

KNOWLEDGE AND QUALITY OF WOODWORKING IN ANCIENT GREECE REVEALED FROM A SIMPLE FINDING

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Abstract:

Humans recognized the value of wood and used it in a variety of applications from the early years of their appearance on earth. Because of its biological composition, wood is easily destroyed and therefore, the discovery of wooden archaeological findings seem to be very limited, compared to the respective findings of inorganic materials, such as gold, marble, etc. During the archaeological excavations for the construction of a Metro station, in the center of Piraeus (Greece), almost a whole leaf of a wooden double door of a Hellenistic house was found in a well, which was destroyed by the Roman invaders in 86 BC., when they captured and burned the city and consequently, the materials coming from the demolition of the houses were thrown into the wells and tanks of the city. The abovementioned wooden finding was examined, as long as its current state allows, in order we to determine the quality of the timber used, the manufacturing-processing technology and the connections/joints techniques applied, to assess the level of knowledge and of the available processing equipment.

Key words: door; timber; quality; processing technology; joints techniques.

INTRODUCTION

Wood is a highly valuable material, with numerous advantages compared to other materials. An important advantage of wood is that it can be used in a very wide range of applications, unlike all other materials. It is suitable to be used in simple applications, without the appliance of any special processing, in splendid, of high elegance creations and more complex structural applications till the production of energy. This material is being easily processed, consuming low amount of energy, while it is also easy to be connected. It is understandable, that the sum of all these favorable features of wood have led to its widespread use since ancient times, constituting the basic material in a number of applications. It is characteristic that the Greek word for "material" comes from the ancient word "ύλη" meaning wood (Liddell and Scott 1883). However, wood is considered to have several drawbacks. As a biological material, it has a variable structure and its quality is influenced by hereditary factors, as well as the environment of its growth. It is also a hygroscopic and anisotropic material and is being burnt and decomposed.

Taking into account the abovementioned drawbacks of wood, that result from its biological composition, in combination to the environmental conditions that prevail in Greece, which are favourable to its biological degradation, as well as, the great number of wars and looting that the country has suffered in the past, no wonder is arisen by the fact that the archaeological findings of wooden structures material in Greece are really scarce. Consequently, the relevant information comes mainly from texts or illustrations in vases, wall paintings and other materials. Some information on wood working and processing could also be derived from the neighboring Egyptian culture, from which the wooden findings are quite rich. Egypt, certainly, did not have wooden vegetation and the main wood used for fine carpentry was the species of cedar, being imported from Libya and Syria. Findings of other wood species, such as pine, cypress, boxwood, birch, ebony show that the trade of timber was much developed since ancient times. It is

reasonable, of course, that there was also a trade of the processing equipment of wood and, to a certain extent, the dissemination of the existing know-how and knowledge between cultures. The findings also show that wood processing technology has been highly developed. As an example, can be mentioned a plywood of 6 layers, dated back to 2680 BC, of which the veneers are of about 1/8 inch thick (Scott 1965).

In Greece, the roots of the decorative use of wood go back to the ancient mythology. All the primordial works of architecture and sculpture, as well as the invention of the saw, drill, fish glue and other glues, tools and materials that are being used even in our times, are attributed to mythical "Daedalus" (before the 15th century BC) (Pliny, 1st century AD, Book 7, chap 56). It is characteristic that his name in ancient Greek means sophisticated (elaborate) artwork. But many of these woodworking tools are considered to have been invented by his student and son of his sister, Talos (Diodorus 1st century BC, Historical Library IV, 76), such as the saw which was made of iron mimicking the roughness of the snake's teeth. The lathe is reported to have been invented by Theodorus Samius (Pliny, Book 7, chap 56).

Homer (8th century BC) in his work "Odyssey" (e234-248) mentions the use of double-edged axe, made of copper and handle of olive wood, adz and drill, wood-nails and the existence of techniques for grinding and aligning the wooden surfaces. Concerning the wood species used, he reported alder, poplar and fir.

However, basic prerequisite for the achievement of a wood processing of high quality is the right choice of wood species and wood part, on which carpenters of those years seem to have had particularly good knowledge, as can be seen and proven by the ancient texts that have been preserved. The Greek philosopher Theophrastus (371-287 BC), a pioneer in the study of wood, reported that the quality of wood is affected by the time of harvesting (*Historia plantarum*, V, 1 -2) and that stronger and better in appearance timber can be obtained by logs that are free-of knots (V, 2 -2). He also states that the best quality of Greek timber for structural uses originated in the region of Macedonia, which was smooth, of straight grain and containing resin (V, 2 -1) and further, that the wood from species of juniper, chestnut, cypress, cedar, ebony and mulberry are among the most durable to biological degradation (V, 4-2). Concerning the cutting of wood, he indicates that the peaks of the saw teeth should be bent alternately, and further analyzes the effect of moisture content of wood in the ease of implementing processing procedures, such as sawing, drilling or turning of wood (V, 6 -3,4), while he indicates which species is the most suitable to be chosen in each case of use (V, 7, 1-8).

