

CONSTRUCTIVE SOLUTIONS AND ERGONOMIC ASPECTS IN THE DESIGN OF A CARAVAN

Abstract: This paper presents both the exterior and the inner structure that come into the concept, focusing on the main components that make up the two main characteristics of the caravan design, namely the comfort and functionality. Regarding the comfort of the caravan, this is described in particular by ergonomic factors and the functionality feature is highlighted from the functional structure of the caravan and described by components.

Key words: caravan, functionality, comfort, functional structure, ergonomics.

INTRODUCTION

Many types of caravans have been manufactured over the last 100 years, therefore to build a home to penetrate a market captured by big brands, in the preliminary stage of this project, we have established the main segment of consumers - young adults - young couples.

Designing the caravan is done by identifying the needs of the consumers, having as main requirements getting a product that fulfills all the functions for which it was created but with a lower cost than other similar products and without affecting the comfort.

Being a complex product, the caravan should be viewed as an assembly composed of several subsystems, which are made from components. Because of its complexity, the caravan is characterized by both technical aspects, and by social, ergonomic and economic factors.

Unlike other similar products on the market that have a lot of space but which have high costs - my concept complies with the mandatory requirements related to technical, safety and resting functions, exceeds the minimum requirements and is equipped with bathroom, living space, dining space, table, but it also achieves a minimal fulfillment of the desiderata, which refers to optional features mirrored in the caravan's interior with a TV set, a panoramic roof - all this in a small space and at a low cost, but without compromising the caravan in terms of comfort.

The functions that the trailer complies with and for which it is created, such as transport, the dining space and the living space, introduce modules, for example, it is necessary to have a living area in the caravan, introducing the module that fulfills it, namely the bedroom, this also is found in the caravan's case's sub-functions.

All the caravans' features are in its functions, starting from the global function to the freedom to move while enjoying comfort, the caravan is described by both technical factors: movement by introducing the braking, signaling, etc., and ergonomic factors, such as natural or artificial lighting, the elimination of stress conditions, the design of ergonomic components being a desirable achievement.

All of these steps have ultimately led to the achievement of a concept that satisfies consumers.

All components of the caravan are divided into two main categories, namely the outer structure of the caravan, the modules that are part of the interior and with which the user interacts most, and the auxiliary utility systems.

Presented next is the concept of the outer structure of the caravan, highlighting the ergonomic factors that were taken into account to achieve an interior that fulfills both the mandatory requirements and the desires.

2. THE EXTERIOR STRUCTURE OF THE CARAVAN

The exterior of the caravan is designed as being a small space to produce a lower cost; the caravan has the interior dimensions of 3m in length, 2m in width, and 2.1m in height (Fig. 1).

On the outside, at the back of the caravan is placed a luggage storage of 0.5m; and in front has a chassis of 1.5m length, for safe and functional attachment of the car.

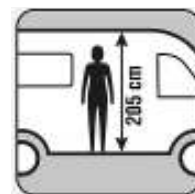


Fig. 1 Minimum height required inside of the caravan [1]

Dimensions are chosen according to the proportions that are needed so users do not feel trapped in a space that is too small (Fig. 2).



Fig. 2 Vitruvian Man - Space required for a man [2]

The material of the caravan body is made from aluminum because it is a lightweight material, one of the most important factors for the caravan being the low weight to generate low fuel consumption (Fig. 3).

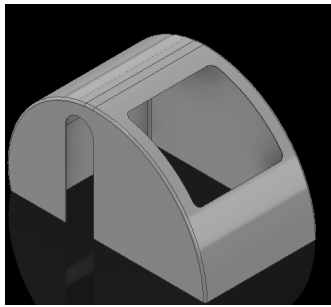


Fig. 3 Caravan body

Another important factor for the caravan is the center of gravity; the shape is made so that the center of gravity is located in the volume's center, to ensure safety during the journey.

The shape is aerodynamic, being a tear-drop type with straight sides, because more rounded edges would have reduced the interior space too much.

The carriage has a large window on the front, with a large enough size of 1.6m^2 which suffices to guarantee natural light, other windows no longer needed. (Fig. 4)

The caravan doesn't have a panoramic roof both for economic and structural reasons.

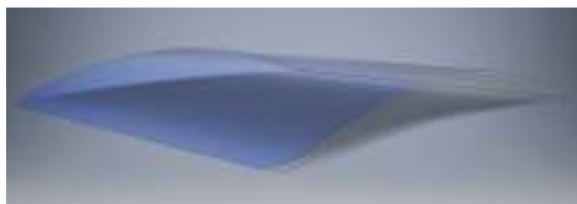


Fig. 4 Panoramic window

This panoramic window exists for social and economic reasons, having an attribute that is not common to small caravans, meeting a desideratum and adding value to the product, a single window means fewer technological operations for components manufacturing as well as fitting them.

