

Jerzy Smardzewski

# Furniture Design

 Springer

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# Preface

Wood is an excellent construction material, which has been used by people for thousands of years for the production of building constructions, machinery, tools, interior design, including furniture, accessories, and even jewellery. In particular, pieces of furniture made from wood are structures, which sometimes have not changed their form and technical solutions for several millennia. Many excellent furniture models were the work of outstanding designers, who have mastered all the details with reverence. To this day, they are appreciated and recognised among connoisseurs and collectors of works of art.

Today, many countries have recognised design as a priority direction for the development of education and economy, seeing in it the quintessence of innovation and an opportunity to modernise European economy. However, it should be noted that modern furniture is not only the fruit of the work of individual architects and artists. Creating an attractive, functional, ergonomic and safe piece of furniture requires an effort of many people working in interdisciplinary teams, and to them, among others, this book is addressed.

The aim of the book is to present the principles of designing furniture as wooden structures. It discusses issues related to the history of the furniture structure, classification and characteristics in terms of the most important features essential during designing, ergonomic approach to anthropometric requirements and safety of use. It presents methods and errors of designing, characteristics of the materials, components, joints and structures, and rules of developing design documentation. It also raises the issue of calculating the stiffness and endurance of parts, joints and whole structures, including the questions of the loss of furniture stability and of resulting threats to health and even life of the user.

Jerzy Smardzewski

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# Chapter 1

## The History of Furniture Construction

### 1.1 Introduction

At the dawn of human civilisation, when the concept of furniture was not yet known, man, driven only by the need to make life easier, in a natural way used various objects made spontaneously by nature. A trunk of a tree felled by the wind or rock served as a place to sit (Fig. 1.1), a flat stone block served as a base for performing a variety of common work, and soft moss or woollen skins served as a bed. Over the years, as a result of the creative activity of humans, artefacts began to be made which replaced the spontaneously made objects mentioned earlier. Over the centuries, due to the preferences of societies that lived in a given age, their forms changed. New types of furniture were created that fulfilled specific functions: to sit, lie down, for work, for dining, storage and others.

Generally, the remaining furniture constructions from the first dynasty of ancient Egypt are accepted as the beginning of the history of furniture (the years around 3100–2890 B.C.) (Setkowicz 1969). Meanwhile, there is much evidence to suggest that furniture was manufactured and used by humans in the late Palaeolithic and early Neolithic period.

Historically, the most commonly used material for manufacturing furniture was wood. Archaeological finds, however, indicate that in steppe and permafrost terrains, stone, metal and animal bones, especially mammoth bones, were also used. Despite the fact that the reconstruction of prehistoric homes with their equipment is not possible, there is not the slightest doubt that they housed furniture. Archaeological discoveries in the pool of the middle River Don (among others, in the region of the village of Kostienki near Voronezh 16) indicate that in this area, groups of mammoth hunters continued a semi-sedentary lifestyle, also in the period after maximum glaciation (the second pleniglacial, i.e. after 18 thousand–17 thousand years ago) (Kozłowski 1986; Escutenaire et al. 1999; Svoboda 2004). Such a lifestyle was conducive to the creation of innovations, which preceded the civilisation achievements of the first sedentary farmers and breeders. These

**Fig. 1.1** Stone shaped by nature as one of the first objects that functioned as a piece of furniture



innovations include many areas related not only with settlement and economic strategies, symbolic culture and religion, but also with material culture. The building type, for both residential ground buildings and half dugouts, was characterised by unprecedented soundness and stability. Due to a lack of wood, caused by the gradual disappearance of trees in the periglacial steppe environment, mammoth bones were used to build foundations, and also the construction of walls and ceilings of structures.

The first houses built almost only from mammoth bones we know from Moravia (e.g. Milovice), as well as from eastern Europe: from Kostienki, approximately 18 thousand–17 thousand years B.C. (Anosovka II site, cultural layer Ia), and established 16 thousand–14 thousand years ago in the River Dnieper basin (sites—Mezhirich, Mezine, Dobranichevka in Ukraine) (Svoboda 2004).