The Roman writer Plinius Secundus (Pliny) in his work "The Natural History" (1st century BC), in which he collected almost all the knowledge of his time, provides useful information on species that are resistant to biological attacks, mentioning the species ebony, cypress and cedar as the most resistant ones (book 16, chapter 78, 79, 81), the species that are appropriate to be used in structural and carpentry applications, their adhesion ability (ch. 83) and the production of decorative wood veneers (ch. 84). As a particularly precious wood species, he highlights the ash, which, according to Homer, the spear of Achilles was made of (ch. 24). Beech wood is referred to, as an easily processed, soft and easily curved wood species, which can be cut into thin veneers, but is used only for the manufacture of boxes and desks. For the construction of wooden tools, such as mallets or drill handles, the wood of wild olive, boxwood, holm oak, elm, ash (ch. 84) are mentioned as the best materials. Regarding the construction of doors, he mentions fir as a suitable wood (ch. 82), while the dogwood timber, used for producing wood-nails, which were as strong as iron-nails (Ch. 76).

The Greek philosopher and lexicographer Iulius Polydeukus (Pollux) (2nd century AD) distinguishes roundwood (logs) into that intended for processing and that intended for fuels (*Onomastikon*, book VII, chapter KE, 109). Referring to the works and tools of carpenters (*Onomastikon*, book VII, chapter Ks', 111), he distinguishes the craftsmen of those years, in shipbuilders, door-manufacturers and «κλινοποιοί» (meaning bed manufactures), a word which was used generally for the furniture manufacturers, whose work includes, among others, tables, tripods, diphros, thrones, desks and stools. The recognition and classification of the quality of manufacture of a product was already widespread, since he refers that among the many origins of manufactured diphros, the best was considered to be the Thessalian one. Concerning their tools, he mentions the adz, the axe, the drill, the saw, and "rini", as an abrasive means, a word derived from the Greek name of the fish *Squatina squatina* (angelshark), whose rough skin was used to polish wood and other materials surfaces. Referring to the doors, he distinguishes them into the types of «garden», «courtyard» and «double leaf door», with the latter being the main entrance of the house, which usually was higher from the ground level. As parts of the door, he mentions the "pivot", the "frame", referring to the wood pieces found on sides of the door and the main parts of the door, the door leafs, which were called "planks" (book I, chapter H, 76).

However, the archaeological findings can be considered as a much more clear evidence and can provide detailed information on the impact of different cultures on the development and evolution of technology. An investigation into ancient tools (Petrie 1917) reveals that the differentiation of the two edges of the double axe (Fig.1) into axe and adze began in the early part of the bronze age from Sparta, Crete and

other Greek cities. Furthermore, the earliest European bronze saws seem to be those of Knossos (Fig.2). Indeed, it seems that copper tools and many other products of Crete were in great demand by the people of Egypt and other regions (Jonshon 1953). The comparison of ancient tools from Egypt and Greece also shows a qualitative difference in their technology. Jonshon (1953) points out that one of the strangest things about the Egyptians was the fact that they never learned to incorporate handles to their hammers. Generally, from every important archaeological finding, useful conclusions can be drawn about the level of development of a civilization. Especially on the occasion of the "sophistication Antikythera Mechanism" finding, the historian Price (1975) pointed out that, it makes us completely rethink our attitudes towards ancient Greek technology, while author Sir Arthur C. Clarke (Marchant 2008) mentioned that "the technological equipment of the ancient was far more sophisticated than we believe". If the evolution of knowledge, as depicted in Antikythera's computer, had not been halted, today science would be a thousand years ahead".



Fig. 1.

Stone mould for making axes. Crete 1800-1700 BC. Archaeological museum of Heraklion.



Fig. 2.

Oversized bronze crosscut tree saw. Knossos 1700-1450 BC. Archaeological museum of Heraklion.

Regarding the result of the quality of wood processing, although there are few preserved wooden archaeological findings, useful conclusions could be drawn from the numerous surviving findings of exceptional aesthetic construction of other materials (gold, iron etc.). Additionally, as it is already well known, the sense of quality and artistry in ancient Greece has been highly developed, as evidenced by the fact that most of the words used internationally in the field of fine arts and aesthetics originates from the corresponding Greek words, for example, calligraphy, harmony, architecture, technology, analogy, enthusiasm, fantasy, idea, melody, music, rhythm, symmetry, metrology etc.

