



## **Furniture as a Design Product**

### **Dr. Demet GÜNAL ERTAŞ**

*Istanbul Technical University, Faculty of Architecture, Department of Industrial Product Design, İstanbul, Turkey  
ertas@itu.edu.tr*

### **Prof. Dr. Seçil ŞATIR**

*Fatih Sultan Mehmet Vakıf University, Faculty of Architecture and Design, Department of Interior Architecture, İstanbul, Turkey  
ssatir@fsm.edu.tr*

### **ABSTRACT**

Furniture has been one of the indispensable articles of our living areas from past to present. Furniture is significant element in the planning of a building enabling the spaces to specifically perform their functions. Various spaces such as the living room, office spaces, concert halls and schools provide manifold services, which may require that furniture design is to be practiced in relation to these manifold services. In addition to wood, various materials are being employed in the manufacture of furniture. Factors such as the risk of forest depletion and sustainability require minimizing the utilization of wood. In addition to traditional methods in furniture design, the utilization of infinite elements and such programmes as solidworks, various measurement test analysis methods, contemporary manufacturing techniques and current technologies could provide environmentally friendly products reducing material consumption and shortening the process of manufacturing. While reducing the number of materials, weights and parts in furniture manufacturing, criteria such as durability, difference in appearance, the utilization of materials appropriate to the function should be considered. This paper explicates that furniture design could be considered with different viewpoints thanks to the principles of the discipline of design. It stresses some key points that should be noted in furniture design. Some experimental studies that combine technical and aesthetical works are mentioned.

**Keywords:** Furniture design, material, structure, optimization, laboratory experiments.

### **1. INTRODUCTION**

This paper deals with furniture on the basis of product design. It chiefly considers the differences that design viewpoint could bring to furniture.

The paper explicates that furniture design could be considered with different viewpoints thanks to the principles of the discipline of design. It stresses some key points that should be noted in furniture design. Some experimental studies that combine technical and aesthetical works are mentioned. It provides examples from laboratory studies done in order to design durable furniture with less materials and components.

Industrial design is a field in which designed products are manufactured and labor, energy, and materials are consumed. It could be asserted that design means diminishing consumption that is the result of production and making the object of design most efficient in terms of materials and use. Given that design is a creative field, it important to develop solutions that contribute to sustainability.

### **2. METHOD OF STUDY**

A literature review is undertaken in the study. In addition to this, experiential studies on furniture are included. The paper will also mention various methods that could be employed in order to advance furniture constructions. What is more, the paper will



display in a matrix special features of furniture that could be developed on a basis of industrial design and thus portray different industrial design viewpoints. In this context the other method of this paper is the method of interpretation called hermeneutics.

### **3. DEFINITION OF INDUSTRIAL DESIGN**

Industrial design has a similar definition in different resources. Although the tenets of the profession remain the same, industrial design advances and changes keeping pace with the changing dynamics of our era. Below provided are definitions of and explanations for design given in various resources.

Industrial design is the conceptualization and realization of projects for new industrial products intended for end-users taking into consideration their functionality as well as appropriateness for needs and tastes of the target market. Industrial design is a profession that is devoted to establishing relationship between people and objects manufactured by industrial methods. Industrial methods aim to economize on expenses such as material, number of operations, and workmanship required for the products that have to be manufactured in large quantities to meet the needs of targeted users in the market. Designers know these methods and communicate with the other elements of the industrial environment (engineers, managers, etc.) using the language of these methods (<http://etmk.org.tr/tr/endustriyel-tasarim/>).

If we have a look at international definitions, IDSA's (Industrial Designer Society of America) definition: "Industrial Design is the professional practice of designing products used by millions of people around the world every day. Industrial designers not only focus on the appearance of a product, but also on how it functions, is manufactured and ultimately the value and experience it provides for users. Every product you have in your home and interact with is the result of a design process and thousands of decisions aimed at improving your life through design..." "Design is a plan for arranging elements in such a way as best to accomplish a particular purpose." —Charles Eames ([https://www.idsa.org/events/what-id-Industrial Designers Society of America; What Is Industrial Design?](https://www.idsa.org/events/what-id-Industrial%20Designers%20Society%20of%20America%3F)).

On the other hand, as per "Decree-Law No. 554 On the Protection of Industrial Designs" kept in the system, "Design" means the whole formed by various elements and qualities perceived by human senses such as lines, shapes, forms, colors, textures, materials, and flexibility of the whole or part of product or its decoration (Decree /KHK, 1995).

"Industrial design is a long-established term. The term is known to have been used in 1919 by industrial designer, Joseph Claude Sinel. Christopher Dresser, who lived between 1834 and 1904, is generally accepted as the first industrial designer. A precursor to Bauhaus and established in 1907, Deutscher Werkbund was a state-funded effort that would merge traditional handcrafts with industrial mass production techniques to put Germany on a competitive ground with England and the United States of America (Yaziciođlu Y., 2017)."

The establishment of Bauhaus School in 1926 and the global economic crisis called "the Great Depression" in 1929 that quickly spread the world and caused a new beginning in the 1930s are generally accepted as the origins of design.

### **4. FURNITURE AND ITS PLACE IN INDUSTRIAL DESIGN**

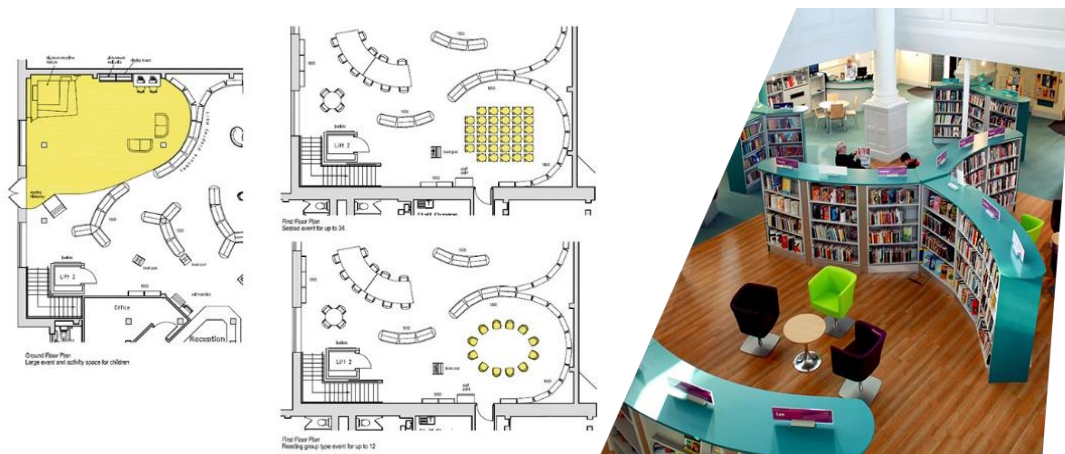
Everything around us from glasses to the computers, from pens to chairs are designed products. Industrial design has a vast product range and furniture design takes an important place in it with the diversified materials it employs.

