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ARTISTIC ANALYSIS AND GEOMETRIC PROCEDURES IN FURNITURE DESIGNING

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ABSTRACT

At present, the perfection of forms is one of the prerequisites that the furniture and interior complements have to meet in order to be a success at the competitive market in our material world. Ample technological opportunities facilitate creating various forms using different materials. However, the final form of shape has to take also some aesthetic criteria into account. One of the possible ways how to obtain a satisfactory shape and form of interior elements is the use of geometric constructions and artistic analysis as a supporting tool when designing and creating a particular object. The paper deals with the relationships of artistic geometry and design, and with artistic analysis and geometric procedures which are suitable to be used for designing furniture and other functional items. It shows possibilities for the use of geometry as a control and supporting tool in designer´s creation. The aim is also to present work with chosen geometric procedures when analysing particular existing furniture articles as well as at designer creation itself. The chosen works of the worldwide design creation were subjected to the artistic analysis and completed by geometric – construction charts and figures concerning the sphere of observation. The work results in designs of furniture elements that were made on the principle of the aforementioned analyses and chosen geometric principles.

Key words: artistic analysis, design, geometry, golden section, proportions.

INTRODUCTION

Designing new objects which jointly create space around us entails a complex creative process. First of all the outward appearance, look of a product or its part lying especially in properties of lines, outlines, forms or materials of the product itself are considered to be design.

"The word ***design*** has its origin in the Latin verb *designo, designare* meaning *designate, depict, elect for next period, organize, lark*. In the English language which has borrowed it from Latin, this word means *different activities* and *their results*. Thus, the English word *design* implies the meaning of the French words *dessin* (*painting, sketch, draft, plan*) as well as *dessein* (*intention, intent*)" (PETRÁNKY 1994).

In general, "design" is said to be an outward appearance of objects, though, in fact, it is only one of the aspects embraced by this concept. By means of an appropriate form, designers carry out their purpose-content intention, i. e. above all, they combine a particular form with a practical function of the item or object. However, with regard to the functional

products it is essential that the content expressed in a particular form should achieve also some aesthetic value. It is taken for granted with respect to the objects of art.

To meet aesthetic requirements, which is the main prerequisite of the design object, it might be helpful to use the method of geometric-artistic analysis and apply suitable geometric procedures. These represent an important part of the design practice. Due to its characteristics and possibilities, geometry supports precision and clarity of shape and so it contributes to its harmonizing. Nowadays, when technology has exceeded traditional constructional principles, it is important to realize the necessity of precise approach to designing and constructing new objects and thus also to the solution of their shape. Just the use of geometry can be a useful aid. Geometric procedures and constructions can help at the beginnings of a design or, on the contrary, at the end when the shape is elaborated more thoroughly. At the same time, applying geometric procedures expects conscious and thought-out work along with the process of abstract thinking.

The aim of the paper is to show possibilities of using artistic geometry and chosen geometric and compositional methods when designing interior elements and furniture as well as their representation in already existing objects. Geometric construction was used already in the past and many world-recognized designers and artists had a tendency to use it during their creation as it can be seen in artistic analysis of particular objects. Familiarity with applicable composition principles leads to more exact procedures at a proper design creation. It can be seen at the end of the paper where the chosen geometric principles are applied. The actual drafts of the furniture articles presented in the paper were formed just on these grounds.

Observing the chosen problems of applying geometry and appropriate geometric constructions at designing utilities started from the initial basic acquisition of geometry knowledge and overview of needed constructions. Consequently, the chosen articles were subjected to the artistic analysis. The obtained knowledge was applied and profited by authors´ designs.

ANALYTICAL PART

One of the most frequent geometric methods which are used in practice to correct and emphasize a special design and artistic quality of the designed object is the work with its **proportions**. Just introducing the proportions of an object into harmonious and consistent relationships helps to its overall good final effect of shape. The aim of these methods is introducing all elements and parts into mutual correspondence, appropriateness, and relatedness.

