to be known as armors. As weapons evolved over time, so did the armors that accompanied them. This project is a study of that evolution; how its material, design, and manufacture changed through a selected period of time.

Due to the vastness of time and the lack of information concerning certain periods and regions in time, this project will focus on only those time periods that contain a myriad of information, and where the use of armors was predominant. These periods are the pre-medieval period of antiquity and the medieval period. This project will focus itself on the pre-medieval period of antiquity. This period spans form the 800BC to around 400AD. The myriad of information for this period exist because this era is also the transitional period from the ancient world to the medieval world in which there existed many grand civilizations such as Rome, Greece, and Persia who left a great length of literary and cultural information.

This project will focus on two regions: Europe and West-Asia, and will study the civilizations within each region in correlation to armors because differences in design and methods usually originated from the civilizations themselves. By looking at the civilizations

within a specific region, we will show the intra-regional armor differences that existed, and by looking at the civilizations of each distinct region we will show the inter-regional differences of armors of each specific time period.

The definition of armors that will be adopted for this project is from the American Heritage Dictionary and is as follows: a defensive covering, as of metal, wood, or leather, worn to protect the body against weapons. Due to the human physiology such defensive covering is not a single piece of material, but a combination of pieces worn together to create a whole. It is these pieces that we will consider as armors. The pieces that will be considered in the composition of armors in this project are the helmet, cuirass, Gauntlet/Bracer, greaves, shield. Each of these pieces covers a part of the human body: the helmet covers the head, the cuirass covers the chest/midsection and the back, the gauntlet covers the arms/hands, the shield is simply a hand held protective tool.

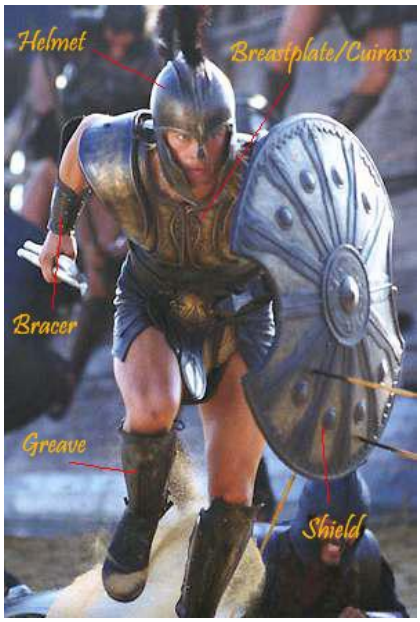


Figure 1. A warrior with his armor.[i]

With each civilization, information will be given concerning the type of armors they inspired; and with these armors, the main focus will be, but not be limited to, addressing the following issues:

1. Date of use/discovery of armor;
2. Civilization that used armor (if possible);
3. Material or composition of the armor;
4. Design and specifications of the armors such as shape, dimensions, and weight;
5. Process used to build the armor.

Similar Project of Interest

Another project exists in collaboration with this project that covers the mid-late medieval period. Its focus and objectives are the exact same as this project, but differ only in time periods. It is also done by WPI students such as ourselves, and is a great resource for those interested in medieval armors. The knowledge in both Antiquity Era and Medieval Era achieved in the two projects will be posted on the same website.

II. ARMORS IN EUROPE

In studying the evolution of armor in Europe, three different time periods will be observed: the 8th to 6th century BC, the 5th to 2nd century BC, and the 1nd century BC to 4th century AD. The 8th to 6th century BC is also known as the Early European Iron Age, during which the major material was still bronze with iron metal work under development. The 5th to 2nd century BC is also known as Late European Iron Age, during which La Tène culture was the dominant culture in Central Europe, The Roman Republic was free from Etruscan rule, and Greece reached its Hellenistic period. Around 1st and 2nd century BC was the conquest of Rome over the Europe, transforming it from a republic to an empire.

II.1. HISTORY

The 8th century BC marked the ending of the Bronze Age and the beginning of the Iron Age. Therefore, many armors found in that period were mostly made of bronze with some made of iron. It was only around the 5th century BC that iron became more prominent than bronze. This change is suggested by some historian to be due to the shortage of tin necessary to make bronze (Snodgrass, 1967). Iron allowed for the production of better armor, and around the 4th century BC gave rise to the mail armor. The mail armor was then used to protect those parts unprotected by the rest of the armor; but for those that could not afford the rest of the armor, it was their only protection.

Ancient military forces were more like a militia then a military due to the fact that one had to buy their own armor. It was only until around the 1st century BC that the Romans began a system of buying the armors for their soldier. The money was, however, deducted from the individual pay of the soldier. The affordability of the armor dictated the type of warrior units that existed, and all these units had different purpose on the battlefield due to their armors. These

units can be generalized into four categories in order of decreasing armor pieces: the Calvary, Infantry, Light Calvary, and Light Infantry.

Before going to research about armors used in different regions an introduction to some of the cultures of this period is needed in order to provide a solid historical and geographical background of the regions witch this project is focused on.

A. Greece

A remarkable culture of the ancients that cannot be ignored is Greece. Greek history in this studied period spans from 800 to 146BC. Ancient Greek history can be divided into three well-known periods: the Archaic Period (around 800BC to 480BC), the Classical Period (around 5th and 4th century BC), and the Hellenistic Period (from Alexander the Great's death at 323BC to Roman conquest of Greece in 146BC). Two notable wars in or with Greece during this period were: the Peloponnesian war between Athens and Sparta, the two notable city-states in Greece during 431BC to 404BC; and the Persian War (492-490BC, 481-479BC) against the invasion from Persian, a large and powerful culture majorly in Asia and later expanding to Europe and even Africa. The Ancient Greek civilization thrived after successfully stopping the Persian invasion. The Greek influence on Europe can be seen by the many monuments and armor designs that can be found in a multitude of other civilizations.

B. Etruria

Etruria was dominant culture in central Italy in 650BC and ruled over Rome from its founding to 509BC, when the last Etruscan King was removed from power in Rome and the Roman Republic was established. The Etruscans are descendent of the Villanovans who existed in northern Italy from approximately 1100-700BC. The Villanovans are believed to be descendants of Danubian, and are closely related to the Hallstatt culture of the eastern Alps.

C. Rome

Although there are no evidence to support this claim, legends have it that Rome was founded in 753BC by Romulus. It was under Etruscan rule for two centuries before it became a republic. It expanded into a vast empire from a mixture of subjugation and politics until its fall in 410AD. Although part of the empire continued after that date it changed dramatically and became a new empire entirely which came to be known as the Byzantine Empire. The Roman civilization is one of the most widely studied civilizations and tremendous amounts of information exist concerning it in the form of books and websites.

D. La Tène

La Tène culture is named after the site in Switzerland where it was first discovered (Celtic Culture-Hallstatt and La Tène-Website). This culture flourished and expanded from the West to the East of Europe, in the regions which are today France, Switzerland, Austria, southwest Germany, Czech Republic, Slovakia, Slovenia, Hungary, and Romania. Developing from Hallstatt, an earlier European Iron Age culture, it lasted from 450BC to the Roman conquest around 1st century BC (Kruta, 2003). When we mentioned La Tène culture, we also usually referred to Celtic people, a group of tribal societies, who also settled in La Tène territories. With their developed metalworking techniques, especially for iron, Celtic people created several armors that were widely adopted by the army of Roman Empire. People in La Tène culture were also known to Romans as Gauls (Celtic Culture-Hallstatt and La Tène, 2011), which explains why some of the armor designs that Romans adopted from this culture had the names such as “Gallic Helmet”. Although different names were used, they all referred to those belonged to La Tène culture. This culture also had an active warfare with their neighbor culture,

such as the Gallic Invasion of Greece in 279BC, or the Gallic War, from 58 to 51BC, in which they were conquered by Julius Caesar.

E. Gaelic People

At the time of the Roman Empire, and well afterwards, Celtic civilization survived beyond Hadrian's Wall in modern day Scotland, Ulster and Ireland. Armor was not heavily emphasized in Gaelic conflicts between the Gaels and enemies such as the Roman Empire or Viking raiders, where Gaelic warriors relied on quickness and a greater amount of martial arts than was seen in the rest of Europe at the time. Being a Celtic people, the Gaels borrowed heavily from the armors of La Tène and Hallstatt cultures.

II.2. EUROPEAN ARMORS IN 8th CENTURY BC-6th CENTURY BC

II.2.1. Greece

Figure 2. Map of Ancient Greece.[ii]

Hoplites, Greek name for soldiers, were well-known for their heavy armors with distinguished design. A notable feature of Greek armors in this period is that their designs covered almost all critical parts of the body with metal while still enabling mobility and vision for the soldier. The helmet covered all the head and neck with thick metal, except for eyes and small portion of the mouth for communication, and the cuirass also covered the entire torso with

thick metal. Such designs and materials use were so effective defensively that many other cultures adopted them for their own use. These kinds of armors played an important role in Greek warfare and led them to many victories such as that of the Persian war.

A. Greek Metalworking and Materials

The metals regularly used by Greeks were gold, electrum (alloy of gold and silver), silver, and bronze. Bronze, an artificial alloy of copper and tin with sometimes a little lead, was far more common and, being also much more tractable than iron, it remained the normal metal for armor. An increasing tin content in the creation of the bronze would render the bronze piece more fragile, but it gave the piece a yellowish color like gold, which was more favorable for some artistic pieces such as the Derveni krater, whose tin content reaches 15% (Wilson, 2006).

Two principal bronze metalworking techniques in early Greece, and also in many other places in the world, were casting the molten alloy in a suitably prepared mould, and shaping the metal piece with a hammer (Wilson, 2006). Hammering was still the basic method to produce armors, possibly because it was faster to produce a large number of custom-fitted armors in the Greek army. To create joints between metal pieces, Greek people also developed techniques such as folding, soldering, welding, or riveting.

The evidence of how people actually performed the processes in ancient times, perhaps, best comes from artistic compositions, such as paintings or engravings. The following is one of those artistic compositions which depict the hammering of the shield of Achilles, a hero in ancient Greek mythology.

Figure 3. Production of the shield of Achilles.[iii]

The sculpture shows that hammering in ancient times was a rather laborious process which involved many individuals with almost no means of protection for the blacksmiths. However, some features of the depiction possibly are not what really happened in the ancient blacksmiths' shop, such as the women, or the lack of other tools such as the furnace, because ancient depictions sometimes involved superstition or exaggeration.

Other notable techniques used also include repousse and chasing (or engraving), which was used to create many decoration on the armors (Greek Metalwork-Website). Repousse is the technique in which malleable metal is shaped by hammering from the reverse side. Repousse can be followed by chasing, which is the opposite technique to repousse. The basic steps in repousse and chasing techniques can be illustrated in Figure 4, which was applied to a gold piece.

Figure 4. Repousse and chasing of a bracelet. From left to right: Step 1, Step 2, Step 3, and the final bracelet.[iv]

In the first step, the strip of gold is placed in a pitch bowl and the design is chased on the front of the piece using straight and curved liners to create the profile of the artistic shape. In the next step, the piece is then placed facedown and the relief is raised form the back of the metal using punches of different shapes and sizes. In the third step, after raising the relief, the metal is put face up again in the pitch for final chasing. The piece is then bent into the final bracelet as in the bottom right picture (Yotkov).

In fact the Greeks were not the only people in ancient time mastering the techniques of repousse and chasing. These techniques were used quite popularly to create decorative details on the armor piece.

Figure 5. Repousse work on the pair of Greek greaves.[v]

B. Greek Armors

1. Helmets

Each territory in Greece had developed different designs for their helmets. They differed in various aspects such as shapes or components. However, However, a typical Greek helmet design consisted of six pieces: the Cap, conformed to the shape of the head; the *Falos*, a metal ridge running from the front to the back of the cap at the centre designed as a support for the crest; the *Lofos* or crest, commonly of horsehair and constantly ending in the horse's tail; the Visor, the Cheek pieces, and the Neckpiece. In fact the design of a crest, a distinguished figure

in Greek helmets, did not originate from Greece but was borrowed by the Greeks from the Carians, the inhabitants of the eastern regions of Greece (Lahanas). Figure 6 is an example of a Greek helmet.