"Furniture (Italian: mobilia, French: mobilier), refer to the things that are used to decorate and furnish seating spaces for various functions. As this definition suggests, furniture is a product that decides the usefulness of a space with its functionality, make

it look nice or unpleasant with its aesthetical value. Furniture makes our homes and work spaces cozy, lovely, and colorful. In short, it's a product that merges art and technique (<https://www.birofis.com/mobilya-nedir.shtm>)."

Furniture units have generally been designed and manufactured with wooden materials, perhaps as an effect of the most ancient times of history. Furniture units, particularly as equipment used at homes give the household environment a cozy effect. Either in homes or in public spaces, physical effects that include materials, shapes, and structures, as well as heat, light, texture, pattern, smell, color, etc. contribute both the space and furniture and add efficiency and value. These physical factors contribute to a better experience of furniture by striking a balance between the structural and organizational intensity of the space.

Furniture has always been an indispensable component of our habitats since ancient times. Structures are built. Architectural elements such as walls, flooring, windows and doors are planned according to the requirements. Together with the planning, furniture also constitutes the important elements that make spaces specific to their function. For instance, it is furniture that is inside it that makes a space a library, along with the architectural qualities that come from planning such as shape, dimension, and window and door locations. The space gains the functions of a library thanks to the existence of an abundance of furniture units from bookshelves to tables and chairs (Figure 1).



**Figure 1.** Library plan and furniture

(<https://www.openingthebook.com/library-design/library-space-planning>)

Furniture has an important place in industrial design as the category of the product that is mostly used in all kinds of spaces in daily life that include houses, offices, hotels, cinemas, cultural centers, and hospitals. Furniture units affect people's interaction with the spaces thanks to the possibilities they offer. They determine the life scenario in the spaces. Efficient results could be obtained in terms of spaces and users when furniture is considered as integrated designs that bring elements of interior architecture together.

#### **4.1. Furniture As An Evolving Product Of Design**

Having continuously evolved since ancient times, the typology of furniture further changes greatly according to countries, masters, craftsmen, manufacturing methods, tools, machinery, styles, art movements, and aesthetic understandings of the times, etc. A great number of factors affect furniture design. These include developing manufacturing technologies and materials, fashions and trends, changing lifestyles, proliferating areas of use, changes in articles, increases in technological devices such as telephones, televisions and computers, structure typologies, availability of materials as well as developments in storing and shipping facilities.

When we look at prehistoric periods, around 4000s BC we witness Anubis, "son of Osiris, God of the Earth and Heavens". Anubis has a jackal's head, and he reminds of death as jackals roam around the graves. In the mummy scene "Anubis is interested in the mummy of Sennedjem, who is thought to be a famous person. The lion-headed and lion-pawed piece of furniture there, a kind of palanquin, is an excellent specimen of workmanship on hard wood (Akdeniz, G., 2016), (<https://tr.wikipedia.org/wiki/Anubis>).

One of the most important works of Egyptian civilization, Queen Hetepheres and Tutankhamen furniture units, dating back to 3000 and 1325 BC, respectively, are proof that furniture has a time-honored past and dates back to the times when man existed. These furniture units have an elegant and sturdy look thanks to an excellent employment of "wood, leather, and gilt" (Crochet T., 1999).

The history of furniture that has had a brilliant story of evolution and differentiation from 4000 BC to the 1900s, is not the main subject of this paper. However, if we briefly mention Bauhaus period furniture which had a great effect on modern furniture culture, we appreciate the use of metal for the first time as well as the welding method tried for the first time in that period. Some benchmarks in Industrial Product Design include Le Corbusier's resting chair in 1928 that employed chrome plated steel tubes, rubber stretchers and leather upholstery; Rene Herbst's Steel tube chair in 1929, Marcel Breuer's steel tube chairs and Wasilly armchair between 1920-1929, as well as Barcelona chair by Ludwig Mies Van Der Rohe in 1929 again that used welding method for the first time (Miller J., 2011).

In old Turkish houses furniture was mainly in the form of built-in cabinets. People used furniture elements such as built-in cupboards, niches, built-in shelves (Figure 2a,b). Later these pieces of furniture became movable and changed according to art movements and dynamics of the age. Wooden furniture left its place to furniture with metal frames for a certain period with the increased industrial use of metal. Furniture production continued with different materials such as metal, fiberglass and plastic (Figure 3a). Designs with lighter and in more original forms were also made. Curved and original forms were designed with plastic based materials (Figure 3b, 3c). While regional and traditional materials like bamboo were employed, contemporary materials like fiberglass and corian were also used in furniture. Quests for unifying furniture with the space continued as well. Italian designers Dante Donegani and Gioani Lauda made designs different from classic furniture. They designed furniture suitable for the space such as eating unit, seating unit and study unit for residence (Figure 7a,b,c,d). From time to time built-in furniture as well as furniture integrated with the structure were designed. In addition, some designers came up with architectural furniture, that considered space and furniture as a whole (Figure 5a,b,c,d, Figure 6a,b,c,d, Figure 7a,b,c,d).



