Optimizing Dimensions in Furniture Design: A Literature Review

Anna Jasińska,[a,]* Maciej Sydor,[a] and Miloš Hitka [b]

Wooden furniture design necessitates the integration of both technological requirements and aesthetic considerations. To guide designers in achieving this balance, this article explores how established design principles, such as proportions and preferred numerical sequences, can inform decision-making for both technological and aesthetic aspects. The goal is to demonstrate how these principles can be integrated with modern CAD tools. In reviewing the scientific literature, this study compiled and compared mathematical and non-mathematical models that support dimensional decision-making. These models included ancient canons (Egyptian, Greek, and Roman) alongside those of Leonardo da Vinci, Palladio, Dürer, Le Corbusier, Zeising, McCallum, and Brock. Additionally, the article examines numeral systems used in modern technology, such as Renard's series and convenient numbers. It is proposed that designers should experiment with geometric design templates to achieve balanced proportions. All geometric design principles contribute to aesthetics, creativity and effectiveness in design. The literature identifies two groups of dimensional design templates: organic, inspired by the human body or the Fibonacci sequence, and inorganic, based on numerical order. It's impossible to pinpoint a single "optimal algorithm" to support dimensional decisions in design. Specific geometric design principles serve as valuable tools, not the ultimate answer.

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Contact information: a: Poznań University of Life Sciences, Faculty of Forestry and Wood Technology, Wojska Polskiego 28, 60-637 Poznań, Poland; b: Technical University in Zvolen, Department of Economics, Management and Business, T. G. Masaryka 24, 960 01 Zvolen, Slovakia;
** Corresponding author: anna.jasinska@up.poznan.pl*

INTRODUCTION

Designers consider many dimensional product variants when designing spaces, buildings, and smaller forms, such as furniture. Design in a CAD environment provides additional ease of alternative testing and almost unlimited design possibilities. Analyzing alternative courses of action is an essential part of the decision-making process. Therefore, design is a creative process of constant search for new forms and assimilation of known solutions (Falessi *et al*. 2011). Design engineering literature identifies different techniques for making choices among alternatives but does not provide clear guidance on which technique is more appropriate than another and under what circumstances. The best possible decision-making technique probably does not yet exist, but some techniques are more prone to specific difficulties (Polikar 2006; Jasińska and Sydor 2021). According to Falessi *et al.* (2011), some decision-making techniques are more vulnerable to specific challenges than others. Ideally, architects could choose a technique based on the problems they want to avoid. However, lacking empirical evidence hinders understanding of which circumstances lead to particular difficulties with specific techniques. This makes it difficult to predict the challenges that might arise.

For overcoming the design process complexity, an adaptive approach to the key meta-decision of how to make design decisions is necessary (Harman 2007). Many types of decisions include selections, acceptances, evaluations, and constructions. Each type, in turn, is assigned an approach that the decision-maker should follow (Acosta 2010). Two fundamental approaches are indicated: normative (rational) and naturalistic (Zannier *et al*. 2007). Depending on the approach taken, *e.g.*, decision matrices or SWOT analysis are performed (in the normative approach), or it is based on unconscious emotions by constructing stories, mental simulations, and various scenarios (in the naturalistic approach) (Jonassen 2012). Regardless of the approach, personal intuition is also a decisive factor; however, the primary decision points can be identified to help control decisions in the design procedure. These points are: project preparation, preliminary design, executive design, concretization, and materialization of the idea (Hsu and Chen 1996; Lee 2014).

Furniture designers, architects, and engineers in various fields of technology are obliged to make many decisions at the early design stage. In particular, the first two groups of designers focus special attention on making appropriate dimensional decisions (Yao and Carlson 2003). These considerations are multidirectional and concern, among others, technological feasibility, functionality, durability, and aesthetics (Thompson and Davis 1988; Suandi *et al*. 2022). From a technical perspective, the right dimensioning is crucial for ensuring structural integrity and low manufacturing costs. Simultaneously, the aesthetics of wooden furniture is impacted by dimension choices. Harmonious proportions, balanced dimensions, and thoughtful scaling are crucial in creating visually appealing and aesthetically pleasing designs. The synergy between engineering reasons and aesthetic considerations in dimension choices is essential for crafting acceptable wooden furniture for customers. In normative terms, the path of choices is seemingly simple; the design should be adapted to human dimensions and ensure the rational use of materials and appropriate dimensions of parts based on the functionality, strength requirements, and technological and economic aspects of product suitability. Using a more naturalistic approach, one can notice a tendency to choose certain dimension values without giving specific arguments but only relying on intuition and generally accepted standards for defining objects as aesthetic (Azizi *et al*. 2016). Assessing aesthetics seems complicated; however, research is being undertaken to indicate the relationship between the design decisions and the achieved aesthetic qualities of the end-product. Figure 1 shows exemplary variables that could function as guidelines for evaluating the aesthetics of projects.

Currently, CAD tools provide significant support in the design process. The software has complex modeling features that support various geometry types. Creating NURBS (Non-Uniform Rational B-splines) curves and surfaces is standard, offering possibilities for modeling organic shapes. Thanks to the mathematical model based on B-Spline curves, high precision is achieved, which is essential in applications requiring accurate measurements and rendering. Their widespread use is facilitated by standardization, which facilitates data exchange between different programs and work environments. Performing simulations and analyses or automating repetitive tasks using scripts and macros facilitate the design, production, and lifecycle management process (Hu *et al*. 2000). When describing modern CAD solutions, it is worth mentioning the increasingly popular method of generative design, based on the use of algorithms and parameters for automatic generation and optimization of projects. In this approach, the designer initiates the idea, and the resulting concepts result from artificial intelligence algorithms and cloud computing power. This allows for the generation of hundreds or even thousands of different solutions (Khan and Awan 2018). Even with significant advances in computer design techniques, a solution for fully supporting designers in making dimensional decisions has yet to be found.