Figure 6. Thracean full size helmet dating back to 500BC.[vi]

The helmet in Figure 6 is from Thrace, a northern territory in ancient Greece and in the South of Europe. It is made of Bronze, but generally helmets could have been made of various alloys of copper. Except for the crest which may have been degraded, other components of a typical helmet are shown including the Cap, the metal ridge on the top, cheek piece, neck piece, nose guard. The sample in Figure 6 has a height of 55cm and a weight of 11kg (Hellenic Art-Website).

However, some helmets, such as the one in Figure 7, lacked the Falos, and the Crest was supported by a rod that fitted into the center of the cap such as the following made in Sparta, a notable city in ancient Greek.

Figure 7. Spartan Hoplite full size helmet dating to 490BC.[vii]

Nevertheless, many helmets made in Greece even lacked the whole crest, such as those made in the Peloponnesian city of Corinth in Central Greece (Figure 8).

Figure 8. Corinthian full size helmets, dating back to the second half of 7th century BC, and right helmet dating to 540BC. [viii]

The Corinthian helmet actually was made with a single piece of Bronze adapted individually for each warrior. It was the most used type of helmet in Greece (Lahanas). The estimated height and weight of the Corinthian helmet are 22cm and 5kg respectively.

We have not found specifically how ancient Greek people hammer the metal piece into their helmet, but today blacksmiths who give effort to manufacture the replica of ancient armors can provide some legitimate hint. According to their work, two techniques could be used to create the helmet: raising a single disc of bronze into the helmet or forging and welding pieces together. Between the two, raising technique requires more advanced skills and produce the best pieces. To complete a raised helmet, the craftsman needs somewhere in the order of 10,000 hammer strokes, and often more. To create the subtle shapes of the helmet, frequent heat treatment (softening) is needed (Piela). Different hammer's sizes or even different hammer's materials were needed to achieve a fine final product. For the well-known Corinthian helmet that we just mentioned in Figure 8, which was made from only one solid bronze piece, this raising technique might have been used, and some decorative details above the eyes space could be achieved with repousse technique. Other helmets in other regions could be made from more than

one piece, and then welding or riveting techniques are needed to attach them together, as discussed with a Celtic helmet in Figure 36. (Piela)

2. Cuirass

Figure 9. Bronze Ancient Greek cuirass, dated 620BC-580BC. It shows the two-plate design, one in front and one in back.[ix]

The most common type body armor of this time was the Greek-style bronze cuirass. A typical cuirass consists of two parts: one for the protection of the breast and abdomen, and the other for the back. These were hinged on one side and buckled on the other. They were kept in place by leathers straps passing over the shoulders from behind and fastened in front and by a belt. About the lower part of the cuirass was a series of flaps of leather covered with metal, which protected the hips and groin of the wearer, while not in the least interfering with his freedom of movement (Lahanas). This type of armor is dated to have been used from the 7th century BC to at least the end of the 6th century BC by the Roman civilization.

An example of the described design is a Corinthian muscle cuirass, shown in Figure 10.

Figure 10. Royal Corinthian muscle armor, dated back to 540BC. Material: brass.[x]

The above piece is a reproduced cuirass, which shows all the features. The leather flaps no longer exist in the excavated original ones.

Figure 11. Illustration of Greek muscular cuirass with hinges and rings.[xi]

Although the techniques of making the above cuirass were not explicitly described, from the available metalworking techniques at this time, it is theorized that a piece of copper alloy was heated to a sufficient temperature, and then forged or hammered the into the desired shapes.

3. Shield

Clipeus Argolicus is its original roman name and Aspis is its Greek name. It was designed to look like the sun and was, therefore, originally round in shape. It was usually made of wood or wicker covered over with ox hides or leather of several folds deep bound around the edge with metal. Some shields were found that are made of bronze, but those shields are considered by many historians to have been used solely for ceremonial purposes. It also possessed a central handgrip and a metal stud in the center known as umbo (Figure 13) that allowed the shield to be used as an offensive weapon and weighs approximately 8kg. Aspis shield were decorated with different images, sometimes with a Gorgon head, or the symbol Lambda (Figure 12) as used by Spartans, or the symbol M by Messenians (Lahanas).

The clypeus was primarily used by the phalanx, an ancient military unit whose main defining character was the long spear which they carried, and subsequently disappeared when the phalanx was abandoned in the 4th century BC. Other version of the clypeus possessing oval shapes instead of the circular shape were also developed in this time period and are labeled as oval Clipeus (Rich, 1875).

Figure 12. Front of Clypeus replica (left). Back of Clypeus replica (right).[xii]

Figure 13. Spartan Hoplite shield with the umbo at the center.[xiii]

4. Greaves

The greaves were made of flexible metal lined with felt, leather or cloth; were "sprung on" the leg; and then fastened behind by straps or buckles. Like the cuirass, they were made to fit the individual person and also had muscular shape (Lahanas).

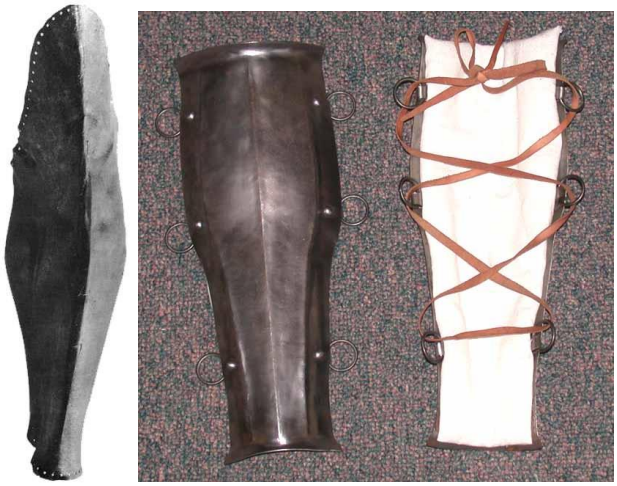


Figure 14. Left greave, Bronze, 6th century BC, Archaic, Olympia (left). Greek style greaves replica padded with wool and linen. The straps are made with leather rather than cords or thongs for more comfort (right).[xiv]

Greek greaves were usually made of bronze and usually followed two various designs: one in which they covered the knees to the ankles (Figure 14, left), and the other where they just cover the shin (Figure 14, right).

II.2.2. Etruria

Figure 15. Map of Ancient Italy showing Etruscans territory.[xv]

A. Etruscan Metalworking and Materials

The Etruscans fashioned metals to create various objects using the sophisticated techniques of granulation, incision or stamped decoration. The Etruscans were particularly skillful in gold and bronze working. Bronze was hammered, worked in repose, cast and engraved, and was used primarily to produce helmets, shields and other types of armors (Mitchell, 2011). The composition of the bronze that most of the excavated materials of this time period has been found to contain 10-12% tin with the rest being copper (Adkins & Adkins, 2004).

B. Etruscan Armors

1. Helmets

The Etruscans or The Villanovans as they were still known till 700BC inspired the design of one helmet that was widely used in Italy during the period of 800BC-600BC. The Helmets of their design were called *Villanovan helmets*. They also used another type helmet which was of equal popularity known as the *calotte/bell* helmet whose origin is unknown.

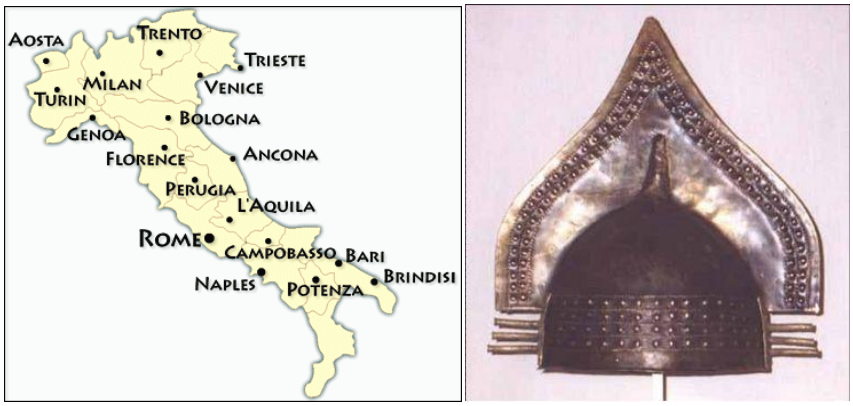


Figure 16. Map of Italy depicting the location of Bologna which is near Villanova (left). Example of Villanovan helmet (right).[xvi]

The *Villanovan helmets* are named after the town of Villanova situated near Bologna where the first excavations of a Villanovan cemetery were conducted. There were no mass production of armors in this period; which indicates that each piece was costumed made. For that reason, no specific measurements can be given in association with this helmet. What is known, however, is that the Villanovan helmets were formed by joining together two pieces of bronze, each shaped to fit half the side of an individual's head, along the crest of the helmet (Adkins & Adkins, 2004).

Another very common helmet used in the mentioned time period is the *calotte or "bell" helmet*, named so because of its shape. The oxford definition of calotte is a skull-cap which is an appropriate description of the helmet. One of the first physical evidence of this helmet was recovered in Esquiline tombs located in Rome, and it was these helmets that were dated to the 7th century BC. Evidence from the tomb also suggests that some of these helmets contained plumes and decorations at their tops, and some of the helmets found possess a downward elongated back portion that is thought to have been a form of neck guard (McNab, 2010). The estimated period of use for the calotte helmet is from before the 8th century BC to approximately the 6th century BC in the roman civilization. It is estimated that the average thickness for helmets of this period to be about *2.5mm.*

Figure 17. Modern day replica of calotte helmet (left). Calotte helmet found in Esquiline tomb, dated to the first half to the 7th century (right).[xvii]

In addition, some designs of Greek helmet also appeared in Etruria, such as those in Figure 18.

Figure 18. An Etruscan bronze helmet, 7th BC (left). Another Etruscan bronze helmet (right).[xviii]

Recalling the Greek armor design, these helmets can be recognized as having been borrowed from the Corinthian type helmet of ancient Greece. The import of Greek style helmet into Etruria can be seen possibly as the result of the expansion of the Greek civilization over the sea to the south territory of Etruria in 8th century BC.

2. Cuirass

The design of the Etruscan bronze cuirass is very similar to that of the Greeks. According to some samples found, it is two solid pieces connected by hinges at the hips and on either side of the necks. This design is also anatomical because the bronze plates are designed to look like the chest and the back of a strong man.

Figure 19. A bronze Etruscan cuirass dated to the 7th or 6th century BC.[xix]

3. Greaves

Like chest plates, Etruscan greaves are also similar to those of the Greeks in that their design is anatomical, this means that the greaves are formed to look like the leg of the man. As other Etruscan armors, greaves are often made of bronze. The green color that appeared in some pictures so far is also a strong indicator of the material, because bronze turns green when it is corroded by the air.

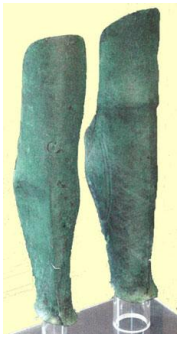


Figure 20. Etruscan greaves currently located in the Vatican Museum in Rome and dated to 600BC.[xx]

II.3. EUROPEAN ARMORS IN 6th CENTURY BC-2nd CENTURY BC

In this section, we will review pieces of armors that were found to be commonly used from the 6th to the 2nd century BC. While many armors of this period were also made of bronze, iron starts to be widely used as metalworking techniques continued to develop.

II.3.1. Greece

Lighter weight seems to be an innovative move in today industry, but that concept was not new to ancient Greek people. After defeating the Persian invasion in 490BC and although the heavily armored army was key to their victory, Greek people started to create lighter armor designs that could improve the mobility of their armies but still maintained good protection. Lighter weight of armors was achieved by reducing the thickness, making more space for vision and hearing to remove materials from the existing designs, and by using different materials such as use less metals and more strengthened linen or leather. Scale armor, whose origin we do not know for sure, also appeared in Greece this period, which compromises the flexibility of the linen and the strength of metal. Some other changes to armors were also made to adjust to their new equipments or new opponents.

Ancient Greece in during 6th century to the Roman Conquest is usually divided to two periods: Classical Greece (around 5th and 4th century BC) and Hellenistic Greece (around 3rd BC and 2nd century BC), with the death of Alexander the Great, the king of Macedonian, in 323BC as a transitional event between the two times. His death led to a split of Greek army, and therefore a few changes in war fares as well as arms and armors used.