**Figure 2 a.** Niches, shelves in traditional Turkish houses



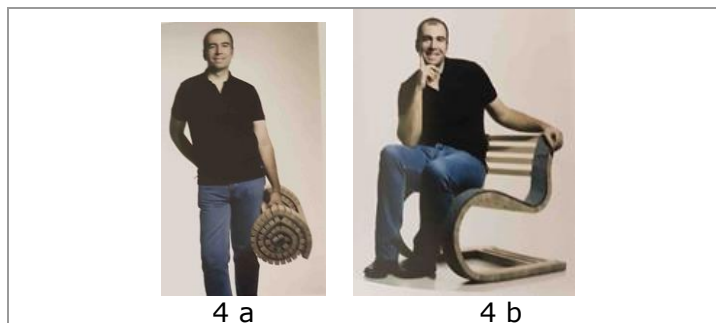
**Figure 2 b.** Built-in shelves in modern Turkish houses(<https://tr.pinterest.com/pin/514958538617146233>)



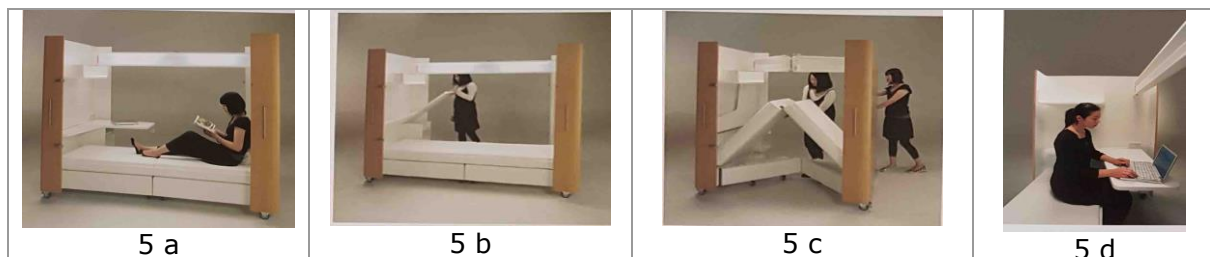
<p><b>Figure 3 a.</b> Tubular steel design by Marcel Breuer, Wassily chair        (<a href="https://www.knoll.com/product/wassily-chair-gold">https://www.knoll.com/product/wassily-chair-gold</a>)</p>	<p><b>Figure 3 b.</b> 1967 Plastic Panton chair by Verner Panton        (<a href="https://www.dwr.com/dining-chairs-and-stools/pantonchair/431231.html?lang=en_US">https://www.dwr.com/dining-chairs-and-stools/pantonchair/431231.html?lang=en_US</a>)</p>	
<p><b>Figure 3 c.</b> Stainless steel monoblock office desk by Ben Swidens, 1966        (<a href="http://www.moderndesign.org/2011/06/ultimate-space-age-office-desk.html">http://www.moderndesign.org/2011/06/ultimate-space-age-office-desk.html</a>)</p>	<p><b>Figure 3 d.</b> Boomerang Desk France 1970 by Maurice Calka        (<a href="https://tr.pinterest.com/pin/547961479657456026/">https://tr.pinterest.com/pin/547961479657456026/</a>)</p>	<p><b>Figure 3 e.</b> Nest Chair by Nina Bruuns        (<a href="https://www.home-designing.com/uniquely-artistic-modern-sculptural-chairs">https://www.home-designing.com/uniquely-artistic-modern-sculptural-chairs</a>)</p>

**Figure 3 a,b,c,d,e.** Furniture with original shape, designed with current materials

When designing for future lives, today's research takes it into consideration that in the future mega cities will have smaller houses and design will be made accordingly. In this context, "structural, compact, integrated, flexible, multifunctional and organizational" designs become more and more important (Hudson J., 2010). Recyclable materials also find good use.



**Figure 4 a,b.** Rollable and collapsible chair made of composite wood.  
 Design: Thomas Heatherwick (Hudson J., 2010, p.111)



**Figure 5 a,b,c,d.** Flexible piece of furniture is a good bed for guests.  
 Design: Tashiniko Suzuki, Kenchikukagu Architectural Furniture; made of composite wood  
 (Hudson J., 2010, p.132,133)

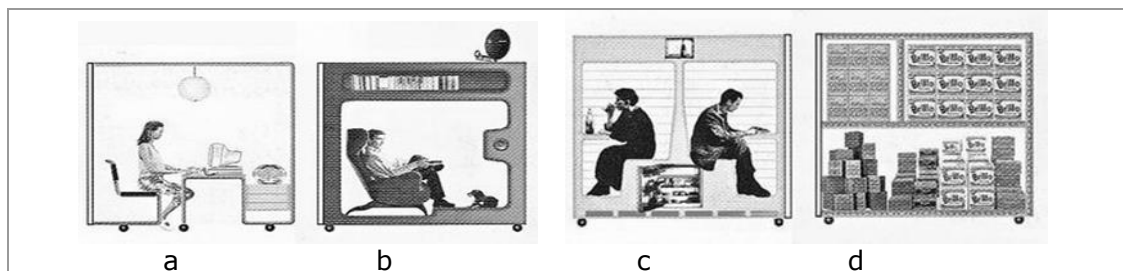


**Figure 6 a,b.** Furnitures that integrate with interior space  
 (<https://www.youtube.com/watch?v=4Su8bsWQLGA>)



**Figure 6 c,d.** Futuristic furniture supported by new technologies  
 (<http://www.ba-bamail.com/content.aspx?emailid=17865>)

(<https://www.cgtrader.com/3d-models/furniture/furniture-set/futuristic-office-furniture>)