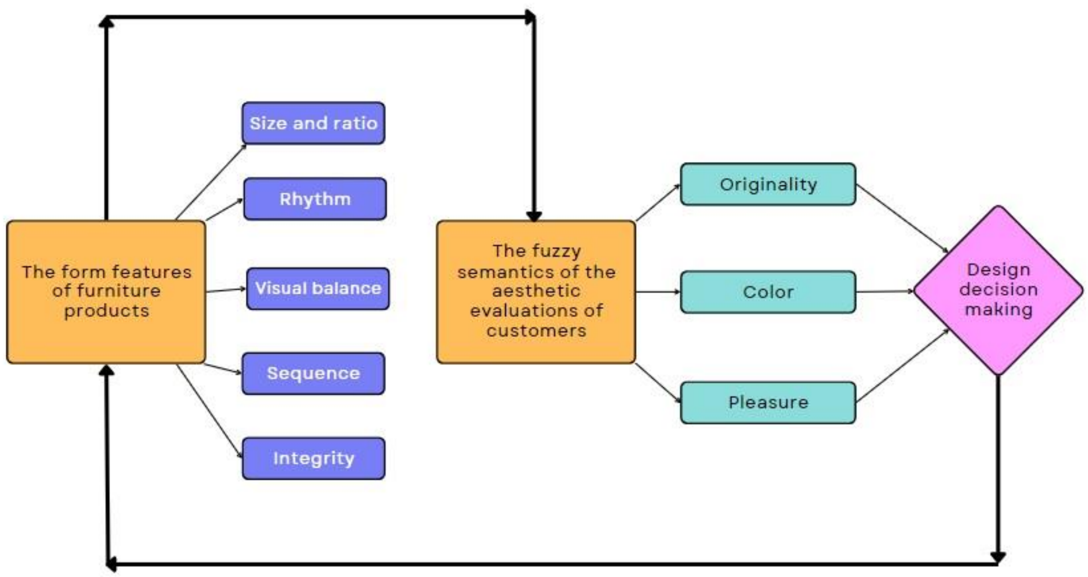


Fig. 1. Scheme of aesthetic evaluation of furniture products (own elaboration)

This article aims to review canons, preferred numerical sequences, and proportions that support the decision-making process by the designer, who is the initiator of creative actions, possible to support in subsequent stages by artificial intelligence and tools for generating curves, shapes, and planes. Considering all these issues, the research questions can be formulated. Can one universal template for decision-making regarding dimensions by the designer be identified? What design assumptions should be adopted to ensure that the end-product has high aesthetic quality? Are objects with a known, harmonious, and rhythmic structure more attractive and perceived as beautiful?

DIMENSIONAL DESIGN INSPIRED BY NATURE

When looking for the optimal method of making dimensional decisions in design, the ideal proportions of the human body can be taken as inspiration. Over the centuries, canons, *i.e.*, systems of proportions, were born, and their summary is shown in Table 1.

Table 1. Groups Supporting Dimensional Decision-Making

Human Body Proportions			
Origin of the Canon	**Type**	**Characteristics**	**Examples in the Scientific Literature**
Canon of the art of ancient Egypt	A way of depicting a man depending on the social hierarchy	– in figurative sculpture, a modular system built on a grid of squares existed – the standing figure was divided into 19 parts (21 or 25 from the Late Kingdom), and the sitting figure into 15) – individual parts of the body corresponded to a fixed number of squares: from the top of the head to the base of the arms 3, from the top of the head to the eyes 1, from there to the base of the nose 1 and the shoulders 1, the body from the shoulders to the knees 10, and from the knees to the feet 6 – if it was an image of a man wearing a loincloth, its lower edge should be 12½ squares from the top of the head	(Gombrich and Bell 1976; Lorenzen and Iversen 1977; Davis 1982; Shute 1985; Robins 1993; Robins 1994; Vegter *et al.* 2000; Littlewood 2010; Rampley *et al*. 2012;)
Greek canons	Canon of Polykleitos	Human height is divided into 8 modules, with the head accounting for 1/8th of the total	(Tobin 1975; Stewart 1978; Boys-Stones 2009; Rampley *et al*. 2012; Jayesh 2014; Fré 2018)
	Canon of Lysippos	Human height is divided into 9 modules, with the head accounting for 1/9th of the total	(Bieber 1961; Osborne 1986; Naini *et al*. 2008; Soyöz 2015)
Roman Canon	Vitruvian Man	Human height can be described as 10 modules. Each module corresponds to the height of the head, measured from the chin to the hairline	(Howe 2005; Naini and Gill 2008; Ashrafian 2011; Riggby 2016; Fuchs 2020; Dinter and Guérin 2023)
Modern canons	Canon of Leonardo da Vinci	Based on the studies of human anatomy, the canon depicts a human figure inscribed within a square and a circle, centered on the navel	(Yale 2001; Pevsner 2002; Murtinho 2015; Tubbs *et al.* 2018; Laurenza 2019; Magazù *et al.* 2019)