The main theme that is presented in Palaeolithic arts is a woman's figure with strongly marked gender features, occurring during the period 30 thousand–20 thousand years ago throughout all of Europe from the Atlantic Ocean to the River Don, known as the so-called Palaeolithic Venus (Soffer et al. 2000). The woman presented in Fig. 1.2, on the contrary to many other figures of Venus, is sitting on a seat especially designed for this function. This indicates the fact that, regardless of the lack of reconstructions of complete homes from that period, people of the Palaeolithic Era not only made tools that were necessary to acquire food and its processing, but also made usable objects, including furniture.

**Fig. 1.2** Venus figure from Gagarino approx. 21000 B.C. (Gorodnjanski V.). Gagariono is located on a loess terrace on the north lip of a ravine on the right bank of the Don River about 5 km north of the junction of the Sosna, a tributary stream. It is north of the well-known Kostienki sites



Therefore, it seems that upper Palaeolithic mammoth hunters of the periglacial steppe, due to their semi-sedentary lifestyle, over 10 thousand years earlier achieved a standard of development that came close to the Neolithic societies in the Middle East (Kozłowski 1986). This thesis is all the more likely because in the Middle East many innovations, such as the appearance of monumental architecture and stone sculpture, attributed to the peoples of the pre-ceramic Neolithic Era, was in reality, as recent discoveries in eastern Anatol show, the work of settled hunters and gatherers (today defined as “sedentary foragers”) in the eleventh–tenth century B.C. This indicates that many civilisation achievements did not depend directly on the production of food, but it was primarily the result of the sedentary lifestyle regardless of the type of farming.

We know much more about the creative accomplishments of peoples living in Europe in the Neolithic Era. Near the most famous stone circle of Stonehenge, British archaeologists unearthed a huge settlement dating back to before 4.5 thousand years B.C. This discovery sheds new light on the role of Stonehenge. According to anthropologists, the people who built it also created a similar wooden construction.



**Fig. 1.3** Interior of one of the households of the Neolithic village at Skara Brae: **a** stone cupboard, **b** stone beds (*Photograph* Nick Lee)

Durrington Walls is the largest British wooden henge, and this site is the remains of the largest known wooden British settlements from the Neolithic Era (from before 6 thousand–4 thousand years B.C.). It was created exactly at the same time when the first boulders in Stonehenge were begun to be erected, that is about 4.5 thousand years ago. Today, there is no doubt that the settlement was inhabited by hundreds of people. In September 2006, archaeologists unearthed inside the ring a floor of eight houses. They found imprinted traces of beds and other furniture, the remains of fires placed in the middle of the house, and various household rubbish. The next two houses were found in the western part of Durrington Walls. They were surrounded by their own palisades and ditches.

Another interesting find, presenting the art of making furniture in the ancient times, is the Neolithic village of Skara Brae located on the western coast of Orkney in Great Britain, from 3200 B.C. In the reconstructed rooms of the old one-room households one can find: wardrobe, beds and cupboards made of stone (Fig. 1.3). The residents used this material mainly because of low forest cover on the island, therefore minimal resources of wood, which was used rather as a fuel than a raw material for making furniture.

The use of furniture in the Neolithic Era is also shown by the stone figurines of sleeping or seated figures of women (Fig. 1.4).

Prehistoric designers, like modern designers, paid particular attention to a comprehensive approach to designing, meeting both the requirements concerning a satisfactory appearance, as well as the necessary functions. In fact forms of furniture

**Fig. 1.4** Mother Goddess  
from Çatal Hüyük, Turkey.  
Neolithic Era approx.  
6000–5500 B.C. (Museum  
of Anatolian Civilizations  
in Ankara)



constituted small architectures with legs designed like columns, in other cases they were parts of anthropomorphic forms of animal origin. Furniture design and their form changed from simple to intricate, depending on the period in which they were made. Some of the oldest, well preserved and described objects in museum collections come from the region of the former Mesopotamia, richly gilded furniture constituting the furnishing of palace interiors. We learn of many of them thanks to the good condition of parts of ancient furniture that survived to modern times, such as original parts of gilded Egyptian furniture buried together with the mummies of Pharaohs in the hot sands of the desert. The style and form of furniture evolved much more quickly than other forms of architecture, thus reflecting new ideas and innovative solutions of past designers. In many cases, however, one can conclude that the functionality of those structures still remains impeccable and timeless. Tables and chairs used by Egyptian workers in 2800 B.C. looked and were used identically as chairs of workers in the year 1800, of the Finnish peasants from the region of Yamsakoski (Fig. 1.5). Also Dutch painters of the seventeenth century and American painters of the early nineteenth century presented interiors of rural huts identically.