Processing and creating forms by the method of balancing proportions can be observed already in the past, e. g. in the architecture of temples. Placement of the main sculpture of God in a temple as well as spatial relationships among other temple elements, relationships of height, width, and length were always obtaining different forms of content and expression in different times and they were directly connected with the characteristics of those times and a way of thinking of the then man. Though the form of expression was historically being changed, many principles and rules stayed general and timeless.

In the course of time, some basic methods which were used to introduce particular proportions into mutually consistent and harmonious relationships were established. These methods presented a well-thought-out and geometrically-compositionally well-arranged order.

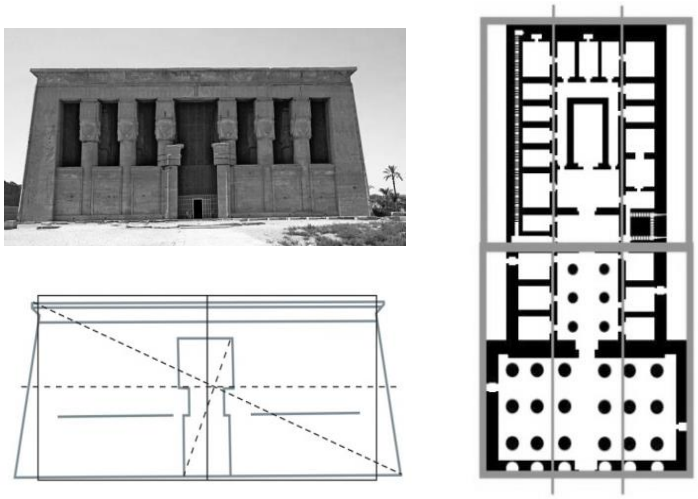

Fig. 1 The Temple of Dendera – House of Hathor.

The simplest and at the same time the most frequently used proportioning system is based on **module**. Its base can be a number or spatial or square geometric shape element (square, circle, cube, and things like that). The use of the module comprises creating a certain draft or grid, which is a base of the whole compositional plan. Then the essential proportions of the object and its parts are inscribed in the grid and so their linkage and mutual balance are reached.

The module system is characteristic especially for the ancient architecture. However, its use can be found in the course of time until now.

Fig. 1 illustrates the facade and schematized ground plan of the Egyptian Temple of Hathor at Dendera. The completed constructional chart illustrates modular structuring. The basis is a square and proportions 1:2 in the front face as well as in the whole ground plan. At the same time, the ground plan is divided on in the proportion 1:3.

Egyptian buildings are characteristic just of the module proportioning system starting from the ratios of the whole numbers 1:2, 1:3, 1:4 etc., that is the module element represented by the number 1 or the geometric shape of square on a plane and cube in space. Another module shape element is a circle on a plane or sphere in space. It often appears in form-philosophical and spiritual views of the Egyptian civilization and its essential expression can be found in "Flower of Life" (Fig. 2).

According to the ancient Egyptian views, the "Flower of Life"– a symbol of sacred Egyptian geometry – depicts the first acts of the creation of the universe. A point (the centre of a circle) gets out of it itself and it makes a line by multiplying its form. The generated energy is transformed and it comes back, thus an equilateral triangle is created. This presents a base of a tetrahedron. By turning the tetrahedron, the first virtual sphere is formed. Then, another movement is done from the centre of the first sphere as far as its edge where there is a base of a new sphere. Afterwards, other movements follow along the perimeter and new spheres are created. The geometric pattern is infinitely repeated and it is considered to be a base of all created. Subsequently, this symbol of sacred Egyptian geometry was used in deducing proportions and relationships used in architectural objects, buildings of temples, tombs etc.

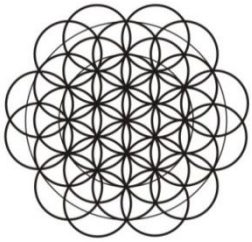

Fig. 2 "Flower of Life"

In addition to the simple module and natural numbers resulting from it, also **irrational numerical relationships** are often used for harmonizing proportions. They help to create shape figures which can be mutually put together in a geometric arrangement. The simplest regular relationship of such an arrangement is created within putting squares in order, where each following one is created by connecting the midpoints of the sides of that previous one.