A. Greek Metalworking and Materials

Techniques in metalworking and materials similar to those used in earlier time continued to be used and developed. In addition, this period also witnessed a wide spread use of gold and silver. For example, in Classical time, gold and silver vessels were made in southern Greece, although none of them have survived. Regions such as central Macedonia, or Alexandria in Hellenistic time were places of exceptional silversmiths and luxurious products from silver and gold (Wilson, 2006).

B. Greek Armors

B.1. Classical Greece

The use of armors in the Classical Greek period were marked by many wars, including the 2 remarkable ones: the Persian Wars (492-490BC, 481-479BC), and the Peloponnesian War (431-404BC). The resources to study Greek armor during this time, however, are more limited than other periods because of several reasons, such as the discontinuation of the Greek practice of burial of weapons/armors, and a decline in quality and quantity of vase-paintings, the most important class of representational evidence (Snodgrass, 1967). Nevertheless, there were many observed changes.

One of them is the soldiers' awareness of the heavy weight of their armors, so lighter designs started to be used. In the Persian War light-armed troops had not played an important role, but about 50 years later, by the time of the Peloponnesian War, the Greeks started to exploit the light arms.

1. Helmet

Various helmets devised in earlier periods were still used in the Persian War. Two types of helmets became predominant during this time: the Corinthian and the newer Attic helmets. The Corinthian helmet, which was already introduced in previous periods, developed continuously. In a new standard form, the cheek-piece that was once vertical now extended forward at an angle, and the neck-guard was also recessed inwards and then extended out at the rim. The skull was set off from the rest of the helmet by a ridge running from the forehead to the back of the neck. There was also opening for the ears, Figure 21 (Snodgrass, 1967).

Figure 21. Replica of a late Corinthian helmet.[xxi]

Corinthian helmets were widely worn up to early fifth century, but after that they fell abruptly out of use, probably because of the introduction of newer and better helmet designs.

A popular variation that seems to be developed from Corinthian helmet is the Chalcidian type helmet. This design improved the hearing and the vision of the Corinthian helmet and was lighter. This helmet also has cheek pieces, neck guards, and a small nose guard, with substantial loops on the sides for the ears. The helmet could either have been one solid piece or the cheek guard could have been attached by hinges. Figure 22 is an example of a bronze Chalcidian helmet, dated back to the late 6th BC to early 5th BC.

Figure 22. Chalcidian helmet.[xxii]

The Attic helmet, which originated in Classical Greece, was also widely used in Italy, Athens, and Hellenistic world well until the rise of the Roman Empire. It also outlasted its other contemporary helmets, and was used to impart an archaic look in the depictions of generals and emperors throughout the Hellenistic and Roman periods. This helmet is quite similar to Chalcidian helmet, but it lacks the nose guard. Figure 23 is an example of ceremonial bronze Attic helmet which dated back to 300BC.

Figure 23. A memorial type Attic helmet.[xxiii]

After Persian Wart, another Greek innovated helmet type was the Thracian helmet. This design was inspired by the everyday cap worn in Thrace. It has a rising forward pointing peak. Its prominent features are the combined forehead-guard and eye-shade. This helmet was greatly popular in the farther north of Greece in 5th BC (Snodgrass, 1967). Materials used in this helmet were bronze and iron. Several thin bronze and iron sheets were hammered and riveted together. At the back, iron plate was fixed to the inside; the rivets were still in place in the sample in Figure 24. The cheek protectors were attached to the cap with hinges.

Figure 24. Thracian helmet.[xxiv]

Figure 25 is a graph that shows the overall evolution of Greek helmets until 5th century BC. The Kegel-Illyrian group (helmets in this group are not much different from other Greek helmets except for some variation in shape) is on the left and the Corinthian-Chalcidian-Attic group is on the right. The last helmet at the bottom of the tree is the late Thracian helmet type.

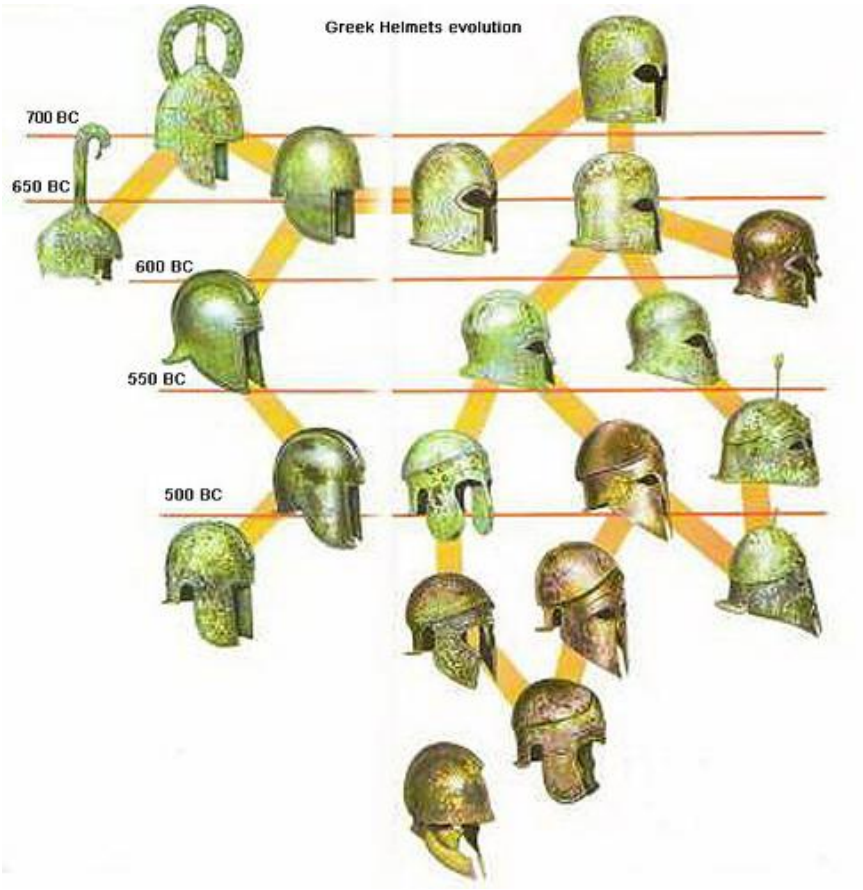


Figure 25. Helmet evolution.[xxv]

2. Cuirass

One of the noticeable changes in Greek cuirass manufacture is the linen corselet, which when lined in multiple layers and quilted together served as a good protection. The Greeks were able to create a compromise that combined the flexibility and ventilation of the linen with the impenetrable of the earlier bronze cuirass. The portrayals on vases depicted two large shoulder pieces, permanently attached at the back, brought over the shoulders, and fastened by laces to the chest. The corselet extended well below the waist, with a sort of skirt formed of one or two rows of leather flaps. The corselet can be partly covered by metal scales (Snodgrass, 1967). This type of armor design was a long-lived and favorite protection which was adopted by many other cultures.

Figure 26. A vase painting of warriors wearing linen cuirass.[xxvi]

This kind of corselet was more comfortable and less exhausting for the warriors while running than the all-bronze bell-shaped corselet shown in Figure 9.

3. Greaves

There was little modification to the greaves in archaic period. The greaves were still made to fit the human leg's muscle. However, there existed some supplementary pieces such as the ankle guards, whose examples were commonly found (Snodgrass, 1967).

Figure 27. Greek ankle guards made in South Italy 400-375BC.[xxvii]

B.2. Hellenistic Greece

After the death of Alexander the Great, his Empire was torn apart by his successors. His death also led to a split of Greek army, and therefore a few changes in war fares as well as arms and armors used. A noticeable war in this period is the Macedonian War, which is the conflict

between the Macedonians and the Romans, the result of which is the conversion of Macedonian into a Roman province, marking the conquer of Rome over Greece.

Soldiers in this period were equipped similarly to those in Classical period. However, warfare tactics had changed, and therefore led to changes in weapons and armors. Since the Classical period the Macedonian infantrymen, called phalange, were deployed in phalanx, a massive rectangular closed formation, and armed with very long spear whose length was about 5 to 7 meters. Because these spears were extremely long and heavy, the soldiers needed to use both hands to hold them. Thus the traditional round shields with handgrip caused much confusion in actual warfare. In a Macedonian shield fragment found in Turkey there was no remain of the grip. Historians described that Macedonian soldiers hung the shields on their left shoulder by a neck strap and the shield is tied to the arm by an armband. However, the entire shield was still made from a bronze sheath attached to a wooden core (Connolly, 1998).

The Thracian helmet continued to be used widely as shown in artistic compositions. These types of high crowned helmets were used widely probably to defend against the slashing swords of the Celts, because this was also an aggressive period of Celtic invasions (Connolly, 1998). Information and pictures of Thracian can be seen in Figure 24.

The linen cuirass, which was popular during classical era, still appeared in this period. Moreover, on many Greek sculptures and paintings, we can also find the illustration of the quilted cuirass, which could be made of both linen and skin and strengthened of straps of thick leather. Each square in Figure 28 was armed with a riveted nail head (Bible History-Website). Quilted cuirass was usually worn with scales armor covering the chest or stomach.

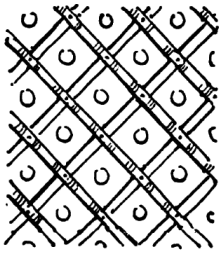


Figure 28. Specimen of quilted linen cuirass.[xxviii]

Figure 29 is an illustration of scale armor (more discussion about scale armor can be found in the section II.4.1., Part B).

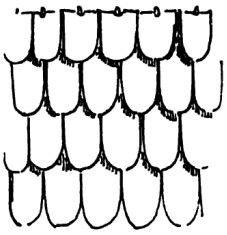


Figure 29. Illustration of scale armor.[xxix]

It can be seen that after the Persian War, the design of Greek armors leaned towards the light and flexible design. Lighter weight of armors was achieved by reducing the thickness, making more space for vision and hearing by removing materials from the existing designs, and by using different materials such as use less metals and more strengthened linen or leather.

II.3.2. Roman Republic (Etruria)

This period is the period of decline for the Etruscan civilization and the beginning of the rise of the Roman Empire. The Romans have just kicked out the last Etruscan king from their kingdom and declared themselves a republic.

A. Roman Metalworking and Materials

No further advances in metalworking were made by the Etruscan in this period, most likely due to their decline.

B. Roman Armors

1. Helmets

Figure 30. Negau helmet from the Museum of Santa Julia, Brescia.[xxx]

A Negau helmet can be thought of as an extended calotte/"bell" helmet with an added L shape bottom section. This type of helmet was most common from the 6th to the 4th century. "It possessed a flat ring of bronze inside the rim with stitching holes to hold the inner cap, and normally a crest" (Adkins & Adkins, 2004) . A series of 26 bronze helmets dating to 400BC were discovered in 1811 in Zenjak, Styria near Negau; now Negova, Gornja Radgona, Slovenia; and it is these 26 helmets that came to be categorized as Negau helmets. Only 23 of them remained preserved till today. The shape of the helmet is credited to the Etruscan town of Vetulonia formerly known as Vetluna.

Figure 31. Map of Slovenia with location of Gornja Radgona highlighted.[xxxi]

2. Cuirass

Figure 32. Square breastplate worn by a warrior. [xxxii]

Being the simplest of all breastplates, the square breastplate existed long before the beginnings of the Roman Empire, but was mostly used as a ceremonial or religious piece. It found some use in the Roman army around the 4th century BC to the 2nd century BC. Square breastplates are rectangular in shape, with curving sides, with typically a little less than 20cm in width and a little more than 20cm in length, and were presumably worn with the long side running vertically. The smaller sides are pierced with holes for the attachment of a leather backing and straps to hold the breastplate in place. They are decorated with bands of geometric ornamentation around the edge, and five bosses; one in the center and one in each of the four corners (McNab, 2010).