**Fig. 1.5** Similarity of furniture structure: **a** chair with a plaiting, Egypt around 2800 B.C. (British Museum), **b** chair with a plaiting, Finland around 1930 (Heritage Park in Jämsänkoski)

## 1.2 Antique Furniture

### 1.2.1 Furniture of Ancient Egypt

We mainly learn about the form and construction of furniture made in ancient Egypt from the perfectly preserved finds, reliefs and paintings that decorate the walls of the tombs of Pharaohs. It was found that many design solutions used by the contemporary artisans are also used today. All retained museum exhibits of furniture of ancient Egypt prove that the Egyptians used many techniques for decorating furniture. Gold plating and ivory incrustation were common methods of finishing the surfaces of furniture. These methods, as well as making legs in the shape of animal paws, became the common practice of carpenters from much later periods. To make valuable furniture, Egyptian carpenters used the wood of the ebony, cedar, yew, acacia, olive, oak, fig, lime and sycamore tree, often by importing this raw material from Asia Minor, Abyssinia or Namibia. Exterior elements of furniture were finished off not only with ebony wood combined with ivory, but also metal (brass, silver, gold), mother of pearl, lacquer, colourful faience and semi-precious stones (Gostwicka 1986). Ancient Egypt was familiar with bone glue, which was used in techniques of incrustation and veneering. The Egyptians used mortise and tenon joints and dowelled joints to combine most structural elements of furniture. In sarcophagi, chests and dressing tables they also used dovetail joints or bevelled joints (Setkowicz 1969).





**Fig. 1.6** Bed of Queen Hetepheres IV, from the dynasty of Snefru, around 2575–2551 B.C. (reconstruction of the original from the Museum of Fine Arts, Boston)

The oldest known Egyptian bed, more or less from the times of the first dynasty, is a design consisting of a horizontal wooden frame, resting on four thick and massive bull legs carved in ivory. The legs were joined to the frame usually with mortise and tenon joints, while on the frame of the bed, belts made from leather or other kind of plaiting were stretched over.

Beds with higher peaks on the side of the head were made with footrests. In some bed designs, the connection of the legs with the frame of the bed system was strengthened by bindings from leather strap stretched across drilled holes (Fig. 1.6). The beds in ancient Egypt did not have headrests, but wooden boards were placed at the side of the feet. The board was fixed by two bolts coated with a copper sheet, which also matched the sockets in the frame that were lined with copper. The board at the ends of the legs was the only ornate part of such a bed. The legs in the shape of lion paws were usually directed towards the head.

It is also known that the Egyptians used litters already during the first dynasty. The litter of Queen Hetepheres has survived to our times. Elements of the litter are also joined by leather straps or with a tongue and groove joint. On the front side of the seat back, at the height of the armrests, was an ebony strip inscribed by gold hieroglyphics.

Sitting furniture in Ancient Egypt had a wide variety of forms and an extremely large number of design varieties. A chair, table, bed and corner settee from the fourth dynasty (2600 B.C.), preserved in the tomb of Queen Hetepheres, had legs in the shape of animal paws usually turned to the front and always parallel to each other. They were not set directly on the ground, but on rounded bricks or spheres. If the armchair had a backboard and side rests, they were filled with papyrus, bas-relief or an openwork crate with figural, human and animal motifs, or symbols consisting of hieroglyphics.





**Fig. 1.7** Stela of Amenemhat, the end of the Middle Kingdom of Egypt (middle of the second millennium B.C., Cairo Museum in Egypt)

Figure 1.7 shows a limestone depicting a scene of a funeral banquet, in which the whole family participates. The father, mother and son named Intef sit on a long bench with legs in the shape of lion feet, with two low backboards on both its sides. Next to the bench is a lower, columnar table set with the sacrifice of various kinds of meat and vegetables.