Irrational relationships are expressed also by so-called "**root rectangles**". They are the rectangles with the ratio of the sides 1: $\sqrt{2}$, 1: $\sqrt{3}$, 1: $\sqrt{4}$, 1: $\sqrt{5}$ etc. "These root rectangles possess the property of being endlessly subdivided into proportionally smaller rectangles. This means that when root 2 rectangle is divided into half, the result is two smaller root 2 rectangles, when divided into fourth, the result is four smaller root 2 rectangles, etc." (ELAM 2011).

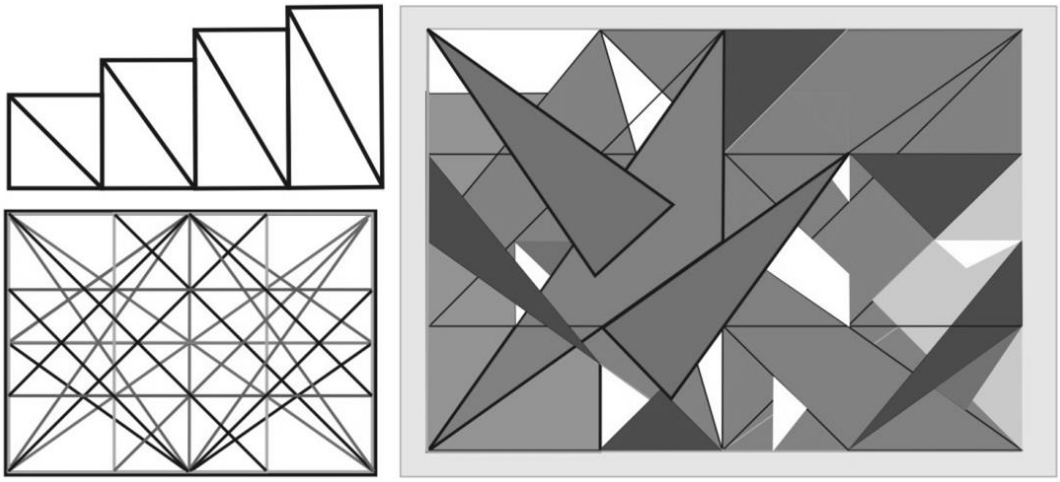

Fig. 3 Root rectangles.

The way of creating the "root rectangles" with the ratio of the sides 1: $\sqrt{2}$, 1: $\sqrt{3}$, 1: $\sqrt{4}$, is shown in Fig. 3, top left. The left bottom illustrates a created possibility of further harmonious interior structuring of the rooted rectangle with the side proportions of 1: $\sqrt{2}$ using midlines and diagonals. The right part in Fig. 3 presents an author artistic composition starting from previous structuring inside the rooted rectangle. Though at first sight it appears disorderly, its inner bonds keep it in a certain system which has its own logics. Proportions of this rectangle approach to the golden section proportions, which makes the given geometric shape interesting and often used in construction.

All "root rectangles" present a dynamic base and offer a number of harmonious divisions and combinations that are relative to the proportions of the original. The process of harmonious division is based on drawing the diagonals and subsequently creating a grid using the right-angle system.

The practical use of balancing proportions by means of irrational relationships can be found in many pieces of work by prominent authors of the 20th century. They were used in drafting ground floors, shape harmonizing of furniture parts and interior as well as in making posters and advertising boards.

Frank Lloyd Wright (1868–1959) was one of the most significant American architects and designers of the 20th century. His work was characteristic of an interest in simple geometric forms and intersecting vertical planes. Outstanding features of Wright´s designer works are simple constructions, direct lines and shapes based predominantly on elementary geometrical shapes (square, circle). "Root rectangle" proportions with the ratio of the sides 1: $\sqrt{2}$ became a basis for the design of the Barrel Chair.