	Canon of Albrecht Dürer	Dürer explored and depicted human proportions in various ways throughout his work, rather than having a singular defined "Canon" like Leonardo da Vinci. In "Four Books of Human Proportion" (1512-1514) Dürer explored mathematical and geometric principles of the human body, outlining different methods for constructing figures based on specific ratios.	(Cobb 1944; Denecke and Meyer 1967; Vegter *et a.l.* 2000; Hofer 2012; Al-Sebaei 2015; Smith 2020)
	Le Corbusier's canon	The "rule of the golden ratio" transferred to the dimensions of a man standing with his hand raised	(Le Corbusier 1961; Loach 1998; Stanton 2001; Tavernor 2002; Raisbeck 2022)
	"Aesthetic Research" Zeising	The division obtained by the point coinciding with the navel of the body is the most important indicator. The ideal proportions of the human body range in an average ratio of 13:8 = 1.625, approaching the golden ratio	(Konečni 1997; Green 2012; Roald and Køppe 2015; Nadal and Vartanian 2022)
	McCallum formula	– the waist circumference is 70% of the chest circumference – 53% of the chest is hip circumference - the neck is 37% of the circumference of the chest – biceps are 36% of the circumference of the chest, and the lower leg is 34% – the circumference of the forearm is 29% of the circumference of the chest	(Rose and McCallum 1987; Brown 1991; Paeratakul *et al.* 2002; Harrison 2003; Gerner *et al.* 2006; Bonafini and Pozzilli 2011)
	Brock's method	The ideal body weight of a person was presented as the height in centimeters, reduced by 100.	
The Proportions of Organic Elements			
Fibonacci sequence	The golden ratio, the golden spiral, the golden figure	The shapes of sunflower or daisy flowers, the number of petals in plants, the order of arrangement of tree branches following the rules of the golden ratio, and the Fibonacci sequence	(Horadam 1961; KonečNi 1997; Park et al. 2003; Falcón and Plaza 2007; Edson and Yayenie 2009; Yayenie 2011; Omotehinwa and Ramon 2013; Zainal et al. 2020; Conti and Paoletti 2021; Schreiber and Pedersen 2022)

Only the Greek civilization departed from the conventional, mechanical canon and focused on the actual dimensions of the human body over their definition in the 5th century BCE. An ancient Greek sculptor, Policlet, worked in this way and set himself to accurately determine the proportions of the human body, striving for an ideal. According to his guidelines, the head should be 1/7 of the total body height, the hand and face – 1/10, and the foot – 1/6. Policlet based his canon of proportions on the parts of the human body, *i.e.*, organic elements. Policlet had successors who also tried to establish ideal proportions, including the Greek sculptor Lysippos who developed a proportional system where the head served as a module, with the body's height being eight times its size. The successive canons of the Roman architect Vitruvius (1st century B.C.) with eight heads, Dürer with 7, 8, 9, and 10 heads, *etc*. share the arithmetic mode with integers or fractions. In 1490, Leonardo da Vinci defined the canon of the human body in the famous drawing "Vitruvian Man" and stated that only the ideal proportion of the human body allows the figures to be inscribed in the indicated positions in a circle and a square. A breakthrough in the perception of the human body and the proportions of organic elements was the discovery of Adolf Zeising in the mid-nineteenth century. He stated that there is a law of proportionality that dominates Nature and governs the proportions of the body of every human being, male or female, of any age, race, and at any point in life. Based on the measurement results of about two thousand bodies, he concluded that the ideal proportions of the human body, such as the ratio of the length of the arms to the length of the head or the length of the face to the length of the whole body, can be expressed using the golden number ($\varphi = 1.618$)

The ideal body proportions can be calculated in various ways, *e.g.*, using the McCallum formula to determine the ideal body weight using the Brock method. McCallum, for example, talks about the need for the trunk and legs to be the same length. He believes the chest should exceed the pelvis size (about 10 to 9). The chest and waist should be correlated in the proportions of 4 to 3, and the arms separated to the sides should be a person's height. The same parameters were once introduced into the "Vitruvian man" phenomenon. Currently, scientists are trying to analyze different parts of the human body. The indicators are calculated for, for example, arms and forearms, fingers, and hands, *etc*. (Fig. 2). Undertaking detailed analyses, certain discrepancies are often found as to the correspondence of, *e.g.*, the ratio of bones in the human hand; however, the conclusion is always a correlation with the Fibonacci sequence or the golden spiral (Park *et al*. 2003). The defining numbers are related by the terms of a sequence, where the first term is 0, the second is 1, and each subsequent one is the sum of two. The first 10 numbers are thus as follows: 0, 1, 1, 2, 3, 5, 8, 13, 21, 34, 55. Based on this sequence, Fibonacci squares are constructed with sides that match the length of each term (Fig. 2)

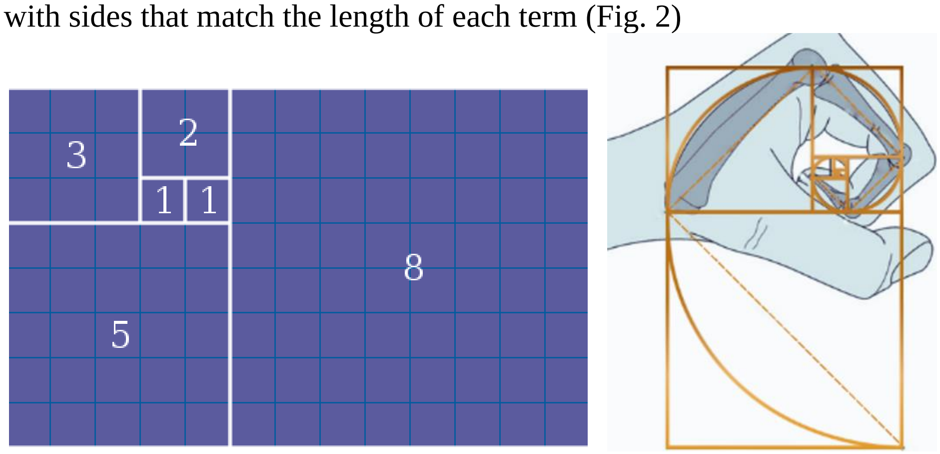


Fig. 2. A human hand inscribed in the Fibonacci squares and the golden spiral as a confirmation of the relationship between the Fibonacci sequence and the center of rotation of the joints of the hand (based on Park *et al*. 2003)