Tutankhamun's throne is extremely impressive, richly decorated with gold, silver, semi-precious stones and a coloured glass paste (Fig. 1.8). Glass paste is a glassy mass consisting of silicates, fused in refractory forms, mixed with crystal and dyed with metal oxides. A special property of glass paste was its susceptibility to plastic working. The legs of the throne have the shape of lion paws, the armrests are two-winged cobras in double crowns of Upper and Lower Egypt, spreading the wings over the cartouches of the king. The front edge of the seat is decorated with two lion heads. The backrest's decoration is a scene depicting Tutankhamun sitting on a soft upholstered throne with a pillow, holding one hand on the rest, and supporting his feet on a footrest. Ankhesenamun is standing in front of him and with his right hand he is rubbing Tutankhamun's arm with an ointment from a dish in his left hand. This drawing illustrates that not only beds, but also seats and backrests of chairs were spread over with soft pillows filled with feathers or wool.

The folding chair found in the annex of Tutankhamun's tomb has a very interesting design, which was transformed from a stool by adding a backrest (Fig. 1.9). It is made from ebony wood with irregular incrustations of ivory, which imitate the skin of a leopard, while the legs have the shape of duck heads. The backrest is also made from ebony wood incrustated with ivory, decorated with semi-precious stones, glass paste and a gold sheet.



**Fig. 1.8** Tutankhamun's throne. West Thebes, Valley of Kings, Tutankhamun's tomb, 18th dynasty, around 1325 B.C. (Cairo Museum in Egypt)

When chairs appeared, the Egyptians also began to build tables. They were similar to each other in construction. The legs were usually made of thin stiles inclined at an angle to the ground and joined together in the central part with a connector, and in the upper part with a case. During funeral banquets, tables were erected on one, it seems, turned column (Fig. 1.10). This is an observation that is extremely intriguing, because so far traces of tools and equipment for turning, which the Egyptians could have used, have not been found. However, it seems highly unlikely that with such a developed technique, for those times, this technology was unknown to them. As reliefs show (Fig. 1.10), the seats of chairs were usually a bit higher than the working boards of tables, on which loaves of bread or incense burners lay.

Aside from chests for storing clothes, the ancient Egyptians made sarcophagi, coffins, dressing tables for storing toiletries and jewellery, as well as trunks. Many of them were made from wooden boards joined at the width, and in the corners dowed, bevel and multi-dovetail joints were used.

The beautiful jewellery chest presented in Fig. 1.11 was found in the tomb of Yuya and Tjuyu. The chest is supported on long, slender legs adorned with a geometric ornament made from faience and ivory dyed pink. The same continuous pattern runs along the edge of the chest and its arc-shaped top. The sides are divided by a geometric frieze into two equal parts, the upper is adorned with a hieroglyphic inscription made in gilded wood, containing the cartouches of Amenhotep III and his wife Tiye, who was the daughter of Yuya and Tjuyu. The lower part is filled by a recurring motif consisting of symbols expressing the wish that the owner of the



**Fig. 1.9** Tutankhamun's ceremonial throne, around 1325 B.C. (Cairo Museum in Egypt)

chest enjoys life and fortune. The lid is decorated with two symmetrical panels of gilded wood and faience.

### ***1.2.2 Furniture of Ancient Assyria and Persia***

We learn about the material culture of the Assyrians mainly from archaeological excavations. Assyrian furniture was usually cast from bronze and shelving, much like in Egypt, placed on supports in the form of lion paws. Also, many carvings and sculptures take the form of animal heads, their full figures, as well as numerous

**Fig. 1.10** Relief, Horemheb at a dining table. Sakkara, Horemheb's tomb, 18th dynasty, around 1325 B.C. (British Museum)



**Fig. 1.11** Jewellery box. Valley of Kings, Tjuyu's tomb, 18th dynasty, Amenhotep III's rule, the years 1387–1350 B.C. (Cairo Museum in Egypt)





**Fig. 1.12** Palace in Nimrud, relief presenting king Ashurnasirpal II on the throne, next to which a footrest is standing, around 865–860 B.C. (British Museum)

human figures. Characteristics of the Assyrian culture were also platforms that constituted small construction forms resembling skeletal structures, upon which the actual piece of furniture was set. Thanks to such a solution, the Persians obtained the impression that a seated person has an advantage over a standing one, which was to arouse due respect to the ruler. Structurally, this effect was achieved by applying numerous turned spheres and spirals on which the legs of chairs, armchairs and platforms were set (Fig. 1.12).