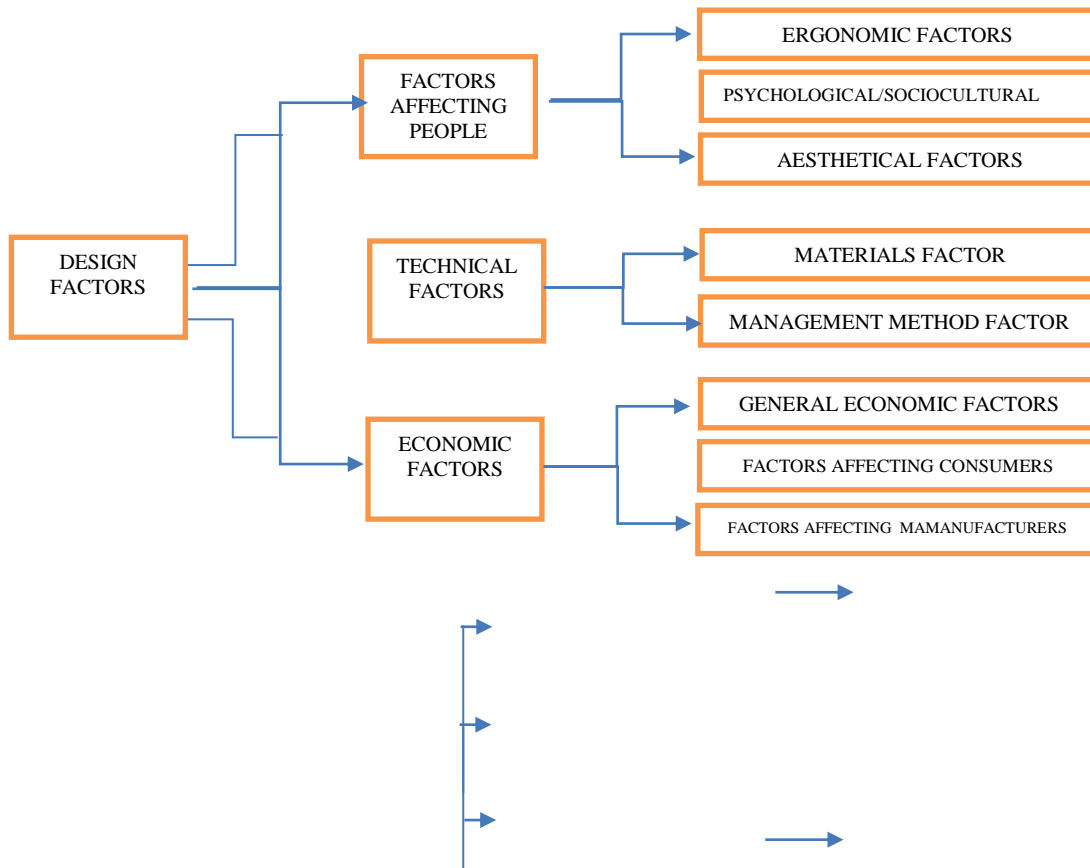


**Figure 7 a,b,c,d.** Product that integrate space and furniture

Function-specific furniture by Italians Dante Donegani and Gioani Lauda  
 (<https://sbandiu.com/2018/05/19/passepartout-di-dante-donegani-e-giovanni-lauda/>)

#### 4.2. Effective Factors in Furniture Design

Both scientific and artistic principles are of importance in the bringing together of a piece of furniture. With this viewpoint: "The ergonomist checks if the dimensions are compatible with the human body, mechanical engineer makes sure that the mechanic components, if any, of the furniture work well. Someone interested in aesthetics looks at measures and ratios that address the eye. Wrongly or deficiently designed furniture is nothing more than a waste of production budget. To prevent these and to produce a functional piece of furniture, the designer's aim is to consider design standards satisfying the objectives as a whole and bring them together on the furniture. The factors that affect the design of furniture manufactured with industrial methods are shown in the diagram below: (<http://ahsapteknolojisi.blogspot.com/2011/04/endustriyel-tasarimin-tanimi-ve-onemi.html>)."



**Table 1.** Factors that affect industrial furniture design  
 (<http://ahsapteknolojisi.blogspot.com/2011/04/endustriyel-tasarimin-tanimi-ve-onemi.html>)

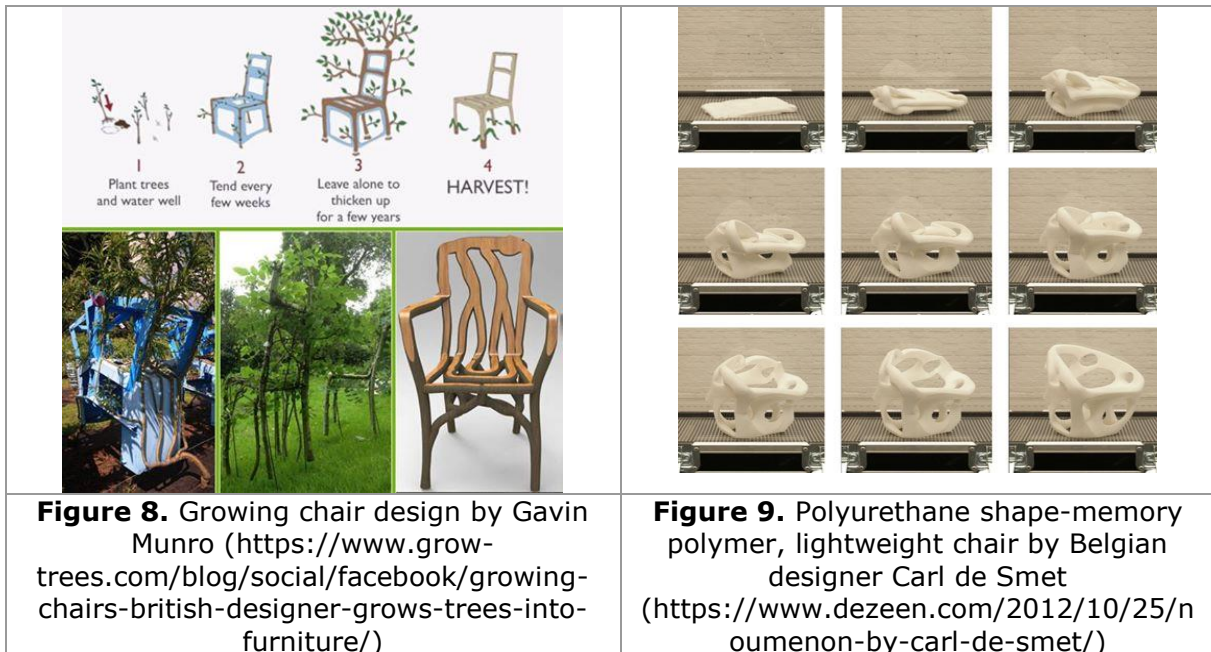
As seen in the table above, factors that affect furniture design could be counted as technical and economic factors as well as those affecting people. Factors affecting people include ergonomics, sociocultural factors such as habits, tastes and lifestyles, also aesthetical features of the furniture including shape, dimension, color and texture. Economic factors could be those affect customers and manufacturers. These include subfactors such as the production, shipping and storing costs, sales price and price ranges while technical factors include subfactors including materials and product management factors.