"The Refined Barrel Chair has pleasing proportions. The front view fits in a root 2 rectangle with the seat frame just below the centre point. The arms of the chair are a tone half the distance from the seat to the top of the chair. The height of the chair is twice the diameter of the cushion …" (ELAM 2011).

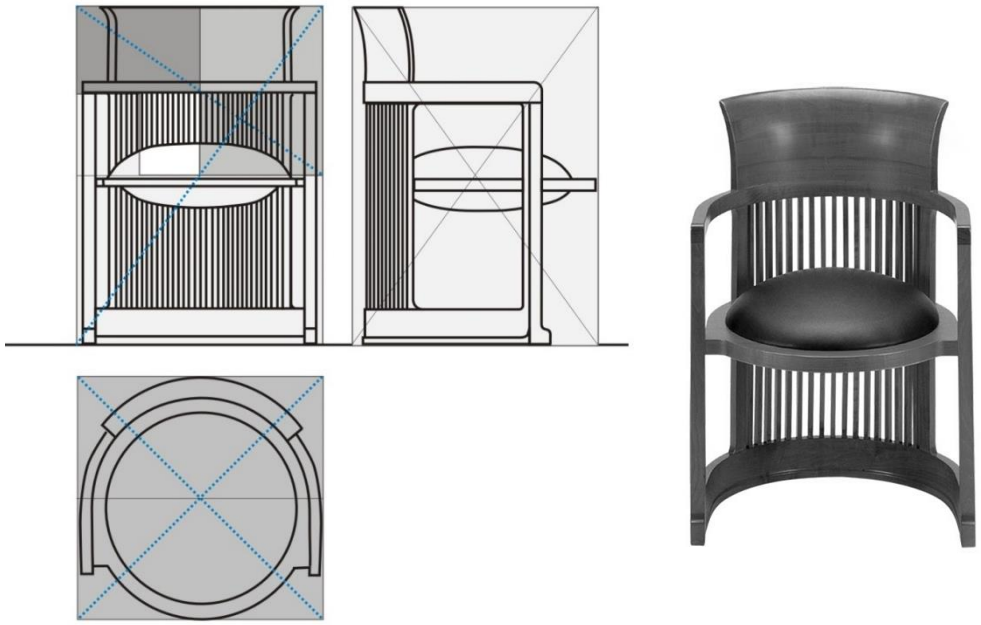

Fig. 4 Barrel chair – Frank Lloyd Wright.

A peculiarity among proportions is the **golden section**. The "golden section (lat. *sectio aurea*) is a division of an abscissa into two parts so that the longer part divided by the smaller part is also equal to the whole length divided by the longer part" (ŘÍMAN 1987).

Generally, it is considered as a universe law manifesting itself in nature. The golden section proportions, in general, are characterized as the most harmonious, the most balanced and the most beautiful. This ideal harmonious compositional proportion has been applied in fine arts and architecture since the ancient times. We can find it in the ancient building of Parthenon, in a number of Gothic cathedrals as well as in contemporary furniture and interior.

From the geometric point of view there are essential geometric shapes containing the golden section in themselves. They are: the golden section rectangle (Fig. 5), the golden section triangle, the golden section spiral, regular pentagon, five regular convex polyhedrons, and the so-called Platonic solids. Harmonious proportional relationships are included in the ratios of their sides or diagonals. For their properties, these geometric shapes are often used in compositions; however, we can encounter them also in nature, e. g. the golden spiral in the shape of Nautilus pompilius shell.

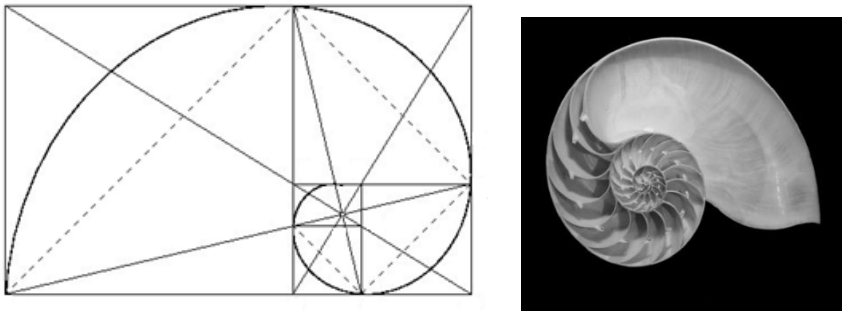

Fig. 5 Golden section rectangle with a simple division and the golden section spiral inscribed in it.