OBJECTIVE

In the present work, an attempt is made to analyze and evaluate the quality characteristics of the processing and construction of a recently discovered finding of an ancient wooden door section in the area of Piraeus and draw conclusions on the knowledge level and techniques of woodworking used 2000 years ago in Greece.

MATERIAL, METHOD

Ancient Piraeus was planned by Themistocles to operate as the port of Athens. The city was built in 460 BC by Pericles, based on Ippodamos' plan, father of the urban planning system. Streets parallel to each other were designed, dividing the city into square blocks of equal size. The houses that were built had in their yards underground rainwater storage cisterns and wells. They were used by the inhabitants of the ancient city to pump the necessary water from the aquifer (Steinhauer 2012).

After a period of prosperity during the Hellenistic period, the Roman troops of General Sulla captured and burned the city in 86 BC (Garland 1987). The buildings remains and the housewares of the Hellenistic houses, together with abundant wooden objects, were discarded into the wells and cisterns. During the archaeological excavation for the construction of the Municipal Theater Metro station, in the center of Piraeus, 27 of these wells were investigated.

Into one of these wells, an almost entire leaf of a double wooden door from a Hellenistic house was found, which was destroyed by the Roman invaders (Fig.3). The sherds of the terracotta vases that were found together are dated between the early 3rd and the late 2nd century BC (Rotroff 1997), while at the bottom of the well, lamps were found, which are dated between the late 4th and the early 3rd century BC (Howland 1958). They had fallen into the well during its use. Therefore, the wooden door was constructed in the Hellenistic period, a time before the destruction of 86 BC.

This wooden finding was conserved, all these years, because it was situated at the level of the aquifer in the well, in steady conditions of permanent moisture and temperature. It was sealed by dense mud in anaerobic conditions, preventing the action of microorganisms that would cause its decomposition. The door has been found in the state of water-saturation, due to the long period of remaining in water and as a result, the cell walls of wood have suffered alterations, mainly because of the hydrolysis of hemicelluloses and cellulose (carbohydrates).

The parts of the door were collected separately one by one and they were immediately transported to the laboratory, where the cleaning and conservation process began. The mud was removed from the surface and the micro-organisms were inactivated. Parallel, the photographic documentation and their recording were carried out.

They are preserved today in tanks filled with water to prevent uncontrolled drying, placed in refrigerators, to prevent the growth of harmful micro-organisms. In the case of uncontrolled drying, excessive shrinkage and the appearance of the "collapse" phenomenon may be caused.

The finding consists of four vertical parts, the two planks on the edges (named also stiles), forming the frame and two thinner planks in the middle, forming the panel of the door (Fig. 4). From the four horizontal boards (named also rails), which were operating as transverse joints, only the bottom rail is preserved. A bronze pivot is preserved, on the vertical edge plank to the side of the door casing (Hoepfner & Schwandner 1986, Müller-Wiener 1988).



Fig. 3.
The wooden door leaf as found inside a well.

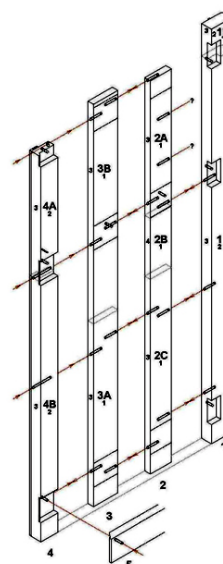


Fig. 4.
The configuration of the door leaf parts.

RESULTS AND DISCUSSION

After the thorough study and examination of the surviving wooden parts of the excavated door, that has been carried out after the cleaning and before any maintenance process, the following conclusions can be drawn regarding the quality of wood, the method of manufacturing, mechanical processing and the technique used in the connection of the wooden parts of the door.

Wood Quality

According to the extensive and thorough examination and macroscopic observation of the parts of the door finding, the wood that had been selected to be used in the construction of the door appears to come from straight grain stems of coniferous species, of good quality without encased knots or other apparent defects or irregularities of structure. In the parts examined, it is observed that the creation of wood cells was fairly smooth and balanced, with the width of the annual rings being relatively small and reaching, in the first years of growth of the trees, to 4 mm, whereas the mature wood ranges around 1.7 mm. In the findings in which the measurements were possible, the width of late wood in annual rings, which is an important characteristic that affects the density and strength of wood, was estimated to correspond to about the 30% of the width of the annual ring. This indicates that the timber may have originated from trees grown in dense

forest, with a limited precipitation, particular during the formation period of the late wood, referring to climatic conditions prevailing in the areas near Piraeus (Attica). Another particularly important feature observed in the wood of this door, is the sawing direction followed during the cutting process, in order to produce pieces of sawn wood, with pure radial surface (Fig. 5). This shows that it has been already perfectly comprehended by the craftsmen of those years, that better dimensional stability and avoidance of distortion (Ross 2010) can be achieved through the use of wood sawn boards, that have their width to correspond to straight grain lines surfaces, obtained through the quarter sawing of timber.