3. Shield

Figure 33. Curved oval Scuta.[xxxiii]

The *oval scutum* is a long curved body shield used mostly by the infantry of the Roman army. It covers more parts of the body then the clypeus and could cover the entire body when its bearer kneeled on the ground. An account from the Greek historian Polybius (200-129BC) describes the early scutum as follows:

The Roman panoply consists firstly of a shield (scutum), the convex surface of which measures two and a half feet in width and four feet in length, the thickness at the rim being a palm's breadth. It is made of two planks glued together, the outer surface being then covered first with canvas and then with calf-skin. Its upper and lower rims are strengthened by an iron edging which protects it from descending blows and from injury when rested on the ground. It also has an iron boss (umbo) fixed to it which turns aside the most formidable blows of stones, pikes, and heavy missiles in general.

An account from another Greek historian named Plutarch describing the battle of Carrhae reveals to us that the scutum shield were not strong enough to protect against the composite bows of the Parthian archers. Some typical dimensions for the oval scutum are 75cm in width and 1.2m in height (Adkins & Adkins, 2004). It became the standard shield of the Roman Legionnaire by 340BC and was reinforced with iron rim.

4. Greaves

At this point in time a Roman soldier would wear a Greek style cuirass. Those who could afford it wore one on each leg, but those who could not only wore one on their left leg. This was so because of the Roman legionnaire fighting style that placed the left leg forward in harm's way while the right leg stayed safely in the back (Summer, 1997).

II.3.3. La Tène

Most notable armors in La Tène culture are attributed to Celtic people. The styles of their armor designs in helmets or cuirasses were popular and many of them were adopted by the army of Roman Empire in later period. Perhaps one of the most remarkable armor designs of the Celts in La Tène era was the creation of mail armor, which still appeared in other parts of the world hundreds of years later.

A. La Tène Metalworking and Materials

Materials used in La Tène culture appeared in a large area. They even exported materials such as tin, copper, leather, gold to other cultures. Different from other cultures where almost all of the metallic armors we found were made in bronze, people in La Tène culture started to produce armors made in iron, such as the famous mail cuirass.

La Tène metalworking techniques were improved from earlier Hallstatt/Celtic methods, especially iron forging. It was the blacksmiths' forge that produced a wide range of products and nurtured all the secrets and skills in alloy mixing. Another technique used in Celtic was casting by the cire perdue (lost wax) method, which is known in modern method as investment casting, and the beating of metal into sheets. Other techniques such as hammering were also used to form the metal pieces.

On the other hand, a number of metal pieces, including armors, found in La Tène culture were accompanied with some type of decorations. A technique to make decoration is repousse, in which the metal piece was typically hammered on its inner side in order to produce a positive relief on the outer side. Numerous other methods of scratching, scribing, and chiseling were utilized to decorate plain surfaces (La Tène Celtic Culture-Website).

B. La Tène Armors

1. Helmets

Celtic helmet and Celtic armors, in general, were often borrowed by the Roman military in later periods.

Figure 34. An East-Celtic bronze helmet.[xxxiv]

The helmet in Figure 34 is dated back to the 3rd to 2nd century BC. The material used is bronze, which can be recognized by the green color produced in its corrosive state. The helmet was basically made in several assembled soldered and riveted parts. As shown in Figure 34, the hemisphere bowl was made from two soldered halves. Also above the forehead two bold arched extruded reinforcing ridges, the avantail embracing the neck almost to the ears and attached by a row of very small rivets. On each side above the ear is a triangular reinforcing plate held by three large ball-headed rivets, and at the bottom of each plate there are two small holes for the hinges where the earflap is attached to the helmet. The earflaps were said to be Etruscan or Macedonian style, and were hinged into the hemisphere bowl. The height of the helmet is 34cm, and its weight is 813g (Browne, 2003). Compared to some of the helmets in ancient Greece or ancient Etruria, which is very thick and weighs several kilograms, this helmet is relatively light and probably more convenient for warrior.

2. Cuirass

Figure 35. Mail cuirass or chainmail with a close up of its interlocking rings.[xxxv]

It is believed that the Celts invented the mail armor, and it was from the Celts that the Romans adopted the mail armor (called Lorica Hamata in Roman army) around 300BC. The chain mail is made by linking metal rings together so that they will create a protective layer that the warrior can wear like his cloths. By this time, there were already various patterns of linking the rings, but the most common one was the four to one pattern in which each ring is linked with four others. "It is made from interlocking one iron ring with four others. The simplest method of construction is to have alternative rows of punched out rings from sheet metal interlocked with wire rings which are either butted or riveted" (Summer, 1997).

Figure 36. Detail of the interlocking rings.[xxxvi]

Figure 36 is a detail picture of the connections between the rings that made up the armor. It can be observed from the picture that four iron rings were locked into another iron ring by a small rivet, making a system of one row of solid rings connecting two rows of riveted rings. This alternative design in fact had existed for a long time until around 14th century, when all the rings were only riveted rings. The rings are made of wrought iron which is tough and ductile, and thus is easy to form into shape.

There are several methods to form the rings. The wire for riveted rings can be made by hammering out the wrought iron into plate and then cut the plate, or by forging down an iron billet into a rod and then draw the rod into wire. The solid rings can be punched from a sheet metal. The wire will be riveted after linking the solid links together. The process of making mail armor required a high level of skills and was, therefore, very expensive. It was at first restricted to Aristocrats, but was later adopted by the Roman Legionaries. The rubbing motion of the rings allowed the mail to remain sufficiently cleaner than other cuirass, requiring less maintenance, and could weigh anywhere from 10-15kg alone. More information on the mail armor can be found in (Summer, 1997).

3. Shield

The shields used by Celtic warriors were quite different from those used in Mediterranean regions (the regions including civilizations such as Ancient Italy and Greece). The latter were normally round or curved, while the Celts preferred to use long, flat shields, which can have rectangular or oval shapes, with a protruding central section. This central section could take the form of a circular boss or a slender, rib-shaped umbo (shield boss). The purpose of this boss is to provide the warrior with more space at the handgrip to achieve optimal maneuverability as shown in Figure 37 (Celtic Weapons Art-Website).

Figure 37. Wooden handgrip of the shield located on the opposite side of the boss.[xxxvii]

As mentioned earlier, unlike the Romans, the Celtic shields were usually flat and are illustrated in Figure 38. Their shields are suggested to be all organic, since the only grave remains are the occasional metal grip reinforcement, or a pair of nails which would have attached the handgrip (Kelly, Brown, Barris, Bell, Grandy, & Goranov, 2010).

Figure 38. Depiction of Gallic/Celtic shield shape.[xxxviii]

Some excavated complete pieces of the Celtic shield were very well-known. One of them is the Battersea shield shown in Figure 39.

Figure 39. The bronze cover of the Battersea shield located in the British Museum.[xxxix]

The Battersea shield shown in Figure 39 is said to be just the covering of a wooden shield, which was made of organic material and has, of course, already vanished. The shield was excavated from the bed of River Thames in London. The Battersea shield probably dates back to 350BC. The Battersea shield's cover is a bronze sheet, as mentioned above, and decorated with repousse and enamel. Although the shield was found not damaged by battle field and thus considered as just a votive offering, it is usable and, more importantly, shows the advanced techniques of metalworking in Celtic in La Tène culture (Stead, 1985). There are other similar shields with sophisticated techniques namely Witham shield or Wandsworth shield.

II.4. EUROPEAN ARMORS IN 2nd CENTURY BC-4th CENTURY AD

II.4.1. Late Roman Republic

A. Roman Metalworking and Materials

The Romans utilized the process of smelting with charcoal in a fire or furnace to process ores into useable metals. The smelting process was used to turn metals into ingots that were transported into manufacturing centers all over the empire to produce artifacts, coins, arms, and armors. Manufacturing centers were established in those conquered lands that were either already a major manufacturing force or were very close mines. The most prominent metals of used in this period are gold, silver, bronze, enameling, and iron.

Gold was processed mostly in workshops and was used to produce mainly jewelries such as necklaces, rings, bracelets, and pendants. Most of these objects were made by gold sheet formed by hammering ingot on an anvil, but gold wires were also used to make necklaces and earrings.

Silver was obtained from the cupellation of lead and was processed in silver industries contained by almost every major city. It was mainly used for jewelry, but was also used for

vessels, strainers and spoons for religious and domestic purposes. Silver was usually hammered into shapes and the polished to remove traces of hammering.

Bronze found less and less use as a material for weapons, but was prominently used now for tableware, coins, and jewelry. Objects of bronze were usually made using stone molds, core casting, or the lost-wax method along with hammering. Core casting was a method of creating a mold of a certain shape in bronze using with clay and wax. The process is further detailed in (Adkins & Adkins, 2004). The lost-wax method involved a beeswax model covered in clay which was fired, melting the wax; then metal bronze was poured into the hollow till it solidified. After which, the clay was removed leaving only the bronze.

Iron was the most prominent metal of this time and found most of its use in tools, fittings, and weapons. The smelting of iron ore was done in bowl furnaces and shaft furnaces because of the increased sophistication of the process. The ingot that was formed after the process was worked by blacksmiths in forges with anvils, hammers, and tongs. The shaping and finishing of objects were done using a variously shaped hammers, and the holes were with punches (Adkins & Adkins, 2004).

B. Roman Armors

1. Helmets

Figure 40. Monterfortino helmet with and without the ear flaps.[xl]

Perhaps the most famous of all the Roman helmets is the *Montefortino* helmet. The design adopted by the Roman army from the Celts, and was used from the 4th century BC to the 1st century AD with an estimated production of 3 to 4 million helmets (Adkins & Adkins, 2004).

The origin of the helmet has not yet been discovered, but it has been mostly accredited to the Celts. Its name originates from the town of Montefortino in Ancona, Italy; from which a large number of them were excavated.

The Montefortino helmet can be described as the calotte or Negau helmet with added check pieces on its sides, an outward extended back to be used as a neck guard, and a topknot. The Montefortino helmets that lacked the topknot were named *Coolus* helmets, but both of these helmets are sometimes termed 'jockey' caps because of their resemblance to modern racing cap worn by jockeys. They were first made by hammering a hemispherical bowl into shape, but were later made by spinning techniques.

Figure 41. Port type helmet dating to the 1st century BC.[xli]

From the Coolus helmet developed the *Port type Helmet* named after Port-bei Nidau, Switzerland. "It was made of iron and had a topknot, now with a slit to hold the crest" (Adkins & Adkins, 2004). The helmet was formed by forging in one piece in the shape of a hat with a conical point, reinforced with riveted sheet-iron protection over the forehead with oval cut-outs arched like eyebrows. Attached to the helmet are strongly curved cheek flaps (one seems to be missing in this picture) with an ornamental boss in the centre and with a riveted ring for the chin straps. The height of this helmet is provided to be 34.8cm.

The port type helmet developed into what has come to be known as the *Imperial-Gallic/Weisenau helmet*. This helmet possessed an enlarged neck guard and was reinforced by adding a strip across the front of the helmet to protect the face from slashes. It also possessed

"stylized eyebrows" on the helmet bowl, which distinguished it from the Imperial-Italic helmets. By the second century, they were further reinforced with cross bracers. By the 5th century, helmet caps began to be manufactured by riveting four segments together to a frame.

Figure 42. Weisenau helmet. Notice the "stylized eyebrows" at the forehead of the helmet.[xlii]

2. Cuirass

Figure 43. Scale armor (Lorica Squamata).[xliii]

In the 1st and 2nd century AD the *scale armor* found its most extensive use in the roman army, but its date of origin pre-dates the roman history. It is said to have been invented somewhere in the east and was very popular in the Assyrian civilization that lived in current day Turkey from 2400-600BC. The scale armor is composed of rows of overlapping bronze and/or iron scales 10-50 mm long made to look very similar to fish scales. These scales were sewn into a fabric garment underneath with an extra layer of straw to be added in between the scale and the garment for extra strengthening (Summer, 1997). They were sown in with by wire ties that passed in through holes at the top of the scales. Scale armors are easier to make then mail armor, but are also more rigid than the mail armor.

Figure 44. Lorica Segmentata also known as the articulated plate armor.[xliv]

Also around the 1st century BC came the advent of the Lorica Segmentata also known as the plate armor. Unlike many of the armors mentioned, the Lorica Segmentata is a purely Roman invention. It weighed about 9kg and was made of metal plates held together by leather straps and bukles or by hooks. The hooks and straps fastening of the armor was not strong enough to withstand dramatic movements by its wearer and was thus wear down and break (Adkins & Adkins, 2004). This is what perhaps limited the usage of this armor for only two centuries.