Designer **Charles Eames** used classical principles of proportions in his works. The golden section can be found in many pieces of his work, e. g. in his known Plywood Chair designed in co-operation with the architect Eero Saaarinen for the Organic Furniture Competition in 1940 where it received the first prize. The chair linked together harmonious proportions and, at those times, innovative technology of three-dimensional moulded plywood material. "The relationship of the chair's proportions to the golden section rectangle was fully consciously planned. The chair back fits perfectly into a golden section rectangle." (ELAM 2011). The chair ground plan can be inscribed in the square and the elevation and side elevation catches the golden section proportions. Within moulding we can also notice the rounding of the back and seat, and also constructional circles harmonized in multiples of the whole numbers.

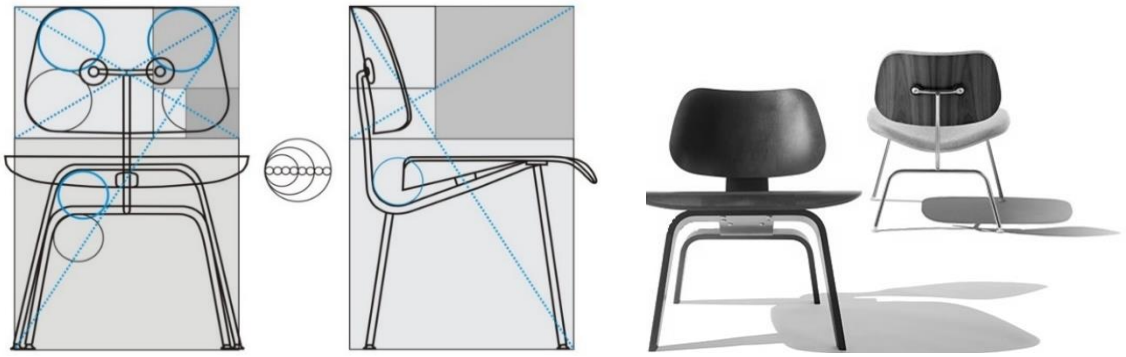

Fig. 6 Plywood Chair – Charles Eames.

The golden section proportions gripped also the French architect, designer, painter, and writer **Le Corbusier**. All his work is characteristic of unique basic forms with no complicated detail using geometric regularities to create harmonious relationships. Within theoretical pieces of work, he has formulated a new measuring system **Modulor,** "based on firm basic sizes derived from the human body and on proportions of formats bonded to the basic size by the system of mathematical dependences" (CRHÁK 2012). The Modulor was meant as a universal system of proportions. This system could be used to provide the measurements for all aspects of design and architecture, and Corbusier believed that it could be further applied to industry and mechanics. The fundamental "module" of the Modulor is a six-foot man. This Modulor Man is segmented according to the golden section. These proportions can be scaled up or down to infinity using a Fibonacci progression.

Le Corbusier applied the Modulor to his buildings, the Unité d'Habitation in Marseilles, the government complexes he built in Chandigarh, India, and his rural retreat, Le Cabanon.