In terms of industrial design, furniture design has other important and more comprehensive criteria. Among these are appearance, compatibility with use and function, original design, dimensions, sturdiness, manufacturing method, ease of manufacture, costs, heaviness-lightness, availability of materials and their compatibility for purpose, durability of furniture structure, details, development of solutions that reduce workmanship, connectors and their details, fashions and trends, designing according to user profile, customer satisfaction, minimized use of resources, environment-friendly design, product-user interaction, correct relationship of furniture with the space, and manufacturing process. An important feature that separates design from other artistic works is that this discipline contains both technical and artistic works.

### 4.3. Importance of Material in Furniture Design

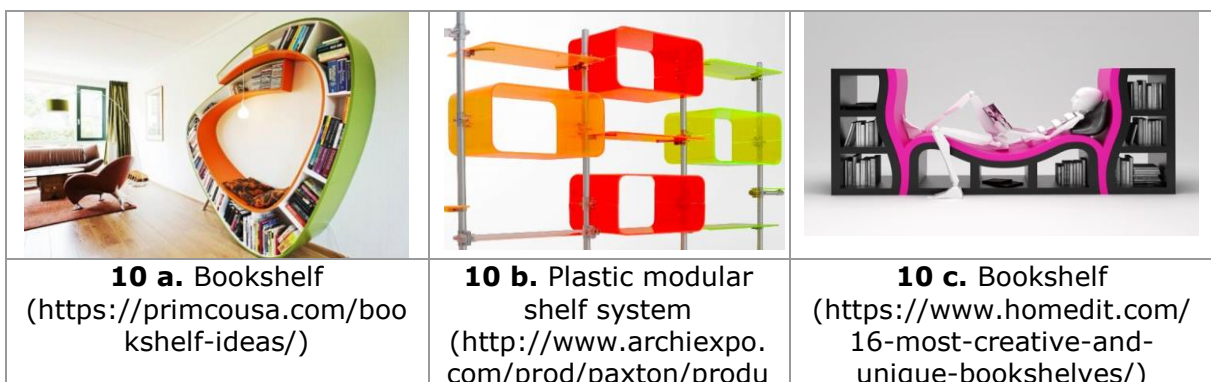
As with all products, material is of vital importance in furniture design because material makes it possible to manufacture designed products, put the construction up, and render it functional, giving the design its visual effect. Materials design has an effect on production method, cost as well as manufacturing process and time. Material is central to

obtaining targeted qualities in the furniture designed. The various physical, chemical, thermal, optical, mechanical, sensory, visual qualities of the material are also decisive in furniture design.



“Depending on the developments in the field of materials until our day, it is seen that the design of certain products have diversified. Thanks to new composite, programmable, shape-memory, growable, bio-based, smart, and recycled materials products with different features could be manufactured (Figure 8, Figure 9). Although some of the mentioned materials are employed in other areas, very few of these are used in furniture design at the moment. As the competitive medium becomes harsher in the furniture sector in our day, along with the various features of designs, the materials they are made of are equally important in providing customer satisfaction.” Designers have to evaluate all kinds of information and experience in material selection and determine the most suitable material for their designs (Günel Ertaş D., 2018).”

Besides wood, furniture is generally made of composite wood, metal or metal alloys such as steel, aluminum, and iron; marble, materials like granite stone, concrete, corrugated cardboard; materials of plastic origin such as polypropylene, PVC, fiberglass, acrylic, polycarbonate, and corian; natural materials such as bamboo, rope and straw; and woven materials such as technical textiles and fabrics. The risk of depletion of forests and sustainability require minimizing the use of wood. Accordingly, wooden composite materials could be preferred. Employing materials other than wood in the realization of furniture may result in different appearances and styles in furniture (Figure 10).





	<a href="https://www.ct-58536-222247.html">ct-58536-222247.html</a> )	
<p><b>10 d.</b> Chaired bookshelf designed by Charles Trevelyan for Londra Viable (<a href="https://weburbanist.com/2014/03/19/reading-room-dividers-13-creative-bookshelf-designs/">https://weburbanist.com/2014/03/19/reading-room-dividers-13-creative-bookshelf-designs/</a>)</p>	<p><b>10 e.</b> Metal book rack (<a href="https://www.laboutiqueblanche.nl/en/j-line-metal-book-rack.html">https://www.laboutiqueblanche.nl/en/j-line-metal-book-rack.html</a>)</p>	<p><b>10 f.</b> Metal bookshelf by Marica Vizzuso (<a href="https://weburbanist.com/2014/03/9/reading-room-dividers-13-creative-bookshelf-designs/">https://weburbanist.com/2014/03/9/reading-room-dividers-13-creative-bookshelf-designs/</a>)</p>

**Figures 10 a,b,c,d,e,f.** Bookshelves made with various materials

Considering resource depletion in furniture sector and the need to provide diversity, the type and amount of material used in furniture construction becomes more significant. For instance a wooden shelf system may have a conventional appearance, a shelf system with a metal frame could look modern, and a plastic shelf system may have a pop appearance (Figure 10).

Material selection for furniture design includes further subfactors that entail matching furniture to its area of use and targeted customers, using easily available material fitting for the manufacturing method, being able to use recyclable materials, reasonable pricing, matching manufacturing method with the design, with the production capacity, and with the technical means available.

### 5. IMPROVEMENTS AND EXPERIENTIAL WORKS IN FURNITURE PRODUCTION WITH A DESIGN VIEWPOINT

Design viewpoint requires that factors related to people as well as technical and aesthetical factors are considered together. It is vital in terms of economy and environment that design is made taking care about the following matters: selection of materials suitable for furniture design; optimization in utilization of material and components; utilization of less materials and components without compromising sturdiness; choice of material that prevents depletion of natural resources; furniture production with easily available materials; a sound relationship between material and design; design suitable to the spirit of the material or use of ideal material compatible with the shape of the design.

In addition to traditional methods in furniture design, environment-friendly furniture that shorten production process could be produced by employing software such as finite elements and Solidworks, various measurement, test, and analysis methods, contemporary manufacturing techniques and new technologies. Further criteria such as using materials that are compatible with function and use and that incur low-cost could be considered. Experimental studies made on furniture taking heed of the mentioned principles are shown below (Figure 11, Figure 12, Figure 13, Figure 14).

The following is an example from an experimental study in Slovakia, made with a view to design chair for overweight people. "In this study, the chair was given a load/weight of 110 kg and 150 kg to inspect its behavior under weight (Figure11a-11f) Population research indicates that the population of overweight people is continuously on the rise.



