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AESTHETIC CONSIDERATIONS IN INDUSTRIAL AND VEHICLES DESIGN

Abstract: *Industrial aesthetics is part of everyday aesthetics and is used to achieve a harmonious unity between objects' utility and visual appearance. The aesthetic value of a product is the result obtained from an organised integration of functional, technological, economic, and cultural factors in the development phase, as well as compliance with the laws of industrial aesthetics. This study examines optimal design development for industrial products using dedicated software. The work begins by describing the requirements of product design development and emphasising aspects of the principles necessary for creating industrial aesthetics. The determination of object proportions and the shape design method are presented in the second part of the study, in which a vehicle design is developed using the theory of the "golden section". The conclusions for determining the aesthetic design of the industrial object are presented at the end of the study.*

Keywords: *industrial design, golden ratio, everyday aesthetics, colour theory*.

1. INTRODUCTION

The exterior aspect of the products and the functional relations between the different elements represent the concept of industrial aesthetics. The main objective of industrial aesthetics is to adapt industrial products to people's needs, which can be achieved on a physical and psychological level. The physical level of adaptation depends on the product's ergonomics. In contrast, adaptation to the psychological level is done through the form's language, including the geometry of form and colours.

Engineering design is usually carried out by interdisciplinary teams of engineers, architects, psychologists, artists, sociologists, and anthropologists. Due to the complexity of factors to which the product must correspond, it must correspond to many users [1].
Over time, the development of industrial aesthetics has been achieved in three stages, as follows:

- Increasing fashion - industrial aesthetics to develop until the First World War.
- Interwar period – duration between the two world wars.
- Contemporary period after the Second World War.

The history of industrial aesthetics is highlighted by the first manifestations of the Industrial Revolution. The symbol is the iron bridge built in 1777 by Abraham Darby III in the locality of Coalbrookdale in England. This bridge is considered the first successful construction in the world, including aesthetically made of metal [2].

1.1 Economic efficiency of industrial aesthetics

Industrial aesthetics encountered obstacles as a widely accepted and recognised discipline, such as the impossibility of assessing the economic effect of the industrial aesthetic intervention or because of conception, and because the whole effect must be concentrated for the optimal satisfaction of the product functionality [3].

1.2 The laws of industrial aesthetics

Establishing a balance between the factors that influence the development of the industrial aesthetics of a product is achieved through the laws of industrial aesthetics. The creation of these laws was done by the French designer Jacques Vienot [4], [5], [6].

- The economy law involves saving used materials without diminishing product quality.
- The law of use aptitude and functional value refers to the harmony between a product's functionality and external appearance.
- Law refers to the composition of the components with a unitary ratio between them or within the assembly.
- The law of style – the character of permanent beauty of an object is maintained if it is conceived outside the influence of fashion.
- Satisfaction law – the designed object must be helpful and aesthetically impressive.
- The Aesthetic Law of Evolution and Relativity requires perpetual change to maintain the product's state of advancement and evolution.
- The taste law states that a product's added taste is ensured by its shape, colour, materials, structure, and balance of proportions.
- Movement law is an aesthetic characteristic found in the movement of some objects.
- The hierarchy and purpose law establishes a moral hierarchy between the produced differences, with priority given to the products that target noble objectives to the detriment of products that refer to minor activities.
- The aesthetic value of a product is not a criterion for its sale, and if the sale is due to its aesthetics, the level of equality between the creator and the product is demonstrated.
- According to probity law, honesty and sincerity are necessary in creating the industrial aesthetic of the product.

- Applied arts law aesthetic creation of a product involves the integration of different artistic creation modalities adapted to the requirements.

1.3 Functions of industrial aesthetics

The harmonious, functional, and economic integration of a new product in manufacturing involves educational studies to develop skills in the industrial aesthetics of products [7]. Thus, the new product must perform the following functions:

- The industrial aesthetics of the product must be directly correlated with the peculiarity of social activity, directly contributing to the humanisation of the labour process.
- The economic function is developing the product by eliminating unnecessary elements and obtaining simple, precise, and economical forms.
- Educational function is, nowadays, industrial production must meet aesthetic requirements, so it is necessary to educate the manufacturer's aesthetic capabilities and the beneficiary of the product.

1.4 Surface colouring

In industry, surface colouring is carried out for functional and decorative-aesthetic purposes. In functional terms, the paint coating of the surfaces gives a higher anti-corrosion protection or may reduce the friction coefficients in contact.

From a decorative-aesthetic perspective, the use of colour on surfaces serves as a powerful tool for expressing aesthetic qualities, enhancing attraction factors, promoting psychophysiological comfort, and conveying information.

The notion of colour emphasises three essential aspects of industrial aesthetics:

- the physical aspect
- the psycho-physical aspect
- the psycho-sensory aspect

The influence of chromatic stimuli on human behaviour in the production process is significant. It manifests in various reactions, such as speeding up the work rhythm, delays, or hesitations in performing operations or making decisions [1], [8].