II.4.2. Ancient Gaelic People

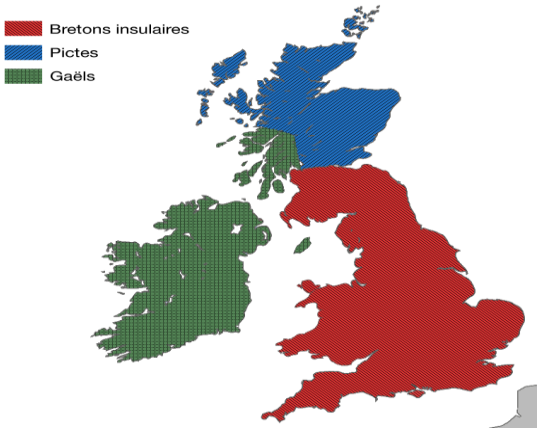


Figure 45. Map of Britain, with red as Roman territory, and the Picts and Gaels as Gaelic people.[xlv]

A. *Gaelic Metalworking and Materials*

The Gaels were the only Celtic peoples not conquered by the Roman Empire, and their lower boundary was set as Hadrian's Wall in 122AD. Their metalworking was quite limited, as only reserves of copper and very small amounts of iron existed in Scotland and Ireland, thus armors and combat styles were quite different than those used by the Romans.

B. Gaelic Armors

1. Helmets

As a Celtic people, the Gaels carried over many Armaments from such civilizations as Hallstatt and La Tène, and one of these is the Hallstatt Helmet. The Gaelic people continued to use this type of helmet up to and beyond the 4th Century AD.

2. Body Armor

Figure 46. The typical armaments of an ancient Gaelic warrior, complete with buckler, padded coat and helmet.[xlvi]

Gaelic warriors largely disregarded heavy body armors, as they interfered with their own swift styles of combat. In fact, the padded coat, a fixture among Gaelic farmers, was the main form of body armor used by the Gaelic warriors. This allowed for more hand-to-hand style combat and mobility, as opposed to the vastly different techniques of the Romans.

3. Shield

A wooden buckler was the shield of choice for Gaelic warriors. These shields were often decorated with regional or clan markings.

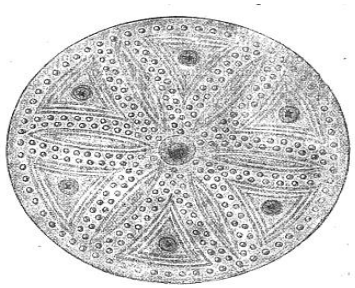


Figure 47. O'Donovan's shield from Ireland, with regional decorations.[xlvii]

Seeing as how Gaelic clothing was also patterned based on region or clan, the Gaelic peoples took great pride in their small regions, or clans.

III. ARMORS IN WEST-ASIA:

Before beginning our study of Mid-Asia, it is appropriate to first define the region that we have labeled "Mid-Asia". This region labeled Mid-Asia is extended from Turkey to India. Due to the limited amount of information, the time periods that will be studied for this region stretches only from the 8th century BC to 1st century BC. This period will, however, also be divided into three sections: from 8th-6th, 6th-4th and 4th-1st century BC. The reason for this specific separation is mostly due to the fact that during this period many single civilizations dominated areas by conquering their neighbors for the separated amount time.

III.1. HISTORY

The period of 8th to 1st century BC was also a transitional from bronze to iron for the West-Asia region. Unlike their European counterpart however, their transition to iron was fairly complete by the 4th century BC, and high quality steel were being produce in India by this time. This period was also a period of great turmoil, and marked the end of many ancient civilizations due to warfare with one another. The Assyrian Empire met their end by the hands of the Medes and Babylonian Empire, the Babylonian and Medes Empire by the Achaemenid or Persian Empire, and the Persian Empire by Alexander the great of Greece.

A. Neo-Assyrian Empire

The Neo-Assyrian Empire refers to the end period of the Assyrian Empire, which was from 746BC to 606BC. The Assyrian Empire itself existed from 1235BC to 606BC, but their culture existed much before that. Their culture did not flourish before the 13th century mostly due to them being subjugated by the more powerful empires that existed south of them, such as the Babylonians (Hooker, 1999). The first monarch of the Empire rose to power at 1235BC and began the conquest of its neighboring empires. By the middle of the ninth century Assyria had

conquered Syria, Palestine, Armenia, Babylon, and southern Mesopotamia (the name given to the area of the Tigris-Euphrates river region corresponding to modern day Iraq, northeastern Syria, southeastern Turkey, and southwester Iran). To ensure peace within its conquered territories, the Assyrians invented a new policy towards the conquered in which they would force a large number of the people they conquered to migrate to other areas of the empire; creating a melting pot of culture within the middle east region. The last monarch of the empire created the library of tablets of all literature in Mesopotamia know today as Ashurbanipal's great library in their capital city of Nineveh, and it is the tablet that rested within this library that are our single greatest source of knowledge concerning the Mesopotamian cultures (Hooker, 1999).

Figure 48. Map of Assyrian Empire at its peak.[xlviii]

B. Achaemenid (Persian) Empire

Figure 49. Achaemenid Empire 550BC-331BC.[xlix]

Achaemenid Empire, also known as Persian Empire, is another power that conquered a significant portion of the world in a long time during antiquity period. The empire typically lasted from 550BC, when Cyrus the Great rose against the Medes Empire and eventually conquered it to create the early Persian Empire, to 331BC, when Alexander the Great defeated Persian army at Gaugamela. Persian Empire expanded to a vast region spanning from Asia to Europe and Africa, and involved in many war fares. A notable war the Persian Empire involved in was the Greco-Persian War, also known as Persian War (throughout 5th century BC), which was a series of their conflicts with Greece. The defeat of the Persian in this war led to the revolt of the Greek cities of Asia, and then the end of Persian Empire under Alexander the Great.

C. Ancient India

Figure 50. Maurya Empire 321BC-185BC.[1]

Various kingdoms existed in the Indian Subcontinent since ancient times. Yet not until 321BC did the Maurya Empire unite much of India. This civilization lasted until 185BC, where it fell to other civilizations in the Subcontinent, such as the Sunga Empire, which retained most of the Mauryan territory, until 75BC. These two empires shared their metalworking and armor techniques with the small kingdoms before themselves. The Mauryan Empire had Alexander the Great taking his eastern border on their northwest, yet managed to keep the Hellenistic forces out. The Mauryan dynasty fell to the Sungas, by way of coup, seeing as how the Sungas sought to reestablish Hinduism in India; the Sunga Empire was marked with wars against interior civilizations and the remaining Hellenistic forces.

III.2. WEST-ASIAN ARMORS IN 8th CENTURY BC-6th CENTURY BC

III.2.1. Neo-Assyrian Empire

A. Assyrian Metalworking and Materials

Bronze was still the predominant metal of the period used to create anything from household appliances to weapons of war. Gold and silver were predominantly used for ornaments. In comparison to the other cultures of this time however, the Assyrians were the first

to widely use iron technology. Their technology was adopted from the Hittites, an ancient civilization predating our period of study, first introduced the technique of iron smelting around 1500BC (Martin, 2009). Smelting is a process used to produce metal from ores by changing the oxidation state of the metal ore using a reducing agent such as charcoal. The charcoal produces carbon or carbon monoxide which removes oxygen from the ore and leaves the metal.

B. Assyrian Armors

1. Helmets

Figure 51. Bronze conical Assyrian helmet.[li]

The Assyrian army equipped themselves with calotte helmets (described in section II.2.2., Part B) and their trade mark *conical helmet* which they referred to as *huliam.* The conical Assyrian helmet can be described has a calotte helmet that rises to a point above the head and were made mostly of iron due to its lower cost. One such conical Assyrian type helmet was excavated in the region that was once Nineveth (capital city of Assyria) and is stored in the British Museum. That helmet has been found to be made of iron with bronze decorations and weight of about 5lbs (Barnett, 1953). Figure 51 depicts another conical Assyrian helmet, but this one is made of bronze and weighs 770g or 1.70lbs.; making it more battle ready then its iron counterpart in the British Museum. The height of this helmet comes to 22.5cm. Other improvements upon the conical helmet were later made in the later years of the empire.

Additional cheek or ear pieces were very common in later Assyrian helmets, and some helmets also possessed an elongated back rim to provide more protection for the neck.

As Assyria grew, they came to conquer many regions which they turned into provinces. From these provinces they summed troops during warfare and these regions possessed their own style of helmets. Most of the troops were from the Aramaean and Neo-Hittite provinces, and their helmets are derived from the Urartian designs in which the top is bent forward or bent into a crescent moon shape as illustrated in Figure 52.

Figure 52. Urartian helmet design.[lii]

2. Cuirass

Figure 53. Cuirass in Assyrian Empire.[liii]

In the early period of the Assyrian Empire, the Assyrian charioteer wore a full body laminar or scale armor from the top of the head to the ankles. The head was covered by a coif or

hood attached to the elongated armor which was more of a short sleeved laminar robe than a laminar shirt (Nigel, 1984). No physical piece of this armor has been found as of today, which leads us to speculate that these armors were most likely made of leather or reed rather than bronze and iron. Furthermore, a leather armor of this size would be significantly easier for movement on the battlefield than its metallic counterparts. Reed, grass like plants that grow in marshy or wet places, lends itself as a possible material due to the fact that artistic evidence shows that they were used for shield making; leading us to suspect that it may have also been used to make these armors.

The full body armor was later shortened in the mid-8th century to reach the upper thigh and the coif was removed. This chance is speculated to have happened due to either or both changes in tactical function and/or expenses. The tactical function change of charioteers was to be able to dismount and continue fighting like an infantry or auxiliary warrior. This armor was, therefore, also adopted by the infantry and auxiliary; but by only those that could afford it. The now short laminar corset was further cut down by some by removing its sleeves.

In the 7th century BC forms of body protection known as the *irtu* was came into wide use. The simplest example of an irtu was a circular flat plate attached to the center of the chest by leather straps. The circular plate was usually made of bronze or iron and could be substituted with a dome shape metal boss.

Figure 54. An Assyrian troop wearing a irtu at his chest.[liv]

3. Shield

The Assyrians very much made use of chariots and each chariot had a crew, which was a group of two to three men in the same chariot. The third man of each crew would act as a shield bearer whose job was to protect the archer from incoming projectiles. A typical shield for shield bearers in Assyria was the *round shield* with a boss in the middle. The shield was typically made of bronze, wood, or iron; and the boss could be imbedded with spikes and could take many shapes. The inside of the shield was worked with wicker in the late 8th century. The origin of the round shield is unknown, and it is the most pre-eminent shield among all cultures.

Some infantry carried with them *rectangular convex shields* instead of a round shield. These shields are very similar to the later Roman scutum in rectangular shape (see Figure 33 for image). "These shields were made of wooden staves, or reeds, and were bound together with leather thongs" (Nigel, 1984). These shields could also be further modified by attaching rows of spikes on the outside so that they may also be used as offensive weapons.

In the latter half of the 8th century around 721BC and after, the infantry guardsman of the emperor carried with them decorated circular, conical shields. Nigel discussed that these shields were made of leather over a base made of wicker and a sheet bronze central boss. Figure 55 is a picture of such a shield in its simplest form.

Figure 55. Illustration of a Assyrian troop carrying a conical shield.[lv]

III.3. WEST-ASIAN ARMORS IN 6th CENTURY -4th CENTURY BC

III.3.1. Achaemenian Empire (Persian Empire)

In contrast to other contemporary European armies, Achaemenid (Persian) army was a light army. Most of the Achaemenid soldiers, except for cavalry, did not wear heavy metallic body protection because of their emphasis on rapid advance and archery. Despite being one of the largest empires in the world history, they did not create novel armor design or new armor making technique. The power of their force was mostly from arduous training and the loyalty of their soldiers. Their army, however, also possessed linen and metal cuirasses as well as metal helmet, but those armors were essentially adopted from the recruited Greek mercenaries. The lack of strong body protection was the major weakness in Achaemenid military which led to their defeat against Greece in Persian War.