THE GOLDEN RATIO IN NATURE, ARCHITECTURE, AND ART

Interestingly, the ratio of consecutive Fibonacci numbers approaches the Golden Ratio (φ) of approximately 1.618 as the sequence progresses (Falcón and Plaza 2007). A graphical representation of this relationship is, for example, the golden ratio, the golden spiral, and the golden figure. These relationships can be applied to human work products and naturally occurring organic elements or phenomena. An example is the shape of sunflower or daisy flowers, as well as the number of petals in plants, the total number of which corresponds to one of the numbers of the Fibonacci sequence (*e.g.* 1 petal – calla lily, 2 – milkweed, 3 – lilac, 5 – ranunculus, 8 – delphinium, 13 – marigold, 21 – aster) (Fig. 3.) (Omotehinwa and Ramon 2013).

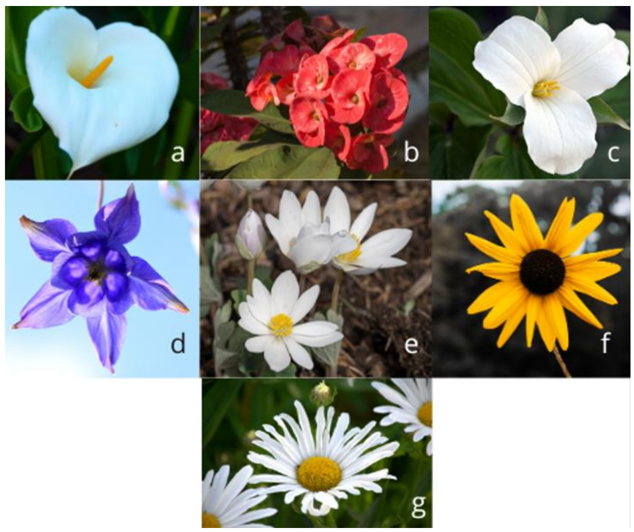


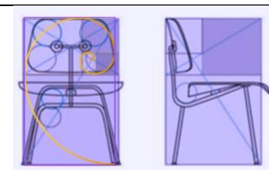
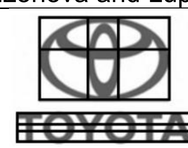
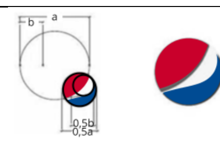
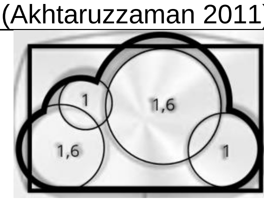
Fig. 3. The relationship between the sum of petals of individual flowers and numbers from the Fibonacci sequence ((a) White calla (1 petal), (b) Euphorbia (2 petals), (c) Trillium (3 petals), (d) Aquilegia (5 petals), (e) Bloodroot (8 petals), (f) Black-eyed Susan (13 petals), (g) Shasta Daisy (21 petals) (based on Omotehinwa and Ramon 2013 and Canva Pro)

The seemingly random arrangement of branches on a tree trunk actually follows a hidden order – the Fibonacci sequence. Similarly, the spirals of galaxies also develop according to the golden ratio. In the human body, you can also find many dependencies remaining with the golden ratio, as already mentioned above (Cohen 2014). By reviewing achievements in the field of biomimetics, one can observe numerous structures inspired by biological systems, which serve as inspiration for problem-solving by understanding the mechanisms of biological systems. Imitating biological structures and functions significantly impacts the development of more efficient, sustainable, and innovative solutions (Kadri 2015).

In architecture and art created even before the golden ratio was identified, there are also many examples using the golden ratio. An example is the proportions of the Greek Pantheon or the Egyptian pyramids, built thousands of years ago. For example, the golden ratio in the Eiffel Tower or Notre Dame Cathedral can be observed. Works created based on this principle are widely recognized as extremely attractive and harmonic. Examples include Leonardo Da Vinci's Mona Lisa, The Last Supper, The Birth of Venus, and the marble sculpture Venus de Milo.

Today, there are many applications of the golden ratio rules. Fibonacci numbers are found in architecture, graphics, fractals, electronics (Intel processors), botany, poetry, and music (Conti and Paoletti 2021). Document formats such as ID cards, driving licenses, and bank cards are golden rectangles. The layout of many websites is also closely related to the golden ratio and the golden spiral. Similarly, logotype designers use golden sequences in their work. It can also be used in furniture design or small architecture products. Even movements in the financial markets can be explained using a precise rule linked to Fibonacci numbers (Conti and Paoletti 2021). Examples of furniture designs and logos designed using the golden ratio are presented in Table 2.