The study aims to design flexible chairs comprised of lamels using finite elements method (FEM). The modelling of flexible chairs was made with finite element method, stress and deformation was determined by elasticity and rupture modules... Testing of chairs, particularly the methodology for loading depended on EN 1728: 2012 standard. The standard accepted the maximum weight as 110 kg, while horizontal force from the back  $F_1=450$  N and the vertical force applied on the seat  $F_2= 1300$  N.

Therefore forces arising from load caused by overweight users have to be defined (Figure 11) (Nadežda L., Roman R., Rastislav I., Ľuboš K., Miloš H., Pavol J., 2019). "The legislation in effect in Slovakia regarding furniture design takes into account a user weight of 110 kg. However, according to anthropometric studies, the weight that needs to be considered in the future is 150 kg. User weights were focused on in the manufacturing of two flexible chairs... It presents the minimum thickness requirements for lamels necessary to produce chairs for users who weigh 110 kg and 150 kg respectively... The results of the study shows that three test lamels (thicknesses 11 mm, 13,5 mm and 16 mm) did not meet the requirements. However a lamel thickness of 21 mm. meets the loading requirements for both 110 kg and 150 kg. (Nadežda L., Roman R., Rastislav I., Ľuboš K., Miloš H., Pavol J., 2019).

In the light of their experience, Herman Miller Company may be said to have made a comprehensive reference to a very comprehensive process of sustainable design. This process includes obtaining the raw materials; choosing processed materials, choosing the most suitable material for environment protection during design process; employing environment-friendly production methods; energy saving; product purchasing and use; and waste formation, recycling process and use of recycled material in design decisions. Even obtaining raw materials has an effect on the subsequent decisions.

Thus, it explains what kind of decisions need to be made:

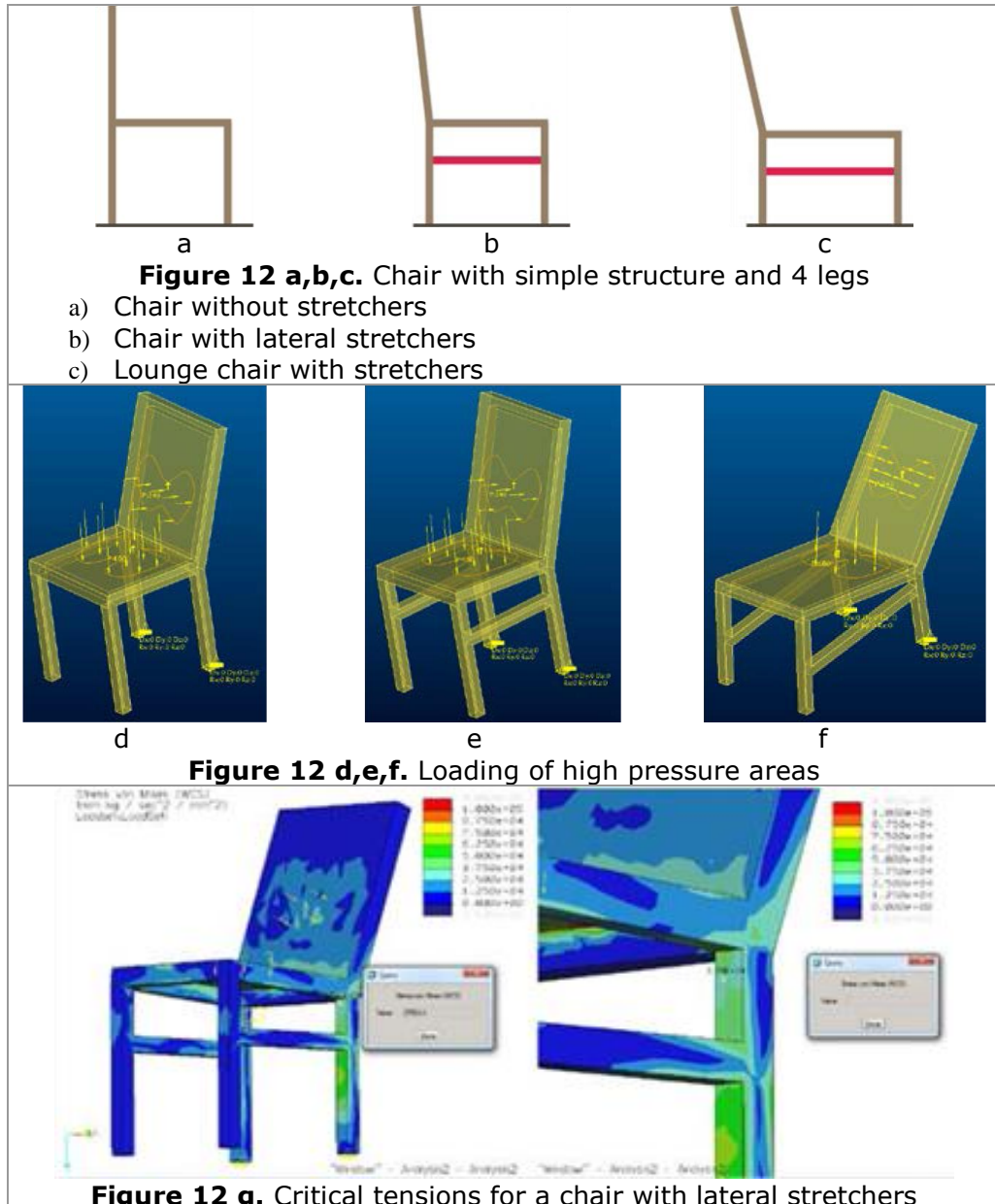
- Preliminary design decisions made with the enterprise,
- Design process decisions,
- Manufacturing process decisions: At this stage decisions on the following will be important for sustainability,
- Decisions regarding use of products after sales,
- Decisions regarding second use or recycling of products

"Energy consumption will dwindle in time with sustainability, higher performance, longevity, efficient operation function, sturdiness, lightness and low costs, optimization of material amounts and number of product components (Ertas D., Şatır S., 2017)(Günel Ertas D., 2007)."