A. Persian Metalworking and Materials

Like other regions in this age, bronze and iron are notable metals that were popularly used. Iron of various qualities was universally used for tools and weapons. Brass, with a relatively low zinc and copper alloy, was also used in vessel for the first time as the Persians developed their navy when they encountered Greeks and Egyptians (Gershevitch, 1985). Achaemenid Empire had also produced skillful metalworkers who were acquainted with many techniques such as chasing, embossing, casting. Gold was also used to produce armors, especially scale armors, for elite or high-rank soldiers in the army. While metals were used mainly to produce weapons, organic materials were popular to produce armors in Achaemenid army. Wicker, leather and wood were widely used to produce shields, which was the kind of protection that Achaemenid soldiers mainly relied on. Wicker is hard woven fiber made of material of plant origin and formed into a rigid material, so it is tough enough to stop weapons such as arrows.

B. Persian Armors

The professional Achaemenid army typically consisted of infantry, cavalry, which rode horses or sometimes camel, and charioteers. Soldiers in different divisions might wear very different armors.

Typically an infantry soldier carried a short sword, a spear with wooden shaft and metal head, a bow and arrows with bronze or iron heads.

Figure 56. An elite Achaemenid infantry.[lvi]

The soldier relied on his wicker shield for protection. The large rectangular-shaped wicker shield was called "Spara" in Persian word. According to some surviving samples of the shield, it could be made of reed and leather. The shield for infantry could also take the violin shape as the one in Figure 58. In some historical portrays, this shield appeared to be smooth, so it could be made of leather or wood instead of wicker. The two cuts on the two sides of the shield that created the violin shape might be just ornamental, or to enable its use with the spear (Drury). Some soldiers also wore metal helmet, but only Egyptian and Mesopotamian contingents wore body armors. Most of the infantry wore various costumes: a fluted hat, a short cape over a shirt, a pleated skirt and strapped shoes as in Figure 49, or a conical felt hat, a tight-fitting tunic, trousers and boots (Shahbazi, 2011).

A well-known and also essential elite force in the Achaemenid infantry was the Immortals. They got their name because the number of soldiers in this force was always kept at 10,000 men. Immortals played an important role in many of the Achaemenian's wars, including the war conquering Egypt, and the Persian War.

Figure 57. An Immortal.[lvii]

Similar to typical infantry, Immortals were not equipped with heavy body armors. Their dress consisted of a soft felt cap (a tiara), embroidered tunic with sleeve, a coat of scale armor underneath the tunic and trousers, Figure 57. They typically carried a light wicker shield, which described above, a short spear with silver or golden counter-balance, bows and arrows (Shahbazi, 2011). Immortals can carry different weapons and shields, and an illustration of an Immortal in other dressing is shown in Figure 58. The soldier is carrying a circular shield (not wicker shield) with an axe, and wearing a tunic inside a leather Greek style cuirass strengthened by scale armor. However, the cuirass worn by the Immortals were also proved to be inferior to Greek's own linen or bronze cuirasses.

Figure 58. Immortal wearing scale armor with different weapon and shield.[lviii]

Because of the above lack of solid body protection due to their emphasis on rapid advance and archery, the Achaemenid infantry was proved to be inferior to Greek hoplites in terms of armors as well as close-range fighting. While Greek hoplite were protected by bronze breast plate, helmet and greaves, the Achaemenid infantry soldiers were easily attacked at their unprotected legs, arms, neck or face. Their shields were also proved to be inadequate against the thrust from Greek weapons. This was the major weakness in Achaemenid military which led to their defeat against Greece in Persian War (Farrokh, 2007).

The Achaemenid cavalry force, on the other hand, was perhaps better equipped than the infantry force, and remained its importance to the end of the Achaemenid Empire. The horseman was described to carry two spears, one for throwing and one for fending, and a shield (not shown in Figure 59). He also wore a helmet with a Greek style padded linen corselet covered with metal scale (Shahbazi, 2011). According to documents in Babylonia, his helmet, corselet, and two spears were made of iron, and his shield was made of bronze (Dandamaev, Lukonin, Kohl, & Dadson, 2004).

Figure 59. Achaemenid cavalry horseman.[lix]

It is not surprising that several Greek armors have been observed to be used in Achaemenid Empire. The reason is that Achaemenid army had recruited many Greek mercenaries in their wars. During their invasion of Greece, to deal with their military weakness against the Greek army they had recruited many Greek mercenary troops, and these troops still served until the time of Alexander the Great's conquest (Farrokh, 2007). During the rebellion of Cyrus the Younger against his older brother Artaxerxes II in 401, he also recruited an army of 10,000 Greek mercenaries. These troops had helped to introduce Greek superior armors into Achaemenid army (Sekunda & Chew, 1992).

III.4. WEST-ASIAN ARMORS IN 4th CENTURY BC-2nd CENTURY AD

III.4.1. Ancient India

A. *Metalworking and Materials*

The Indian subcontinent is home to a rich and storied metalworking tradition. Ironworking existed in the Indian Subcontinent since 1800BC in southern India (Tewari, 2003). The furnaces used to extract the iron from ore was a small fraction of a modern blast furnace's size, so the skill of Indian ironworkers was world renowned (Balasubramaniam). By 200BC, high quality steel, later known as Damascus steel, was being produced. The metalworkers used a crucible method to form steel, where melted iron absorbed charcoal and glass, both carbon compounds, to form ultra-high carbon (1-2% carbon) steel (Ranganathan & Srinivasan).

Large zinc and copper reserves were also used, with copper being the primary metalworking material before 1700BC, while the zinc was largely used for medicinal purposes. Yet the Damascus steel was later taken up by civilizations from China to Europe, as Indian iron became a world renowned product.

B. Indan Armors

Body Armor

Body armor varied widely in India, from either regular clothing in the South, to iron woven armors elsewhere. One constant was silk robes, which could not be penetrated by arrows.

Figure 60. Silk clothing was a constant in Indian warfare.[lx]

Many warriors wore this instead of any armor at all, seeing as how Indian warfare largely relied on archery. This became truer as the chariot and cavalry gradually disappeared from Indian warfare by 500BC.

Figure 61. An Indian archer.[lxi]

Indian infantry, especially in the north, usually marched behind war elephants. This acted as a moving fortress for large armies, who did not require such bulky armors as the Persian armies, and were able to hold off foreign invaders much more effectively.

IV. CONCLUSIONS

Through this project we have mainly investigated in the armor designs, materials and techniques used by selected cultures in the world, from ancient Greece, ancient Italy, La Tène and Gaels in Europe to Neo-Assyria, Achaemenid, and India in Asia. Within the Antiquity time frame, from 8th century BC to 4th century AD, ancient people in many of those cultures had achieved remarkable advances in their armors creation. The fact that other cultures usually adopted good armors from their neighbors made these armors even more popular. Although their materials choices were limited to mainly bronze, iron, or linen, they had mastered basic techniques, such as hammering, with advanced skills, and been able to combine different materials to produce the armors with properties they needed. Mail armors, linen cuirasses or Lorica Segmentata are just some of the examples of the improvement ancient people had made. Our investigation also helped us to obtain an overall understanding yet with sufficient details about the how armors and its related aspects had changed and interacted among the above regions within our time frame. The team members have also gained more knowledge about ancient history, geography and the interactions among different cultures, which are important for our examination yet not known in advance when we participated in this project.

Based on the knowledge we gained through research and instructions from our local blacksmiths, we also successfully created real armor pieces and share all of our findings with the community through our website. The making of the real armor chest plate and shoulders was a valuable hands-on experience through which we have learned interesting metal shaping and fastening techniques, and gained better understanding of how the armors that we just researched on were actually made.

V. RECOMMENDATIONS

Because of time limitation we have restricted our research to only armors. However, armors are closely related to arms, and they also affected each other; change in arms motivates change in armors and via versa. Therefore, if possible, an investigation in arms used in the corresponding times would give us a more comprehensive view about this matter. The project should also be extended to encompass the East Asian civilizations to reach the ideal goal of investigating the evolution of armors in the whole world.

We also realized that the blacksmiths can be a valuable source of information. Therefore, it will be very helpful if later groups that work on the similar topic can connect with a blacksmiths and consult them. Blacksmiths' websites are also helpful, especially from those who also produce armors.

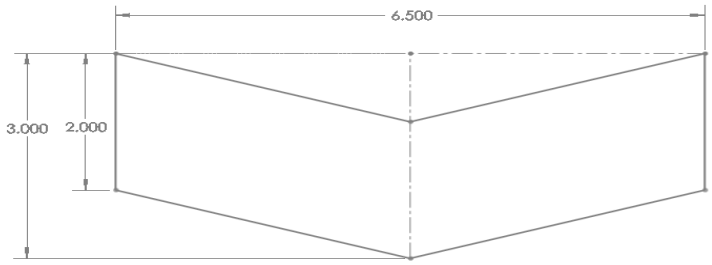
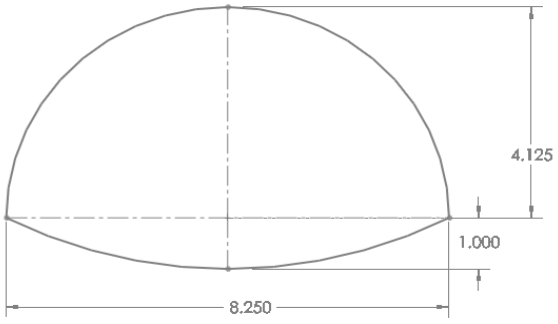
APPENDIX A: Making of the Armor

I. Making of Shoulder Piece

Our group tried to make the shoulder guards of an European armor using traditional hand tools like hammers, shears and files. During the middle ages, blacksmiths had similar tools but they were probably bigger, heavier and less ergonomic.

Steps for making of shoulder part

1. Before making the armor, we drew the different components of the shoulder guards on paper. The measurements we used were in inches and the drawings are as follows:

Part	Drawing
A	
B	

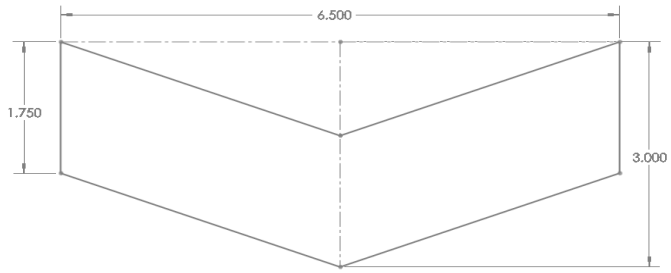
C&D	

Table 1. Drawings of shoulder components.

Using the paper as stencil, we then drew the outline of the paper on a sheet of metal. The metal sheet that we used was made of steel containing around three to four percent carbon.

Figure 62. Tracing of shoulder components on metal sheet.

2. Once the outlines are drawn on the metals, we used shears to cut the different pieces of the shoulder guards. We used shears with different cutting angles; when we used the right most shears in the picture, we had to leave a gap between the pencil line and where we were cutting as the curvature of the cut tends to be more inwards.

Figure 63. Cutting of metal pieces with shears.

3. After cutting, we used a file to smooth the edges and get rid of the dangerous sharp edges. According to Fay Butler, blacksmiths would take a quite thick and hard piece of steel and upset its surface in a consistent pattern using a sharp object like a chisel. After the dents were made at a certain angle, the surface of the metal would become irregular and it would have some small projections or teeth. The piece of metal would then be soaked in horse urine. The effect of the acid in the urine would sharpen the small projections on the metal surface sharper and give the metal surface an abrasive effect.

Figure 64. Filing of metal pieces.

Figure 65. Layout of the cut pieces.

4. After cutting and filing, the next step was to give the different pieces of the shoulder guards a curvature. For this purpose a hammer and a piece of metal block with a smooth surface were used.

   To get a smooth surface, Fay butler used an abrasive on the surface of the metal block. The left picture shows strips of abrasives with different surface roughness. The strips are tied to a circular rotating wheel and the metal block was pressed against it.

Figure 66. Abrasion process.

The diameter of the hammer head is also important because it will determine the curvature of the metal piece after hammering. Since one of our hammers was a too flat (leftmost in the pictures below), Fay Butler adjusted it by using an abrasive to change modify the edges and hence change the diameter of the hammer. In the right picture, many sparks are coming out of hammer under abrasion and this is because of the carbon content in the steel of the hammer. Steels with higher carbon content tend to produce more and shorter sparks under abrasion.

Figure 67. Changing of hammer head radius.