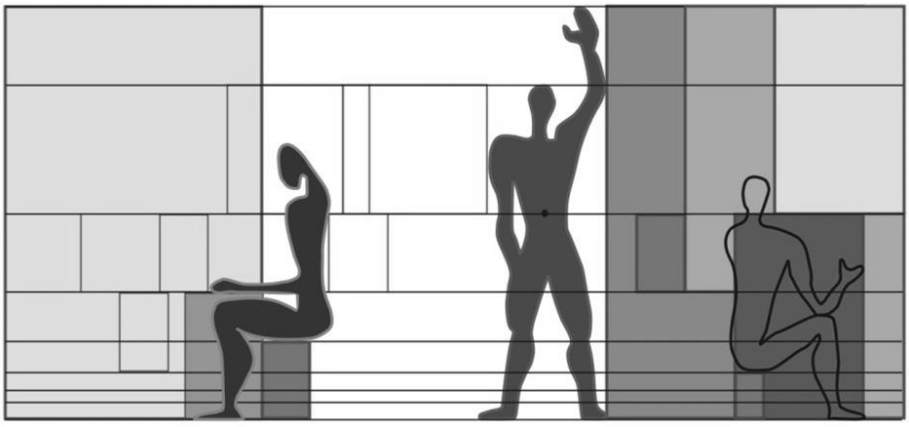

Fig. 7 Modulor and the golden section.

Le Corbusier´s co-operation with Charlotte Perriand and Pierre Jeanneret led to many successful solutions within interior and furniture design. The golden section catches e. g. the Chaise Longue whose proportions present just harmonious division of the golden section rectangle. An important visual as well as functional element is a chrome tubular frame in the shape of a circle part. "This arc is an elegantly simple system that slides in either direction and allows the user an infinite variety of positions, and is held in place by friction and gravity with either the head of feet raised" (ELAM 2011). The circular element is repeated in the form of a cushion. At the same time, the width of the golden section rectangle, of the described elevation of the Chaise, is the diameter of the mentioned circular frame.

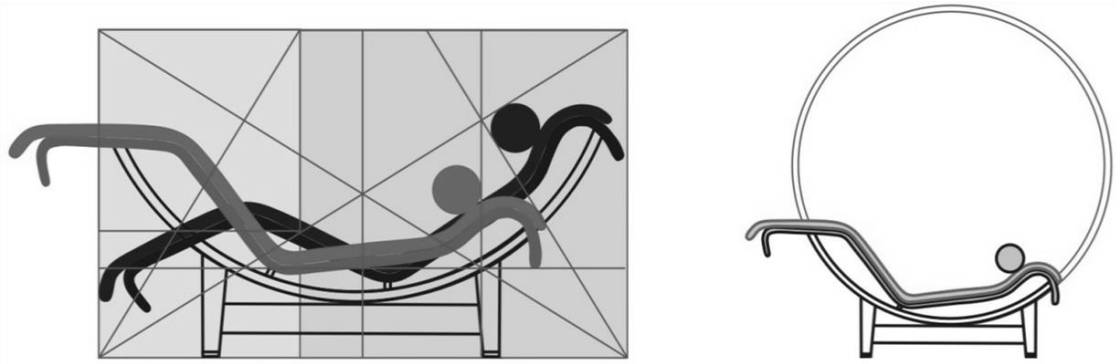

Fig. 8 The Chaise Longue – Le Corbusier.

RESULTS AND DISCUSSION

Introducing proportions into harmonious relationships means an important part of creating a formal part of a new design. Theoretical knowledge of the artistic analysis, creativity and the designer´s inner sensibility can be materialized then and a result are designs, sketches, drawings or objects reaching a high aesthetic quality. The rational approach, geometric and compositional regularities used already in the design itself bring an order and harmony in the artistic objects.

Using the module system as well as the golden section proportions within teaching design plays an important role in the preparation of a young designer. From the visual viewpoint, just the proportional side of the designed objects influences the aesthetic side

most. Applying the obtained knowledge of the sphere of proportions and work with them can be seen in many designs. The following figure (Fig. 9) records one chosen of them.