<p><b>Figure 11 a.</b> Static loading of chair as per EN 1728: 2012 + dimensions of chair</p>	<p><b>Figure 11 b.</b> Deformation of flexible chair</p>	<p><b>Figure 11 c.</b> Maximum deformation definition of elastic chair</p>
<p><b>Figure 11 d.</b> FEM visuals of lumbar curve's bending and compressive points and tensile concentration. Left: 110 kg stress (max. 47.18 MPa) and compression (max. 65.14 MPa) and Right: 150 kg stress (max. 64.25 MPa) and compression (max. 88.98 MPa) for design stress.          (Nadežda L., Roman R., Rastislav I., Ľuboš K., Miloš H., Pavol J., 2019)</p>		
<p><b>Figure 11 e.</b> Elasticity and deformation visuals from finite element method, during load application. Left: for 110 kg, Right: for 150 kg.</p>		
<p><b>Figure 11 f.</b> Visual outputs from finite element method when load is 150 kg and chair's backward shift of 21 mm thickness.          Left: Design compression values (23,781 MPa) and stress value (28,157 MPa),          Right: Value for backward shift of chair (37,413 mm.)          (Nadežda L., Roman R., Rastislav I., Ľuboš K., Miloš H., Pavol J., 2019)</p>		

**Figure 11 a,b,c,d,e,f.** Behaviour of the chair under load

In the experiential study in Figure 12g, during analysis, a particular aspect becomes significant, namely the recommendation from the software's documentation to use Poisson's ratios. This approximations is necessary because wood is an anisotropic material (having properties that differ according to the direction of measurement). The ratio of the transverse to axial strain is called Poisson's ratio. These ratios are denoted with  $\mu_{LR}$ ,  $\mu_{LT}$ ,  $\mu_{RT}$ ,  $\mu_{TR}$ ,  $\mu_{RL}$ ,  $\mu_{TL}$ . The first letter of the subscript shows the direction of applied strain while the second refers to the direction of lateral deformation.



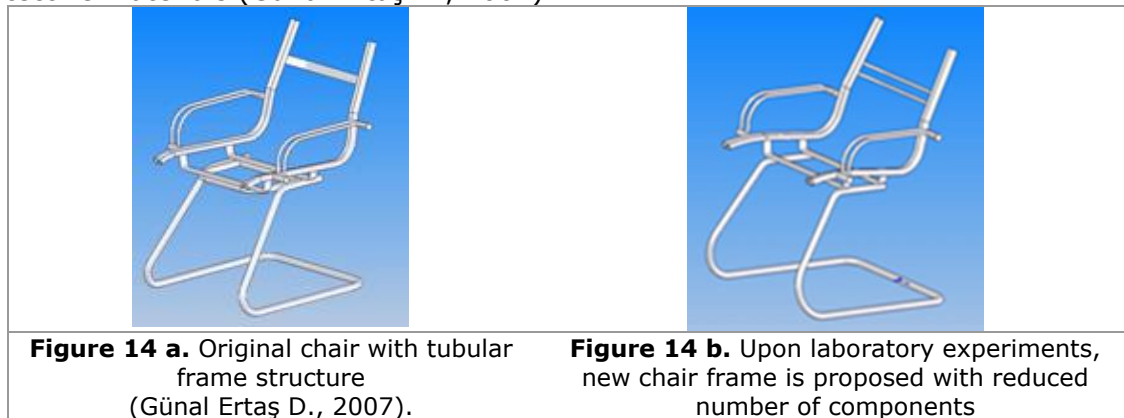
**Figure 12 a,b,c,d,e,f,g.** Behaviour of the chair under load  
([https://www.sensorprod.com/research-articles/2014/2014-10\\_pl/](https://www.sensorprod.com/research-articles/2014/2014-10_pl/))





### 5.1. A Basic Laboratory Experiment On Sustainable Design

Author Ertaş inspects materials on an industrial design basis and tries to realize her designs with minimum amount of materials and components and with environment-protective materials (Günel Ertaş D., 2007).



The new chair is made from a different type of steel and with less material and components than the original chair. The newly designed chair has advantages over the original chair. The proposed new chair has 4 components which is less than the other. While the metal tube diameter of the original chair is 25 mm, the new design's diameter is 21 mm, namely 4 mm less. The original chair weighs 13 kg while the proposed chair weighs only 8 kg. The new chair is lighter as it decreases the diameter of the construction and the number of components. Lightness facilitates the use of the design. It is obvious that chair production improves in terms of sustainability thanks to all these new qualities (Günel Ertaş D., Bayazıt N., 2019).

As examples regarding materials and experiential studies demonstrate, and as the shared quality of furniture used in all spaces, the selection of material is virtually unlimited for products, manufacturers and suppliers as well as for the designers. To supervise the selections, the qualities of material could be inspected in four classes: visual and haptic aesthetical qualities suitable for surfaces and uses; performance specification such as durability, processability, and transformability; sustainability against environmental costs; and cost of material in terms of purchasability and sellability (Coles, Houso, 2012).

## 6. DISCUSSION AND RESULTS

Academic studies show that furniture constructions are given a loading and some measurements and calculations of deformation, stress, shear stress are made. In addition, there are physical experiments made in computer medium. The simulations made in computers using methods such as infinite elements and software such as Solidworks have high rates of accuracy. Thus, the examples and laboratory work

provided in this study both presents the furnitures of the future and necessitate developing more comprehensive and more sensitive furniture design in terms of sustainability. It is important that these example works are seen, adopted and effectively used by the sector. The aims of the experiential studies on furniture could be either similar or different. Some of the advantages of the experiential studies and model industrial design work could be listed as useful knowledge below (Table 2).

**Table 2.** Advantages of industrial design work on furniture

Seeing the behavior of construction material
Discovering the possibilities and limitations of furniture
Lowering costs
Facilitating material selection
Using less materials
Reducing the number of components and connectors of furniture
Decreasing workmanship and process
Shortening manufacturing process
Determining ideal dimensions of furniture
Obtaining lighter products
Decreasing the number of operations during production
Developing relations between production, material and shape
Ensuring increased performance
Ensuring increased longevity of furniture
Improving critical points and areas in the furniture
Causing production of original forms in terms of other qualities
Thinking about ensuring highest amount of durability
Attaching importance to improved construction
Taking future as basis in furniture design improvements
Obtaining efficiency by providing increased user satisfaction
Improving towards excellence in design by meeting different expectations

It is essential that designers should consider technique and aesthetics as a whole, follow the changing trends of the day, take into consideration user satisfaction, manufacturing conditions as well as environmental effects. The spreading and effective use of new technologies, programs and software in furniture sector, doing experiential work on designs, and making technical measurements and calculations with them will be beneficial. The users and manufacturers will benefit more.