The picture below shows the filings of the hammer after the abrasion process. The filings from our hammer are very small and dust like because the abrasive material that we used had small and sharp teeth. The bigger filings shown in the picture below come from another piece of metal from which a greater layer of metal was taken off and a bigger teeth abrasive material was used.

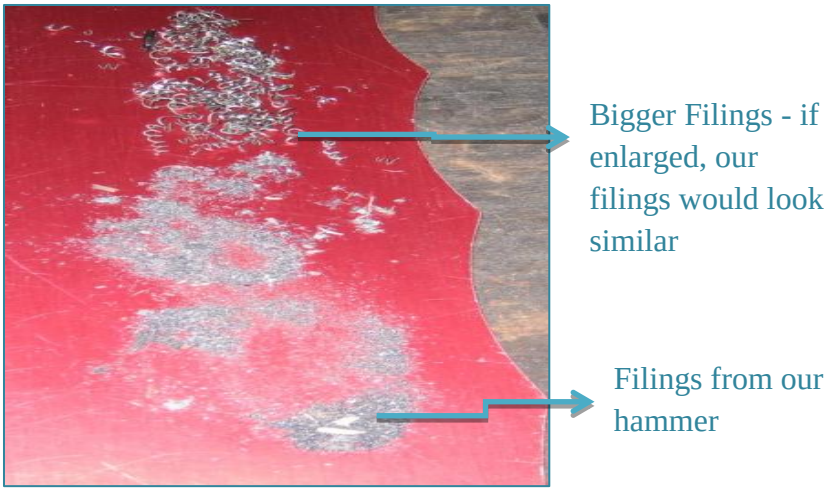


Figure 68. Metal filings.

To get a slightly dome shaped of part A and smooth finish and, we hammered it to bend the metal. This process only involves folding the metal. During hammering, high pressure has to be applied in the center of the piece and less pressure on the outer edges like shown below. This step is then repeated for the other remaining identical parts.

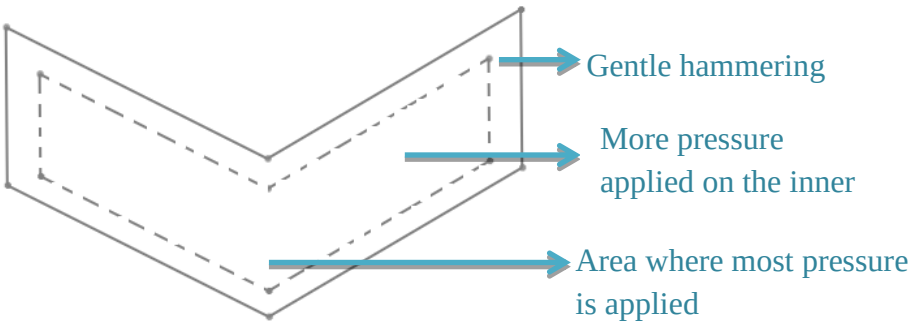


Figure 69. Hammering areas.

Figure 70. Hammering of metal pieces.

5. The hardest part of the shoulder was to get a dome shape out of Part B which looks like half circle. This process involves shaping and the folding of the metal sheet. The first step was to make a tuck in the metal using the straight peen hammer like shown below. The tuck that we made was about one third of the length of the metal piece.

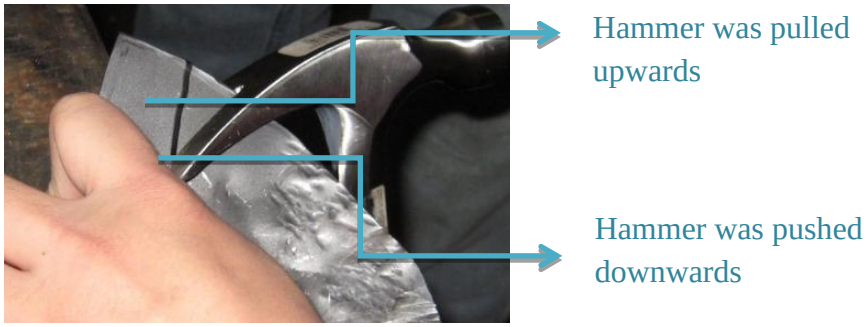


Figure 71. Making of a tuck.

The tuck made looks like the picture below.

Figure 72. Tucks.

6. After the tuck was made, we used the hammer to flatten it out. This is done in order to crush the metal on itself and shrink it. Metal shaping is generally achieved by changing the thickness of metal which produces a curvature.

Figure 73. Steps in flattening of the tucks.

When hammering, we started inwards and went outwards; we also worked our way up the tuck. The hammer blows on the piece of metal should be very close to each other so that there is an even flattening effect on the tuck. It is also very important when hammering not to allow the tuck to return to its original place. Later on more tucks were made like shown below all around the metal piece and then hammered down like described above.

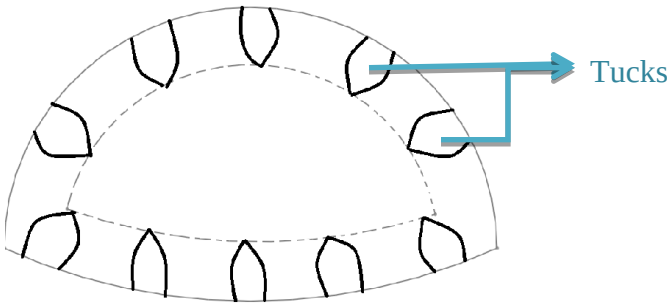


Figure 74. Tuck Positioning.

After some of the tucks we made were flattened out, the metal piece looks like in the pictures shown below.

Figure 75. Tuck making process.

Once all the tucks were flattened out and the outer edges were shrunken, we had to thin out the center of the semi-circular metal piece in order to give it a dome shape. This was done by hammering gently on the outer edges of the metal piece and then applying stronger hammer blows at the center of the metal until we got the dome shape we were looking for.

Figure 76. Hammering middle part of Part B.

7. After getting all the shoulder components a curvature, we made some holes in them using a nail puncher and a hammer. We also used a pair of pliers to remove small pieces of metal remaining in the hole.

Figure 77. Hole-making with a nail puncher.

The holes were placed on the shoulder components as shown below. We did not use any measurements for the holes; we just approximated a distance from the outer edges of the shoulder parts. Holes were made in the shoulder components as shown in the table below.

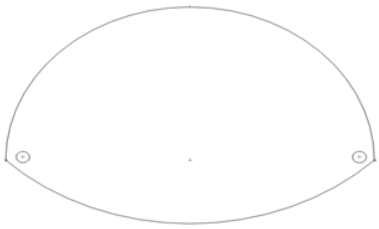
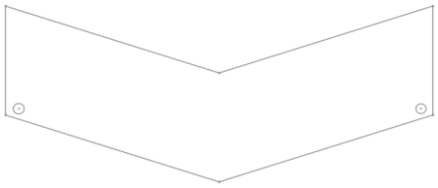
Part	Drawing
A	
B	
C	
D	

Table 2. Hole positioning in shoulder components.

8. Once the holes were made, we assembled the different parts together using copper rivets as in the pictures shown below. To assemble two pieces together, we first inserted a rivet in a hole and then we trimmed a portion of its length because it was too long. Once we got a reasonable length, we added a copper washer and hammered on the trimmed face of the rivet. As we hammered, the diameter of the rivet gradually increased and its

longitudinal length decreases until the washer could not move and the shoulder parts were fastened together.

Figure 78. Assembly of shoulder components with copper rivets.

Figure 79. Before and after assembly process.

II. Assembly of Shoulder Parts

The shoulder pieces were then assembled together. To connect them together, our group decided to use a u-shape piece metal plate to cover the upper part of the chest. The metal piece will then be bent like in Fig.68 below so that it fits the upper body.

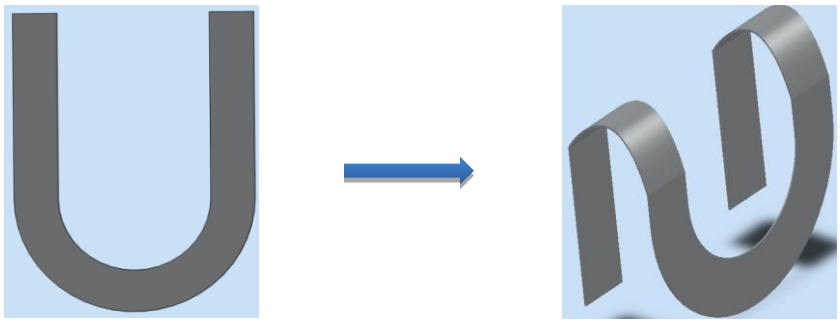


Figure 80. U shape piece of metal (left) and U shape metal after bending (right).

After tracing and cutting the U shape piece of metal, it was filed to remove any sharp and rough edges.

Figure 81. Filing of sharp and rough edges of metal piece.

The piece of metal was then hammered like shown below in order to curve the metal in the areas where the metal piece meets the shoulders.

Figure 82. Hammering of U shape metal piece.

The metal piece was then bent in order to adjust it to one of our team member's shoulders.

Figure 83. Sideway view of metal plate.

To attach the shoulder guards to the chest plate, we initially planned to use 3 rings to connect the shoulder guards to the chest plate. Since the ends of the rings did not completely

close; we substituted some rings for leather pieces. Leather pieces allow greater mobility of the arms.

We made the rings in a similar way rings were made in the middle ages. A long metal wire was coiled around a metal rod like shown in the Figure 72. A rod with a diameter of an inch was chosen since we were looking for rings of about this diameter. A bolt cutter was then used to cut rings out of the metal wire.

Figure 84. Making of rings.

Three holes were made in both the upper part of the shoulder guards and the outermost edges of the chest plate using a nail puncher and a hammer.

Figure 85. Holes made in shoulder guards and the chest plate.

Using a nail puncher and with the help of a screw driver, holes were made in the piece of leather which was then wrapped on the upper part of the chest plate. The leather piece was then closed by lacing it at the back using red leather cords like shown below.

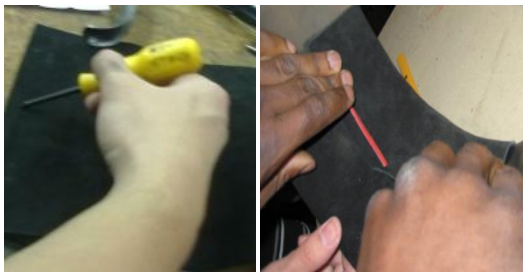


Figure 86. Hole making and lacing of leather.

Once both the upper parts were recovered with leather, the shoulder guards and the chest plate were then assembled using a ring in the middle hole.

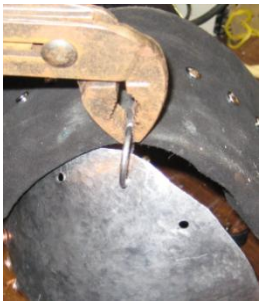


Figure 87. Assembly of shoulder guard and chest plate.

Small strips of brown leather of about one by four inches were then cut and two holes were then made.

Figure 88. Cutting and punching of holes in the leather strips.

One of the ends was riveted to the shoulder guard and the other end to the chest plate using copper rivets.

Figure 89. Riveting of the shoulder guards and chest plate.

Two holes were then made on each side of the shoulder guards and leather cords were inserted so that the shoulder guards can be tied around the arms of the person wearing the armor. Using leather cords has the advantage of being adjustable around the wearer's arms.

Figure 90. Hole making of the sides of the shoulder guards.