Table 2. Examples of Furniture Designs and Logos Designed Using the Golden Ratio

Designer and Project Name	Illustration
Charles Eames, Plywood Chair	 (based on Lizoňová and Luptáková 2016)
Le Corbusier, Chaise Longue	 (based on Lizoňová and Luptáková 2016)
Toyota Motor Corporation brand logo	 (based on Akhtaruzzaman 2011)
PepsiCo brand logo	 (Akhtaruzzaman 2011)
Apple Inc. iCloud, Brand logo	 (based on Akhtaruzzaman 2011)

Graph theory is a widely discussed topic in mathematics (Tutte 2001; Gross *et al.* 2012). Scientists are testing various applications of graphs in chemistry, biology, anthropology, and social sciences and their connections with various areas of mathematics. Fibonacci numbers are of particular interest in this area. Various graphs and structures are defined and tested later (Hsu 1993; Knopfmacher *et al*. 2007). An example would be graphs whose sequence of degrees consists of "n" consecutive Fibonacci numbers (Yurttas Gunes *et al*. 2020). Another example of this consideration is testing Fibonacci cubes used to create hypercube algorithms (Zhang *et al*. 2009). Fibonacci cubes are exactly resonance charts of the fibonaccenes that appear in chemical graph theory, and resonance charts reflect the structure of their ideal matches (Klavžar and Žigert 2005). Klavžar and Žigert (2005) showed that Fibonacci cubes are Z-transform graphs (resonance plots) of fibonaccens, *i.e*., zig-zag hexagonal chains (Fig. 4). The term for hexagonal and square systems were independently introduced by other researchers (Klavžar and Žigert 2002; Fournier 2003; Zhang *et al*. 2009).

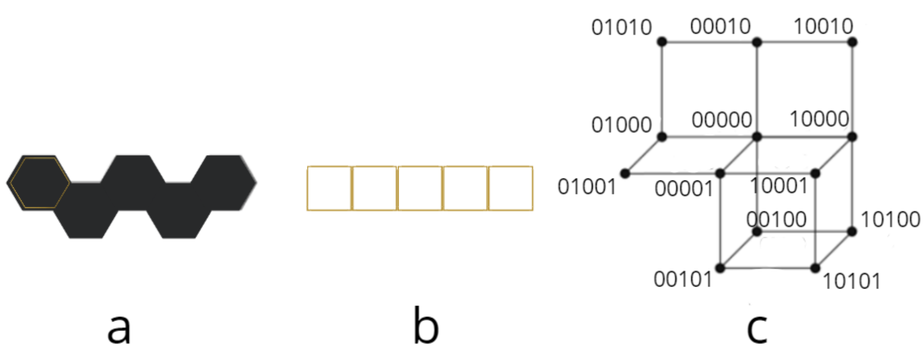


Fig. 4. a) Fibonaccena, (b) linear square chain, and (c) Fibonacci cube Γ5 (based on Zhang *et al*. 2009)

PROPORTIONS AND PREFERRED SHAPES

Proportions play a vital role in architecture because different feelings are associated with them and depend on how a person perceives the surrounding space. Not only in the design of spaces but also in the design of objects, such as furniture, proportions influence the user's perception. The proportions affect work efficiency by creating positive or negative stimuli in the human brain. The beauty of nature lies in the fact that each object has attractive proportions concerning its surroundings. Massive or light proportions are generated by changing various building elements' size, mass, or volume. Depending on the environment, these proportions can promote feelings of strength or weakness, stability or instability, openness or closeness, and fear or security.

A sufficiently lit room can give the impression of openness, but the height of the roof should also be proportional to its length and width. The optimal ratio of room dimensions to ensure the impression of openness was proposed by Andrea Palladio (1508-1580) in Four Books of Architecture, published in 1570 (Palladio 1955). In his book, he suggests that the dimensions of a room can be determined by arithmetic mean, geometric mean, or harmonic mean (Fig. 5) (Constant 1993; Rybczyński 2003; Sharma *et al*. 2012). Describing the dimensions of the room with the symbols a, b, and c, in arithmetic terms, the following relationship is obtained: $a < b = b < c$, in geometric terms: $\frac{a}{b} = \frac{b}{c}$, and in harmonic terms: $\frac{b-a}{a} = \frac{c-b}{c}$.

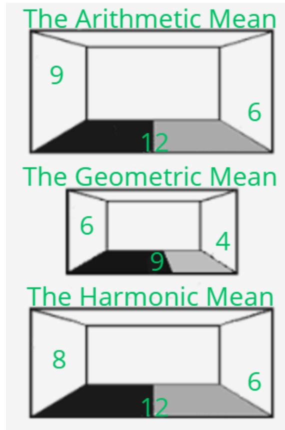
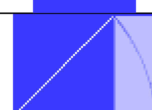
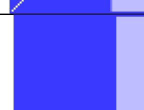
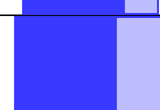
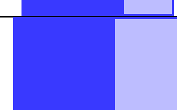
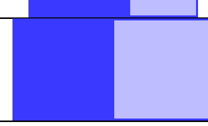


Fig. 5. Dimensions of the room according to Andrea Palladio (based on Sharma *et al*. 2012)

The renowned Italian architect Andrea Palladio, who lived during the 16th century, is considered one of the most influential architects in Western architectural history. Andrea Palladio proposed a collection of architectural principles and measurements that, according to him, give the impression of order, beauty, and harmony in the rooms (Table 3).

Table 3. A Set of Figures and Proportions by Andrea Palladio (Sharma *et al*. 2012)

Figure/Proportion	Visualization
Circle	
Square 1:1	
The diagonal of a square: 1:$\sqrt{2}$	
Square and one-third: 3:4	
A square and one half: 2:3	
Square and two-thirds: 3:5	
Double square: 1:2	

The influence of Palladio's theoretical work on proportions and geometry is evident in the consistent use of preferred figures and ratios throughout his built projects. A prime illustration of Palladio's preferred figures and proportions can be found in the villa plans depicted in Fig. 6.