To balance the operators' comfort, machine tools and devices will be painted blue in small workshops. In large workshops, preference is also being made depending on the type and temperature of the processing to colours such as orange, yellow, and red; blue and green colours aren't recommended because they give the feeling of distance. To routine activities that involve attention, preference is given to red tones. In open workshops, working at low temperatures, colours that give the feeling of heat, such as red and orange, are applied [1].

1.5 Golden ratio in industrial design

From antiquity, the golden section has been the best method to generate proportional objects, which has fascinated great sages since antiquity. The gold section is represented by the first irrational number discovered, denoted by the Greek letter $\Phi = 1.618033$. The discovery of this number dates to antiquity when it was used to make works of art and high-scale constructions. Later in the Middle Ages, associated with the divine Fibonacci ratio, discovered a string in which each term is obtained from the sum of the two preceding ones. The further it progresses in the series of numbers, the ratio between the number and its predecessor is closer to the divine proportion. The golden section of the segment *"a+b"*, shown in Figure 1, is made when the ratio of *"a+b"* to an equal the ratio of *a* to *b*. The segment noted with letter *"a"* is called *"extreme ratio"*, and the one with *"b"* is called *"mean"* [4].

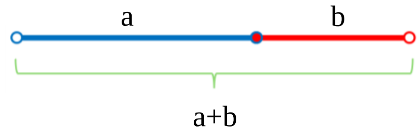


Figure 1 Golden section.

$$\frac{a+b}{a}=\frac{a}{b}=\Phi \tag{1}$$

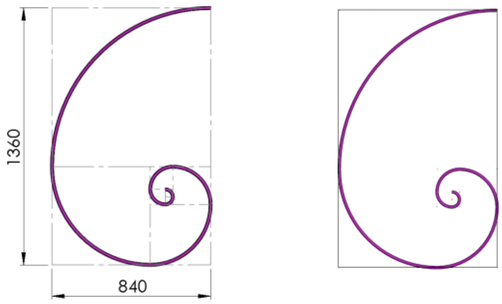
Thus, the most general asymmetric division is obtained. Expression 1 can be written as follows:

$$a^2 = b\cdot(a+b) \tag{2}$$

2. PROPORTION IN VEHICLES DESIGN

The aerodynamic shape of cars was not a significant concern for engineers 70 years ago. Straight edges and angles characterise the shape of the vehicles of that period. With the progress of time and the excessive use of the car, new components, such as headlights, wings, spare wheels, signals, etc., have been added to its structure. Thus, it was necessary to intensify the concern for generating an aerodynamic and pleasant design of motor vehicles. Each car manufacturer also looks for and maintains its product design [9], [10]. An important design study is applied to the structure of the Nissan Z sports vehicle. The silhouette of the car and design elements of the bodywork are generated according to the Fibonacci spiral [11].

This chapter presents the modelling of a sports car body applying proportional design methods. The body car modelling was done in the environment of generating surfaces from the software SolidWorks. The body dimensions determine the starting point of the modelling, so the body height is chosen to be 1360 mm. Figure 2a shows the Fibonacci spiral drawn according to the proposed vehicle height.



a) b)

Figure 2 Golden section – Fibonacci spiral.

Figure 2b indicates only the spiral framed in the gold rectangle for a more accessible view of the body shape. These are inserted into the model to sketch it according to the Fibonacci spiral and the reference diameter. The model's shape keeps the dimensions of the spiral, as seen in the images presented during the realisation of the model. Figure 3 shows how the first part of the surface is generated using a three-dimensional sketch. The contours of the parts are drawn with spline lines that can be modified during the modelling process.

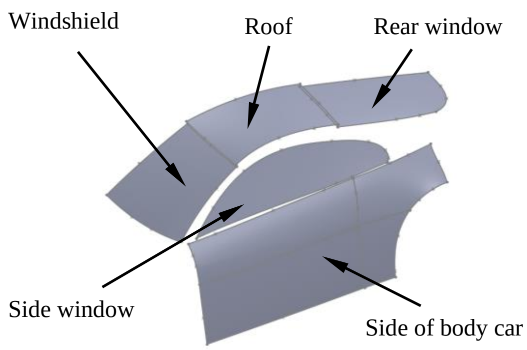
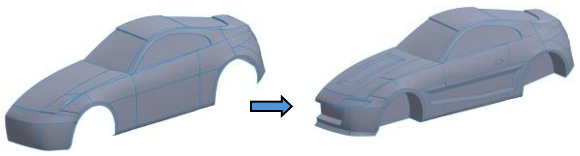
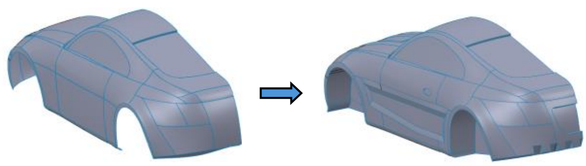


Figure 3 First modelled body surfaces.