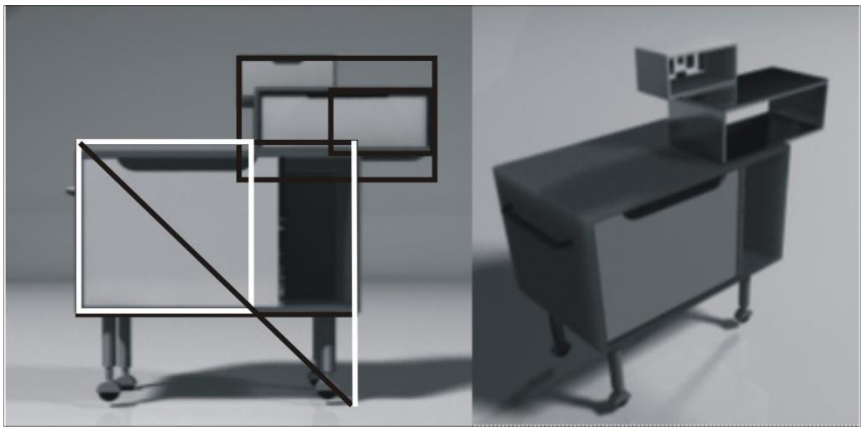

Fig. 9 Handy desk using the golden section.

This represents the design of a handy desk which was made as a student work within the geometry workshop "Golden Section and Its Applications in Design 2013". The work was developed by the students of furniture design Anna Cázerová and Daniela Fričová supervised by their teachers Ing. Denisa Lizoňová, ArtD., and Ing. Zuzana Tončíková, ArtD. The proportions of the object are designed in harmony with the golden section.

A basis was the design of the mobile object which would meet the basic functional conditions. The furniture article is intended to be a handy desk for hospitals or another social facility. It serves the purpose of laying down basic individual needs and it can be used also at catering to arrange meals. The initial shaping solution (that is not presented in the figure) was consequently subjected to proportional analyses and adapted using the golden section proportions. The golden section is contained in the shape of the biggest cabinet, however, also in the proportions of smaller cabinets each other. Also leg placing and leg proportions are designed in the golden section proportion.

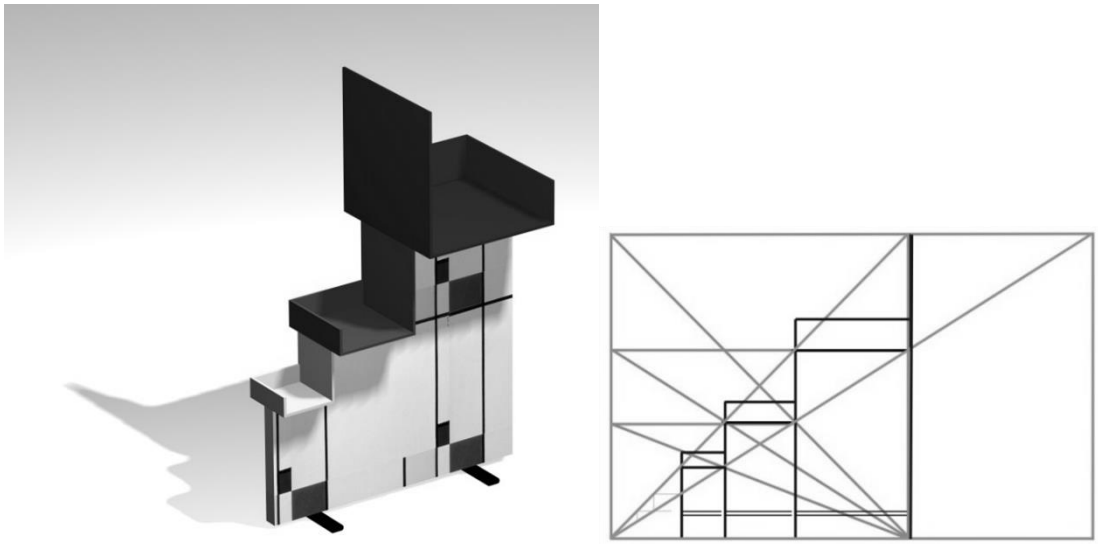

Fig. 10 Storage shelving system Mondry – Denisa Lizoňová.