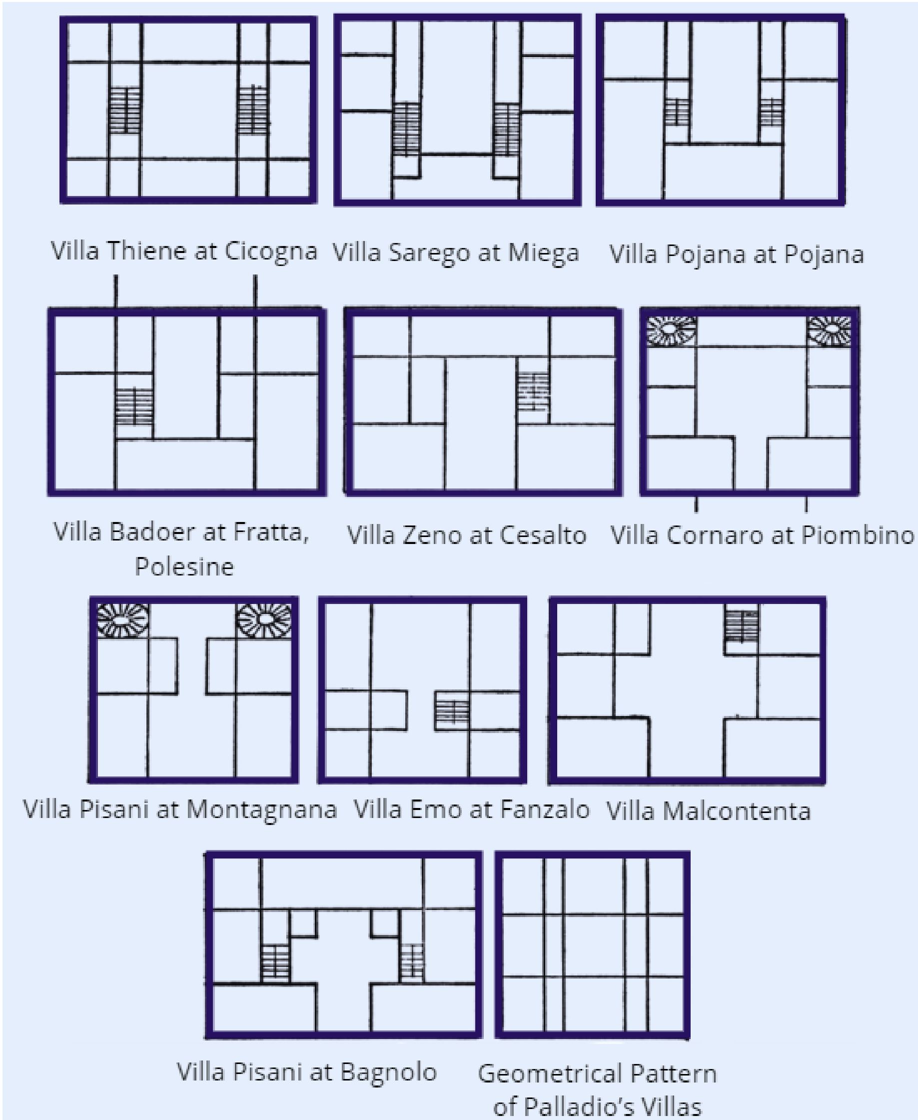


Fig. 6. Plans of Andrea Palladio's villas (based on Constant 1993)

In addition to proper proportions, harmony is one of the most important elements of aesthetics. Balanced shapes are considered attractive and aesthetic, regardless of their specific form. In addition to the square as mentioned earlier and circle, one can distinguish a spiral with a fluid and dynamic form, an ellipse as a combination of a circle with asymmetric properties, an equilateral triangle due to its clear balance, as well as regular polygons such as hexagon and others, and a rectangle in the proportion of the golden ratio. However, not only shapes with harmonious structures are recognized by the human eye as aesthetically pleasing. The association of a given shape with a shape already known (*e.g.*, occurring in nature or culturally established) significantly impacts its perception as aesthetically attractive. Depending on the purpose (*e.g.*, eliciting specific emotions in the viewer during design), shapes can be consciously selected to influence the perception by the future user. An example is survey research, in which impressions of a project of a particular building (its four versions varied in terms of shape selection: more organic or culturally known) were examined (Ruta *et al*. 2019). The presented projects are shown in Fig. 7.