It is modelled only halfway to symmetrical body generation, after which it is reflected relative to the median plane. Two stages are captured in the modelling process, as shown in Figure 4, where you can see the bodywork generated from the surfaces in the basic form and the processed form with the related elements.



a) Front side



b) Rear side

Figure 4 Surface modelling stage – front and rear side view.

Before the surface generation of the body, the gauge is established using the diameter of the wheel, which is 650 mm, as a reference. Thus, according to Figure 5, the wheelbase is set as three-wheel diameters between the front and rear wheels.

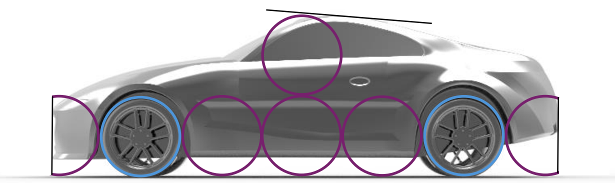


Figure 5 Setting the wheelbase and length.

The rear part is set at 3/4 of the wheel diameter, and the front part is at 1/2. The height of the body is almost two diameters of the wheel. The setting of the line at the doors is determined by the overlapping of the spiral over the side of the bodywork, as seen in Figure 6. The door line, indicated in the figure with *"d_l"* is positioned precisely over the top of the door opening handle. The height of the side window is between the spiral openings, being noted in the figure with *"h_w"*.

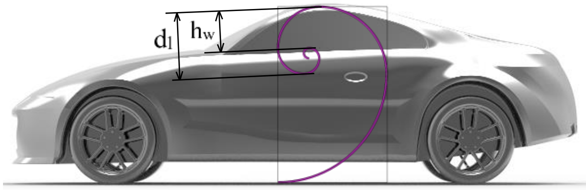
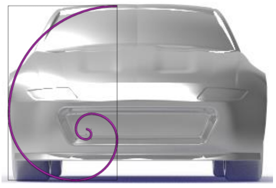
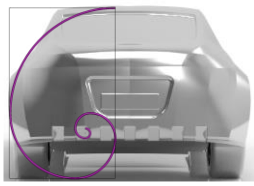


Figure 6 Door line and the height of the side window.

According to Figure 7, the shape of the front part and the back of the body is determined by the golden spiral. The spiral also determines the height at which the front grille is positioned.



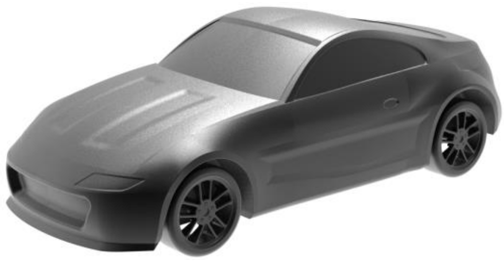
a) Front view



b) Rear view

Figure 7 Setting the front and rear shape.

The final body car designed in this paper is presented in Figure 8 in front and rear views.



a) Front view

b) Rear view

Figure 8 Final model of a body car.

Figure 9 shows the overall body car dimensions, with the car model represented in orthogonal projection. In addition to the constructive design, the proper application of colours to the body elements gives the vehicle model harmony, an aspect that will be the object of the following study.

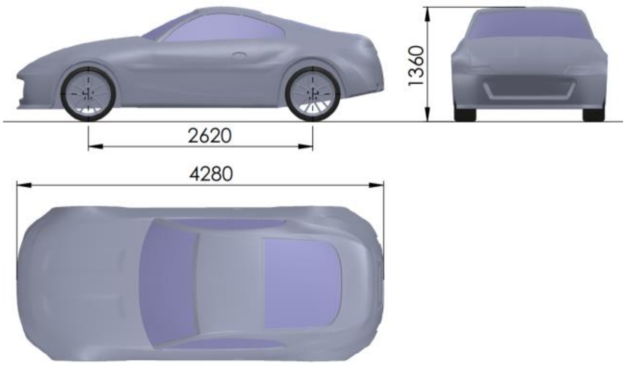


Figure 9 Orthogonal projection of the car model.

3. CONCLUSIONS

Industrial aesthetics is the discipline between art and science, intervening methodically in the industrial product, achieving harmony between the realisation of helpful function, efficiency, economy, form, colour, etc. This paper highlights the stages of generating the new body car by applying the golden section and wheel diameter as a reference for determining the length of the vehicle. The generation of the body car is done using CAD software. A high advantage of using CAD software is the possibility of parametric drawing and the possibility of modifying or adapting the model at any stage of work. Determination of the optimal shape of the vehicle body plays a significant role in vehicle design, making the vehicle model distinct and even contributing to the aerodynamics of the body.

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