Regarding the precise identification of the species of wood of the door construction, which could be one or more than one species, it should be pointed out that, it was not possible to carry out the identification process under the current conditions and the present state of the findings, but an identification process is planned to take place in the future, if the circumstances allow.

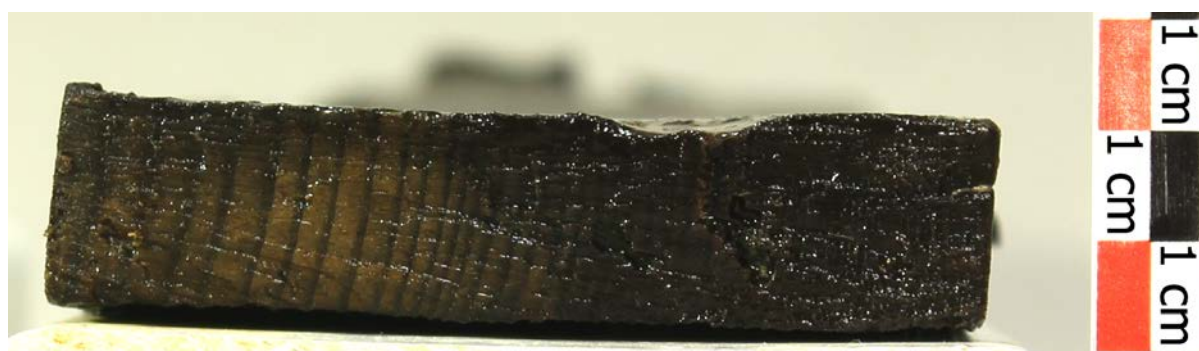


Fig. 5.
Cross section of the plank from the middle part of the door leaf.

Quality of Manufacturing

These wooden findings indicate that they constitute parts of a synthesis of four sawn wood boards, parallel one another and to the door length, resulting in a total synthesis width of about 32 cm, aiming to the formation of the one leaf of a double-leaf door. The maximum length of surviving prismatic sawn wood boards reaches the 122 cm. The wood sawn boards were found to be symmetrically positioned, with the thickness of the internal wooden planks being 18 mm, although it is not possible to state exact dimensions, mainly due to the long period of stay of the wood in the water, while the external planks were of double width, approximately 36 mm. It is characteristic that the two dimensions of thickness and width of these sawn wood boards were found to be the same as the basic dimensions of the thickness and width of sawn timber that is still produced in our times.

The width of each of the two internal planks (planks 2 and 3, Fig. 4) was found to be around 9 cm, while the one in the edge near the side of the frame (plank 1) was 7.9 cm, and the one close to the inner part of the door (plank 4) was 6.5 cm, respectively. The one narrow side of the edge plank, which also bears the pivot, has a semicircular configuration, correspondingly to the marble doors that have been preserved, and constitutes a necessary feature to facilitate the opening of the door through rotation (Fig. 6).

From the exterior side, this plank bears alongside and in the middle of its width, a wooden decorative lath (which probably has also a functional use, holding a decorative piece of fabric), with a cross section of just 4 mm x 4 mm, whose production and use, even in our times with our mechanized equipment, would be quite difficult. Also, the other plank that is placed in the edge of the door leaf (plank 4, Fig 4) carries an additional lath along its side. This additive lath is a composite, consisting of a lath of angled cross-section, of about 26 mm x 7 mm x 3 mm (Fig. 8), into which is seated another lath of rectangular cross-sectional dimensions of 20 mm x 4 mm. The production of these, of small cross-section, elongated wooden profiles may not exhibit such an impressive artistic effect, as is achieved through the woodcarving or woodturning, but it is obvious, that it requires much more difficult and sophisticated machining/processing technique and the appropriate technical means, the expertise, as well as the relevant know-how seem to have been possessed.



Fig. 6.

Semicircular configuration and the lath positioned in the surface of the edge plank.

Nowadays, with the evolution of technology and the automation of work, it is not usual to place embossments on the surface of the door panels, but for their decoration, the faster and easier process of engraving the wooden surface itself is usually chosen.