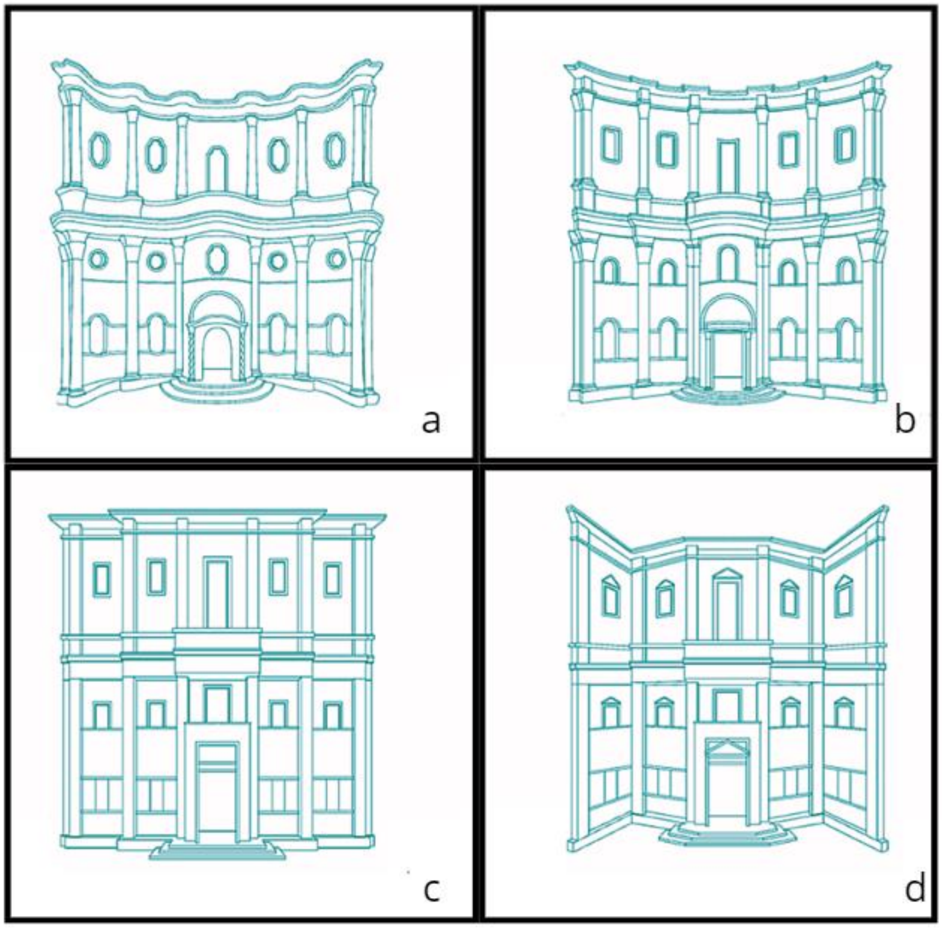


Fig. 7. The four architectural façades (curved (a), mixed (b), rectilinear (c), and sharp-angled (d) version) were evaluated in terms of liking, approach, complexity, and stability (based on Ruta *et al*. 2019)

The analysis of the collected survey data showed that in order from highest to lowest rated in terms of liking and approach were A, D, B, C, in terms of complexity were D, A, B, C, and in terms of stability were C, B, A, D.

As a result of choosing appropriate proportions, dimensions, and shapes, spatial figures are created. An example of a solid based on the golden ratio is the rhombic triacontahedron, all of whose faces are golden rhombi.

SYSTEMS OF PREFERRED NUMERICAL SEQUENCES

The scientific literature addresses the problem of using geometric design principles, but no specific design guidelines are provided (Chou 2011). However, there is a noticeable conclusion that geometric design principles influence design practices in developing new 2-D and 3-D products (Elam 2001). The question is whether applying geometric design principles leads to a more creative design supported by better proportions and a balanced form. The results of the researchers indicate that in the design of 2D products and interfaces, the most appropriate is geometric design principles, while in the design of 3D products, silent thematic principles are most often used, especially the golden ratio principle. Table 4. Lists the fundamental geometric design principles used in technology.

Table 4. Preferred Numerical Sequences Used in Technology

Systems of Preferred Dimensions in Technology		Examples in the Scientific Literature
Packaging	The mutual obligation of suppliers, logistics operators, distributors, and sellers to use modular packaging with dimensions that are multiples of a euro-pallet, *e.g.,* 600 x 400 mm (1/4 euro-pallet), 600 x 800 mm (1/2 euro-pallet), or 300 × 400 mm (1/3 euro-pallet). Repeatable volumes: 0.1, 0.25 (1/4), 0.375 (3/8), 0.5 (1/2), 0.7, 0.75 (3/4), 1, 1.5, 2, 3, and 5 L	(Wansink 1996; Garber *et al.* 2009; Shen *et al.* 2019; Escursell *et al.* 2021)
Renard series	– divides the range from 1 to 10 into 5, 10, 20, 40, or 80 steps – normal numbers form a geometric sequence with the quotient $\sqrt[n]{10}$ where n is the value of the series, *e.g.,* 5, 10, 20, 40, 80, specifying the number of elements in the series – numbers were proposed by the French military engineer Charles Renard in 1870, for use in the metric system – this system was adopted as the international standard ISO 3 in 1952.	(Copeland and Erdös 1946; Jonson 2007)
Convenient numbers String 1-2-5 Exponentiated numbers 2	– convenient numbers with many divisors: 50 and 100; 20, 40, 60, 80, and 100; etc. – the sequence 1-2-5, which divides the interval 1 to 10 into three steps – exponentiated numbers 2: 1, 2, 4, 8, 16, 32, 64, 128, 256, 512, 1024…	(Neugebauer 1931; Niemenmaa 2011; Jeyabharathi and Dejey 2016)
The square root of two	– ISO A, B, and C format paper sizes – in music – calculation of the maximum value of the electric voltage	(EN ISO 216:2009; Neufert and Neufert 2012)
System 32	– in cabinet type furniture, system 32 is used to place fasteners and other hardware in the panels – based on three basic dimensions: 32, 37, and 5 mm	(Hou 2021)

The researchers suggest that design practitioners should experiment with geometric design templates to establish balanced proportions as part of their design conceptualization work, before making design decisions that were previously based solely on technical functionality, manufacturability, and usability. Many dimensional series are used in various fields of technology, often adopted as a custom or conditioned by technological or transport possibilities.

An example of an adopted, advantageous dimensional system is standardized packaging dimensions. The consequence of their production is the mutual obligation of suppliers, logistics operators, distributors, and sellers to use modular packaging with dimensions that are multiples of a euro-pallet, *e.g.*, Euro pallets). Among the packaging of food products or packaging of household chemicals, one can also notice the repeatability of numerical values in the volumes produced, such as: 0.1, 0.25 (1/4), 0.375 (3/8), 0.5 (1/2), 0.7, 0.75 (3/4), 1, 1.5, 2, 3, and 5 liters (Wansink 1996; Garber *et al*. 2009; Shen *et al*. 2019; Escursell *et al*. 2021). In the scientific literature, the subject of packaging is considered not only in terms of dimensional optimization, ecology, or transport but also in terms of consumer preferences and the role of the designer who must meet these preferences (Wever 2011). Therefore, the research subject is the manipulation of specific visual elements, *e.g.*, the shape of the packaging, to evoke an appearance of the preferred size (Garber *et al*. 2009).