#### REFERENCES:

- Akdeniz G. (2016): Tarih Öncesi ve İlkçağ Mimarlığı, İdeal Kültür & Yayıncılık, İstanbul, p. 53.
- Chan E. (2010): Product Design, Rock Port Publishers, ISBN-978-1-59253-638-2, p. 15, 21.
- Coles J., Houson N. (2012): İçmimarlığın Temelleri, Akademik Temeller Dizisi: 05, Literatür Yayınları: 637, İstanbul, p. 88-95.
- Crochet T., (1999): Designer Guide to Furniture Styles, Prentice-Hall Inc., New Jersey, p. 10-13.
- Decree-Law On the Protection of Industrial Designs, (1995)/ KHK Endüstriyel Tasarımların Korunması Hakkında Kanun Hükmünde Kararname, Date of Decree 24/6/1995, No: 554; Issued 8/6/1995, No: 4113; Date of Issue in Official Gazette: 27/6/1995, No: 22326; 5th Regulations Book Vol. 34, p. 777.
- Günel Ertaş D., Bayazıt N. (2019), "Product Economy Through Changing Structural Characteristics", OJAD/ Online journal of Art and Design, Vol 7, Issue 3, p. 96-112, July 2019.
- Günel Ertaş D. (2018): "Kullanıcı Sosyokültürünün ve Algısının Endüstriyel Tasarımda Malzeme Seçimine Etkisi", 6. Uluslararası Çin'den Adriyatik'e Sosyal Bilimler Kongresi, 29-31 Mart 2018, İKSAD İktisadi Kalkınma ve Sosyal Araştırmalar



- Enstitüsü, ISBN: 978-605-9885-65-2, sa142-151, Ankara, Türkiye.
- Günel Ertaş D. (2007): The PhD. Thesis entitled "The Effects Of The Structural Characteristics on Industrial Product Design", Advisor: Prof. Dr. Nigan Bayazıt, İTÜ Institute of Science, İstanbul. p. 120, 121.
- Günel Ertaş D., Şatır S. (2010): "Developing Sustainable Structural Design Features", A-Z, Vol 7 No 1, Spring 2010, ITU Journal of the Faculty of Architecture, İstanbul.
- Günel Ertaş D., Şatır S. (2017): "A multi-dimensional analysis of the relationship between design-material in relation to sustainability", 12th International Design and Design History Symposium, 11-12 Mayıs 2017, Mimarlık Merkezi, Alsancak, İzmir.
- Hudson J. (2010): Design for Small Spaces, Laurence King Publishing, London, p. 111, 132,133.
- Miller J. (2011): Furniture – World Styles From Classical to Contemporary, Dorling Kindersley Limited, London, p. 429-435.
- Nadežda L., Roman R., Rastislav I., Ľuboš K., Miloš H., Pavol J. (2019): "Construction of Wood-Based Lamella for Increased Load on Seating Furniture", Forests, June 2019, volume10, issue 6, 525; <https://doi.org/10.3390/f10060525>.
- Yazıcıoğlu Y. (2017): Endüstriyel Tasarım, İdeal Kültür ve yayıncılık, ISBN: 978-605-5729-75-2, p. 18, 19.

#### WEB REFERENCES:

- <http://etmk.org.tr/tr/endustriyel-tasarim/>
- <https://www.idsa.org/events/what-id> - Industrial Designers Society of America; What Is Industrial Design.
- <http://ahsapteknolojisi.blogspot.com/2011/04/endustriyel-tasarimin-tanimi-ve-onemi.html> / Mobilya ve iç mekan tasarımı ders notları, hazırlayan Sedat Güneş
- <https://www.birofis.com/mobilya-nedir.shtm>
- <https://tr.wikipedia.org/wiki/Anubis>
- <https://www.openingthebook.com/library-design/library-space-planning>
- <https://tr.pinterest.com/pin/514958538617146233>
- <http://www.ba-bamail.com/content.aspx?emailid=17865>
- <https://www.cgtrader.com/3d-models/furniture/furniture-set/futuristic-office-furniture>
- <http://ahsapteknolojisi.blogspot.com/2011/04/endustriyel-tasarimin-tanimi-ve-onemi.html>
- <https://www.grow-trees.com/blog/social/facebook/growing-chairs-british-designer-grows-trees-into-furniture/>
- <https://www.dezeen.com/2012/10/25/noumenon-by-carl-de-smet/>
- <http://www.moderndesign.org/2011/06/ultimate-space-age-office-desk.html>
- [http://bwncy.com/p14j09o\\_8490pz4/](http://bwncy.com/p14j09o_8490pz4/)
- <http://www.home-designing.com/uniquely-artistic-modern-sculptural-chairs>
- <https://sbandiu.com/2018/05/19/passepartout-di-dante-donegani-e-giovanni-lauda/>
- <http://www.ba-bamail.com/content.aspx?emailid=17865>
- <https://www.cgtrader.com/3d-models/furniture/furniture-set/futuristic-office-furniture>
- <https://www.youtube.com/watch?v=4Su8bsWQLGA>
- <http://ahsapteknolojisi.blogspot.com/2011/04/endustriyel-tasarimin-tanimi-ve-onemi.html>
- <https://www.grow-trees.com/blog/social/facebook/growing-chairs-british-designer-grows-trees-into-furniture/>
- <https://www.dezeen.com/2012/10/25/noumenon-by-carl-de-smet/>
- <https://primcousa.com/bookshelf-ideas/>
- <http://www.archiexpo.com/prod/paxton/product-58536-222247.html>
- <https://www.homedit.com/16-most-creative-and-unique-bookshelves/>
- <https://weburbanist.com/2014/03/19/reading-room-dividers-13-creative-bookshelf-designs/>
- <https://www.laboutiqueblanche.nl/en/j-line-metal-book-rack.html>
- <https://weburbanist.com/2014/03/9/reading-room-dividers-13-creative-bookshelf-designs/>