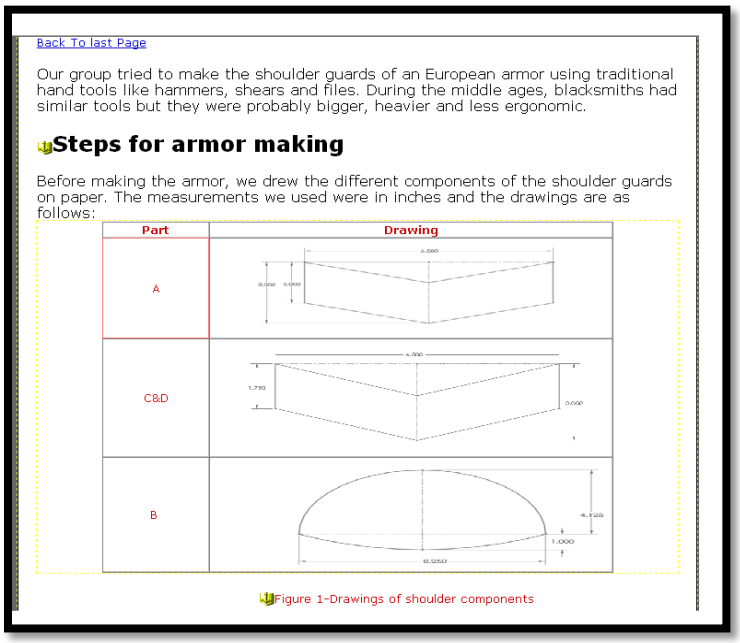
The final armor is shown in the pictures below. The black leather covering the upper shoulder parts have been decorated with leather rivets which can be easily obtained in any craft store and they just need to be pressed together unlike the copper rivets that needed hammering.

Figure 91. Front and side view of the armor.

APPENDIX B: Making of the Website

The website was primarily designed in Adobe Dreamweaver, which can help create the HTML and CSS coding of the webpages. A banner and set of buttons were created in photoshop, adorning the main page, the buttons being part of a navigation bar. The knight icons at the bottom of the page are two stock images found on amazing-animations. The maps are also of public domain for educational purposes. The main page also contains copyright information, reports, links, and making of armor pages.

The making of armor page, shown below, contains pictures and videos of the actual making of our armor. These pictures were taken at Fay Butler's workshop and machine shop at Worcester Polytechnic Institute.



After cutting, we used a file to smooth the edges and get rid of the dangerous sharp edges. According to Fay Butler, blacksmiths would take a quite thick and hard piece of steel and upset its surface in a consistent pattern using a sharp object like a chisel. After the dents were made at a certain angle, the surface of the metal would become irregular and it would have some small projections or teeth. The piece of meta would then be soaked in horse urine. The effect of the acid in the urine would sharpen the small projections on the metal surface sharper and give the metal surface an abrasive effect.

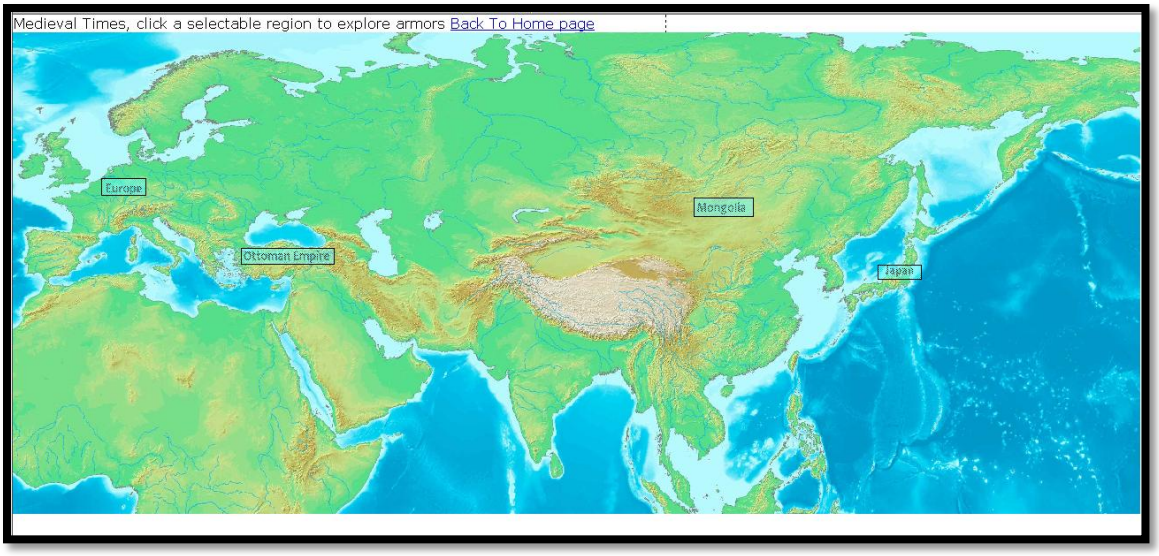
Figure 4- Filing of metal pieces

Figure 5- Cut pieces

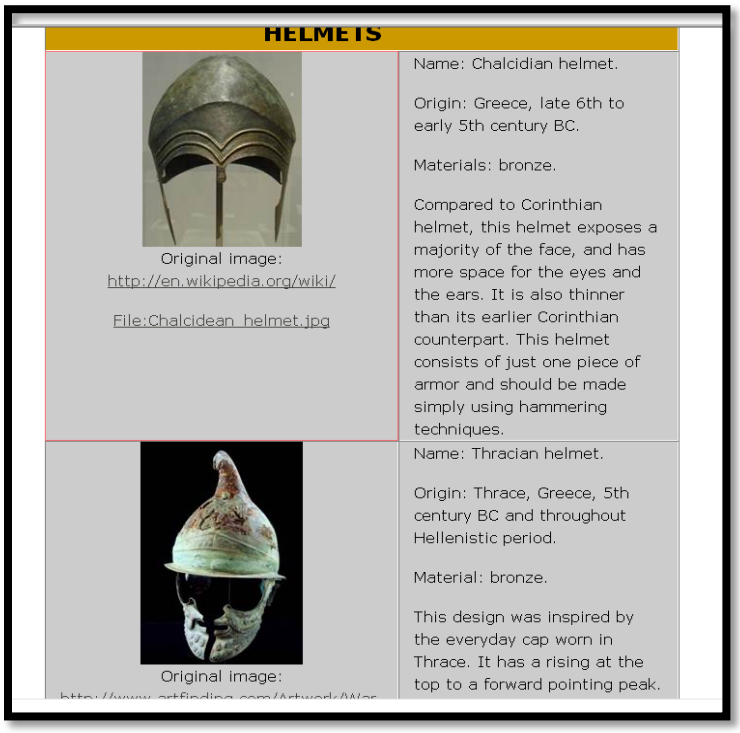
After cutting and filing, the next step was to give the different pieces of the shoulder guards a curvature. For this purpose a hammer and a piece of metal block with a smooth surface were used.

The videos were all uploaded on youtube because it was easier to take the embedded code from youtube then it is to create one.

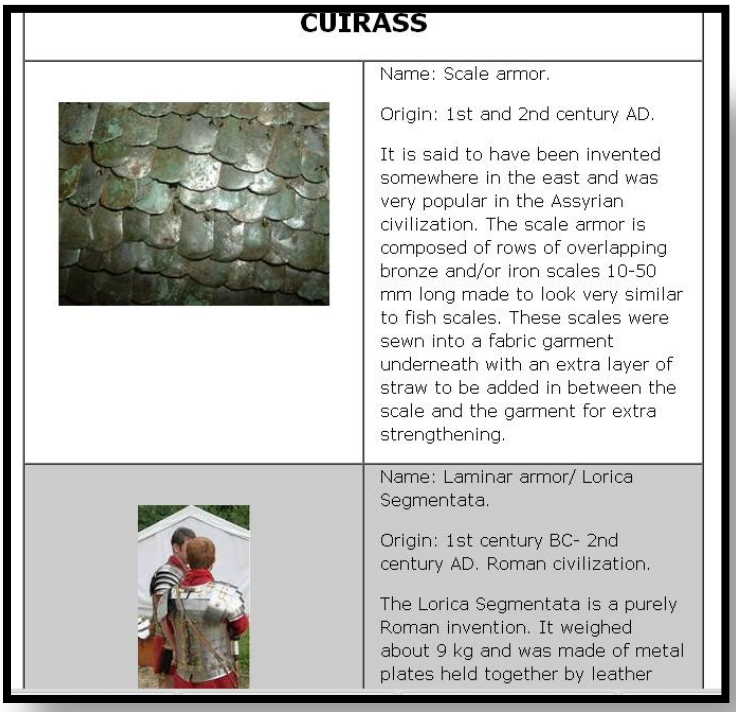
The maps are now interactive because the blue “Boxes” on the map are interactive hotspots, which link to the armor pages, and create links indicated on a browser by the cursor turning into a selector, like it would for any other link. Thus the maps become image maps, with multiple clickable links as shown in the following map of the medieval period.



The armor pages themselves contain summaries of the time periods and summaries of the individual pieces of armor, with more information presented in the report. These summaries illustrate how various types of armor evolved over a short period of time in a region. For example, the helmets of Greece from 600-200BC are shown below.



For some regions individual pieces of armor that were commonly used are discussed, such as here with the Roman Empire.



CUIRASS

Name: Scale armor.

Origin: 1st and 2nd century AD.

It is said to have been invented somewhere in the east and was very popular in the Assyrian civilization. The scale armor is composed of rows of overlapping bronze and/or iron scales 10-50 mm long made to look very similar to fish scales. These scales were sewn into a fabric garment underneath with an extra layer of straw to be added in between the scale and the garment for extra strengthening.

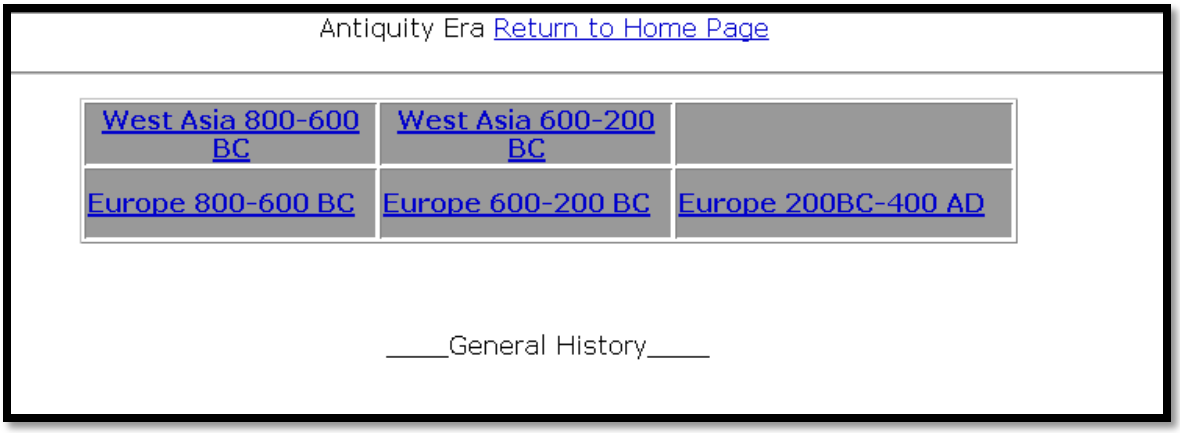
Name: Laminar armor/ Lorica Segmentata.

Origin: 1st century BC- 2nd century AD. Roman civilization.

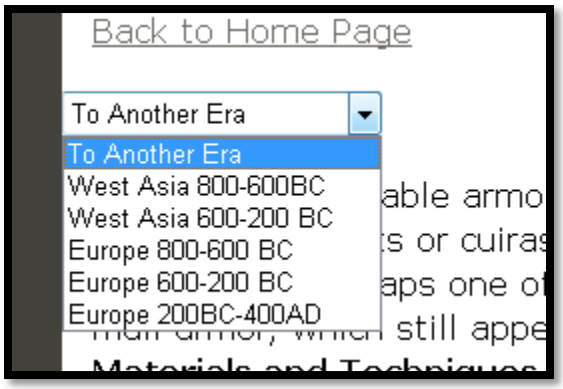
The Lorica Segmentata is a purely Roman invention. It weighed about 9 kg and was made of metal plates held together by leather

Each armor page has a timeline, and for the medieval pages, these timelines appear in separate windows when the link is clicked, while the antiquity map hub has a general history.

Antiquity has a series of five maps, two depicting west Asia, and three for Europe. These maps show civilizations that existed in the same timeframes (800-600BC, 600-200BC, and 200BC-400AD Europe only). Upon clicking the Antiquity button, the user is led to a hub for these maps.



Every armor page has a jump menu on it. The antiquity maps and armor pages have jump menus leading to the other antiquity maps.



The website also has its own report page, which contain the final copy of the medieval and antiquity reports for public access. Also, the links page contains links to works cited, this report, Fay Butler's website, and much more.

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