The Renard series provides another example of standardized dimensional values. This sequence is a carefully chosen selection of 'normal' numbers, offering optimal spacing for engineering applications (Copeland and Erdös 1946). Based on numerical values selected from the Renard sequence, *e.g.,* the diameter of fasteners, beams, and pipes is developed, and geometric sizes of the designed elements of hydraulic and pneumatic systems are selected (Jonson 2007). The research concludes that preferred numbers are best for standard sizes and scales of materials and suggests potential procedures for improving systems engineering. In addition to using normal numbers, the widespread use of convenience numbers is also noticeable. Convenient numbers, *i.e.*, those with many divisors (*e.g.*, 16, 20, 40, 50, 60, 80, 100, *etc*.) have been used for centuries and were, for example, the basis for the sexagesimal number system (Neugebauer 1931). The primary example of convenience numbers is time measurement: an hour is divided into 60 min and a minute into 60 s. The sexagesimal system is also standard for angular measures, especially latitude and longitude. The hexadecimal system can be found in many control or tracking systems (Niemenmaa 2011; Puškár *et al*. 2014; Jeyabharathi and Dejey 2016).

By describing preferred number systems, a number can be identified $\sqrt{2}$ as a commonly used number. The ISO 216 A, B, and C (2009) paper sizes are deliberately designed to produce two sheets of the same length-to-width ratio when divided into two equal parts. This is only possible if this ratio is $\sqrt{2}$. In music, the equal temperament system is formed as follows: the frequency ratio between the extreme notes in an octave is 2; and the whole scale is divided into twelve equal semitones, *i.e.*, the frequency ratio between successive sounds is constant and equals $f = \frac{21}{12}$. Applying the square root of two ($\sqrt{2}$) is also noticeable in calculating the relationship between the peak voltage and the root mean square (RMS) voltage in an AC circuit. The peak voltage is equal to the RMS voltage multiplied by $\sqrt{2}$.

Another example of a repeatable dimensional system is the 32 mm cabinetmaking system used in the furniture industry (Hou 2021). System 32 is used to place connectors and other fittings, such as: hinges, drawer guides, shelf supports, and handles. The main principle of this system is to use a distance of 32 mm between the holes. It also includes several additional dimensions: distance between the front, vertical row of holes, and the front edge of the board: 37 mm, distance between the horizontal row of holes and the upper or lower edge of the board: half the thickness of the board (usually 8, 9, or 9.5 mm). The "system 32" includes a 5 mm pilot hole, an 8 mm clearance hole, and supplementary holes in diameters of 3, 4 and 10 mm. A unified system allows furniture with different external appearances and overall dimensions to share a repeatable internal structure. This simplification translates to the production process as well. Parts can be used on both the left and right sides of the furniture, and for components with twofold symmetry, the top, and bottom can be interchangeable during assembly. The assortment of necessary tools is also decreasing; most holes and sockets are 5 and 8 mm in diameter. Industrial multi-spindle drills have spindles spaced every 32 mm and make many holes in one operation simultaneously – no time wasted on positioning a single machine tool spindle to each hole. As a result, compatibility with various types of fittings is achieved – fittings from different manufacturers can be used interchangeably, and it is unnecessary to equip with separate production and assembly tooling.

CONCLUSIONS

This study has reviewed canons, preferred numerical sequences, and proportions to support designers' decision-making processes. Three research questions were formulated, as follows:

1. Can one universal template for designers' dimensional decision-making be identified?

The research suggests that a single, universal template might not be ideal. However, using established geometric design principles (such as the Fibonacci sequence or golden ratio) can serve as helpful tools for achieving balanced proportions and aesthetics in design; therefore, selecting an appropriate design principle for a design task is essential.

2. What design assumptions should be adopted to ensure a high aesthetic quality in the final product?

The literature review identified two geometric design principles: organic, inspired by the human body, and the Fibonacci sequence, and inorganic, based on preferred technological numerical values. The main finding indicates that mathematical and geometric principles are well-suited for 2D products and interfaces, while non-mathematical principles, especially the golden ratio, are commonly used in 3D product design.

3. Are objects with a known, harmonious, and rhythmic structure more attractive and perceived as beautiful?

The research suggests a strong connection between proportions and aesthetics. Proportions play a significant role, as they evoke various feelings and impact work efficiency and everyday life by triggering positive or negative stimuli in the human brain. Attempting to answer whether there is one optimal algorithm for making dimensional decisions and assessing the correctness of these choices, it is concluded that it is impossible to pinpoint a single approach. Whether the CAD models being designed are models of furniture, buildings, everyday objects, or other projects, the designers should know the available methods supported by the preferred series mentioned in the article. Through consistently using preferred dimensions aligned with the chosen mathematical or non-mathematical method, the correctness of choices can be evaluated based on this foundation. An attempt at such an assessment has not yet been presented in the scientific literature, and other authors do not indicate a possible path for making dimensional decisions in design based on the methods presented in the article.

Understanding preferred geometry supports the design. Using appropriate proportions, dimensions, and shapes enhances the aesthetic quality of the end-products designed. Incorporating organic forms found in nature or culturally significant shapes profoundly affects how the project is perceived and the reactions it evokes from people. Dimensional decisions based on an appropriate system of preferred values can serve as design criteria integrated into CAD systems and processed by modules for generative design using artificial intelligence.

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Conceptualization: A. Jasińska; Methodology: M. Sydor, A. Jasińska; Literature Review: A. Jasińska; Validation: M. Sydor, M. Hitka; Writing – Original Draft: A. Jasińska; Writing – Review & Editing: A. Jasińska, M. Sydor; Visualization: A. Jasińska; Project administration: M. Sydor; Funding acquisition: M. Hitka.

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