Chairs and armchairs were richly lined with colourful textile materials. This particular feature distinguished Assyrian furniture from many others, but these achievements were commonly used by both Greeks and Romans.

Assyrian beds were much higher than Egyptian ones, as the Persians received guests and celebrated at lavishly set tables in reclining positions. Assyrian furniture was extremely massive, heavy, oversized and impractical. Their main task was to emphasise social position of the user, rather than to provide him with maximum comfort of use.

### ***1.2.3 Furniture of Ancient Greece***

Although no good-quality museum exhibits were preserved, the constructions of Greek furniture can be fairly accurately recognised based on frescoes, paintings on pottery, bas-reliefs, as well as on the basis of numerous written messages. The earliest forms of furniture works in Greece clearly take advantage of Egyptian design, but their further evolution was directed in its own original forms, reaching



peak development in the fifth century B.C. Greek artisans perfectly mastered the technology of bending and turning wood, gluing and veneering, as well as finishing wood surfaces with varnish and polychrome. They also expertly used the technique of joining elements using different connectors and glue. They knew of mortise and tenon joints, dowelled and dovetail joints, as well as frame constructions and weaved seats. They commonly used box wood, yew wood, walnut wood and ebony wood (Gostwicka 1986). In Greece, many new, original structural forms of furniture were created, especially chairs and stools. They were ascribed separate, distinctive names, which include: diphros, i.e. a small and lightweight stool, diphros okladias a type of folding stool consisting of a large number of elements under the seat, klismos, klinter or klisja is a lightweight chair with a backrest and legs that are characteristically bent forward and backward, intended mainly for women, kathedra or thronos represented by a heavy chair with a backrest, designed for men, having insignia showing their authority and family or social position.

A diphros stool was relatively low, without a backrest, with straight, turned legs in the shape of a mace, usually placed perpendicular to the ground (Fig. 1.13).

**Fig. 1.13** Diphros-type stool. Relief from Athens, around 430–420 B.C. (British Museum)



The seats of these stools were most often made of a strap weave, leather or fabric. A folding stool with crossed legs was called a diphros okladias, i.e. a folding diphros. Due to the mobility of the construction, the piece of furniture was made of metal or wood.

A klismos-type chair was made from wooden curved slats obtained by both plastic working and bending wood, as well as cutting elements from trees of a large, naturally shaped curve. There are also facts known that the Greeks joined the boughs and branches of trees, fixing them to the ground with anchors, in this way forcing the desired curvature for the planned construction of furniture. The bending of legs of klisja was also important for construction, since it increased the sections of the legs in the case part, enabling technical bonding using mortise and tenon joints (Fig. 1.14).

The throne was usually richly decorated with animal or human figures. In many cases, the Greek throne was similar to the ones manufactured in Egypt and Assyria.

**Fig. 1.14** Klismos-type chair with bent backrest. Relief from Athens, around 430–420 B.C. (British Museum)



**Fig. 1.15** A thronos chair made from rolled elements. The relief shows the seated Gaius Popillius, around 50 B.C. (Archaeological Museum in Thessaloniki)



In particular, the structures of footrests and armrests are characteristic. However, they are distinguished by the impressive height of the backrest and rolling technology used in shaping almost every part of the piece of furniture (Fig. 1.15). The thrones were placed in public places, temples, stadiums and theatres; they were made of marble and always richly decorated by Greek ornamentation.

The ancient Greeks, like the Persians, did not have tables of a function and purpose as we know today. Commonly only feast tables were used, set by the beds and reaching the height of the bed (Fig. 1.16). An exception was sacrificial, column tables, with a wide worktop and height adjusted to a standing person.

Greek artisans paid particular attention to furniture for lying down on. They were made from wood decorated with precious veneers, inlay, incrustated with precious metals or ivory. Wealthy Greeks had beds lined with soft leathers, cloths and woollen fabrics, on which linen sheets were placed. Pillows and mattresses filled with wool or feathers were used.



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