Another example of the use of introducing proportions into interrelationships is the author´s design of the storage system Mondry. Particular shelving units as well as the whole object are designed with the use of the golden section proportions as it is also seen in the schematic construction in Fig. 10, right. The golden section proportions were chosen due to proving a possibility to construct using the geometric support. The designed storage system serves the purpose of laying small things aside and it is also an interior fence. The golden section is contained in the proportions of shelves whose width and length dimensions as well as height structuring gradually harmoniously increases. The very basic proportion of the object (width, length, height) are harmonized so that the object met also the functional aspects, which is, of course, a condition.

As we have already mentioned above, applying geometry cannot be purposeless and when designing it is necessary to select appropriate constructions and procedures. Each furniture or utility has its own functional and ergonomic requirements and thus the principles of geometric constructing must be selected adequately.

CONCLUSION

Artistic geometry makes a connecting link between science (geometry) and art, which makes great possibilities for its use within creative process of constructing a work of art and design. Involving artistic and geometric analyses in the complex of designer activity, work with proportions and composition, requires compact knowledge of various spheres of geometry and perfect linking together with the designer´s talent. This harmonious connecting of knowledge and inner sensibility is a key moment for creating objects of the top aesthetic quality, which is the main intention of every designer.

Geometric construction of a designer´s work provides a possibility of simpler composing in accordance with aesthetic principles. Thus, the phase of searching for ideal forms, especially for compositionally more sophisticated objects is facilitated. In this way geometry, to a certain extent, contributes to rationalization of creation which is in harmony with high demands of the contemporary technical period.

As we have shown in the paper the geometric procedures at designing were used also in the past. An example are inscribed geometric – constructional charts of chosen furniture elements and also the artistic composition based on geometric rules. Applying geometric support is possible already at the beginning of object constructing itself as it was presented in the author´s designs. Thus, the set aims have been fulfilled.

Knowledge and experience obtained from the sphere of artistic geometry and analysis represent an important part needed in designer work with the aim to create a product meeting the high standard and fulfilling all criteria for a good design. The criteria of a systematic designer´s creation whose objective is to correct or shape the work of a designer (planner), offer a wide base for applying geometry and geometric regularities in the system of the construction of a designer product.

REFERENCES

CRHÁK, F., KOSTKA, Z. 1986. Výtvarná geometria. Bratislava : SPN, 1986. 160 p.
CRHÁK, F. 2012. Výtvarná geometria plus. Brno : VUTIUM, 2012.186 p. ISBN 978-80-214-3767-8.
ELAM, K. 2011. Geometry of design: Studies in proportion and composition. New York : Princeton Architectural Press, 2011. 143 p. ISBN 978-16-1689-036-0.
FIELL, CH., FIELL, P. 2001. Design of the 20th Century. Köln : TASKEN, 2001. 191p. ISBN 3-8228-5542-1.

HNILICA, J. 2004. Tajná architektura: Posvátná geometrie na rozhraní mystiky a přírodních věd. Praha : Eminent, 2004. 290 p. ISBN 80-7281-177-0.
KANICKÁ, L. 2007. Dizajn nábytku v současném světe. Brno : ERA, 2007. 120 p. ISBN 978-80-7366-107-6.
LE CORBUSIER 2000. Le Modulor. Birkhäuser Architecture, 2000. ISBN. 978-37-6436-188-4.
MILLER, R.C. 1990. Modern Design in the Metropolitan Museum of Art 1890-1990. New York : Harry N. Abrams, 1990. 312 p. ISBN 0-8109-3612-7.
PETRÁNSKÝ, Ľ. 1994. Teória a metodológia dizajnu. Zvolen : TU vo Zvolene, 1994. 117 p. ISBN 80-228-0318-9.
ŘÍMAN, J. 1987. Malá československá encyklopédia. Praha : Academia, 1987. 927 p.
SPARKE, P. 1999. Století designu: průkopníci designu 20. století. Praha: Slovart, 1999. 212 p. ISBN 80-7209-142-5.
SCHNEIDER, M. S. 1995. A Beginner's Guide to Constructing the Universe: The Mathematical Archetypes of Nature, Art, and Science, New York : Harper Perennial, 1995. 351 p. ISBN 978-0060926717.

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