There was not used any horizontal element (perpendicular to the planks described) on the exterior of the door surface, thus offering a plain appearance, with only the single planks just being placed parallel. On the back surface of the edge planks (interior side of door leaf), suitable rectangular notches, with a depth of about 1.5 cm, have been formed to accommodate, at various heights, four horizontal rails of about 15 mm thickness and 6.9 - 7.9 cm width. The lower horizontal plank was positioned 22 mm above the bottom of the vertical planks and 3.7 cm far from the edge plank bearing the pivot, offering also to the inner surface elegant appearance and functionality (Fig. 7).



Fig. 7.

Edge plank where a notch is used for the connection to a horizontal plank.

Joinery techniques

The construction of this door leaf includes, except for the copper pivot, only wooden elements, for the connection of which, only wooden dowels of different dimensions were used.

In particular, for the lateral connection of parallel vertical planks to one another, were used per 35 to 40 cm, turned wooden dowels with tapered ends. These dowels were of 3 mm in diameter or 5 mm in the case of connection of the internal planks one another or of 8 mm diameter for the connection of the edge planks (stiles). In the edge plank (plank 4), which appears to be added last in the synthesis and construction of the door leaf, the dowels were found to penetrate and run all of its width (through dowels). The horizontal planks (rails) of the door leaf were connected to the center of the formed notches (Fig. 7), on its two edge vertical planks, using a 3 mm or 5 mm diameter dowel, which was not placed vertically to the surface, but inclined to it, in order to ensure a more stable connection and difficulty in disconnection (Fig. 8). For the installation and connection of the thin decorative laths on the wooden leaf, wooden nails of about 3 mm diameter, were used per 13 cm.

For the construction of the door leaf, apart from the wooden joints, it is also possible an adhesive to have been used, but an examination for the presence of an adhesive cannot be carried out in the present state of the findings.

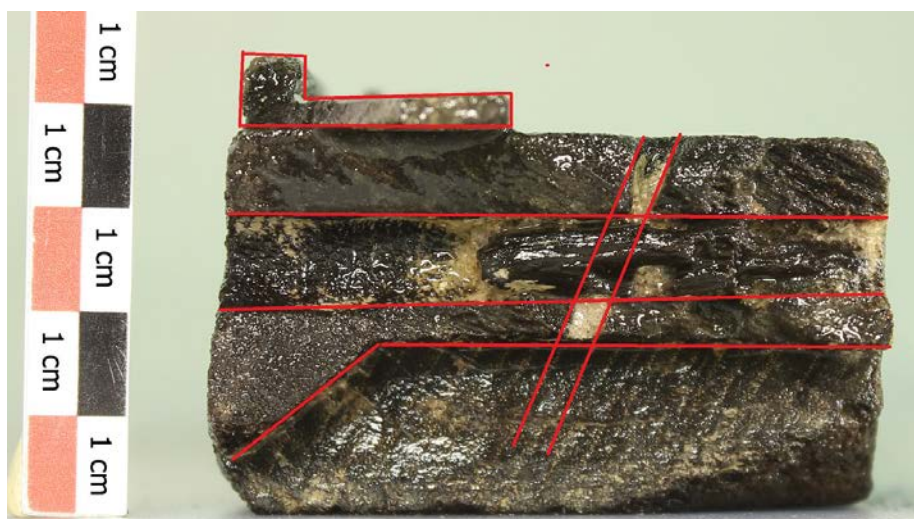


Fig. 8.

Cross-section of the vertical edge plank and its connection to the horizontal one.

CONCLUSIONS

The finding of wooden constructions archaeological material is very limited in Greece due to the climatic and environmental conditions that favor its destruction, as well as the large number of looting the country suffered by its various invaders and conquerors. During the archaeological excavation in the frame of construction of the Metro station in the center of Piraeus, in 2015, an almost entire leaf of a wooden double-leaf door of a Hellenistic-era house destroyed by the Roman, invaders was accidentally found inside a well. The initial examination of the pieces of this wooden finding, which until the beginning of their preservation process, were maintained in a refrigerator immersed in water, shows that it is a typical home entrance door, as roughly described by the ancient writers. The quality of the wood used, the sawing technique and the joining technique chosen, characterize the structure as one of a good quality, appearing to be a professional construction by craftsmen who possess a very good knowledge of the wood properties and have already the appropriate machining equipment for its manufacturing. It could be mentioned, that this excellent structural product, excels in the design, the characteristic Greek austerity and the elaborate work, compared to the corresponding modern products. It constitutes a completely ecological wooden structure, using exclusively wood, a renewable and biological material, and additionally, it was manually or mechanically processed without the consumption of fossil fuels resources and energy.

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