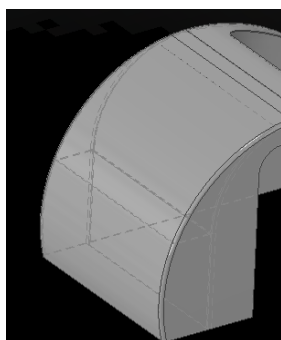


Fig. 5 Storage compartment

The dimensions of the storage space used as a luggage compartment can be used without the user "getting in" in order to get to the rear, and also provides enough space for luggage, having a space of 0.5m width x 2m in the back the caravan, and having a half shelf for an extra space (Fig. 5).

The height of the luggage compartment door provides adequate space when it is opened so it does not hit the users, providing enough space above the head.

It is important that the locks and handles, of both luggage compartment and the technical doors - those where maintenance is done - are easy to open and show the right shapes (Fig. 6).



Fig. 6 Technical door [3]

The entrance to the trailer is made on the right side door, which has a width of 0.5m and a height of 1.90m is very spacious.

It features a window with a width of 0.3m and a height of 0.35m and a lock with locks of 0.1m^2 .

Opening the door creates a danger when the user stands in front of the open door as he can stick his fingers in the hinges.

For this, there is a simple solution, the use of a PVC device that covers the space created with the opening of the door (Fig. 7).



Fig. 7 Hinges with fingers protection [4]

Given the fact that the first contact with the caravan is done through the exterior door, it is very important that the design of the door and especially of the lever be ergonomic.



Fig. 8 Types of caravan door handles [5]

Deciding between many types of door handles that have both advantages and disadvantages, a hidden handle was chosen, considering that although the other ones are easier to grasp, this one is more ergonomic (Fig. 8).

The shape of the door handle allows its grasping and opening of the door simple and comfortable, having also a smooth texture that does not allow the slip of the hand and has locks both inside and outside (Fig. 9).



Fig. 9 Door and door handle

The design of the main components of the module that performs the travel function, but also the caravan floor on which the body will be placed on, are shown below (Fig. 10).

The floor is composed of two parts, the interior of the caravan and the piece for the luggage compartments, which are mounted over the area of the caravan and which has both aesthetic and functional role - the utility modules being installed in this area.



Fig. 10 Chassis with components

The chassis performs many functions of the caravan; it shows both the axle of the two wheels and the coupling for attaching the caravan to the car, the parking brake, the brakes, and other components (Fig. 11).

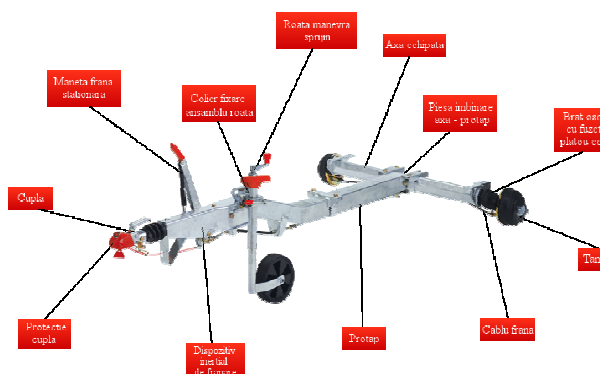


Fig. 11 Highlight chassis components - caravan [6]

The links between the components of the outer structure are illustrated in an explosion of the parts with the help of INVENTOR (Fig. 12).

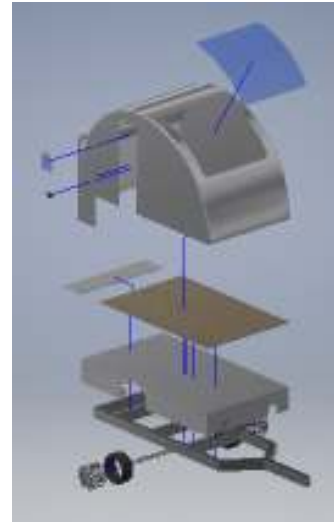


Fig. 12 Explosion of caravan exterior components

The main dimensions of the outside structure of the caravan are highlighted to show that the concept is realized on the correct scale (Fig. 13).

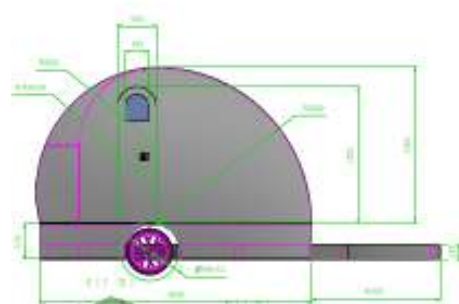


Fig. 13 Side view – dimensions

The 3D caravans exterior design concept is composed in the way that is presented next in multiple views (Fig. 14).



Fig. 14 Multiple views of the caravan

The design is made for traveling, as well as stopping easily on the side of the road to simply enjoy the view (Fig. 15).



Fig. 15 Suggestion of presentation - on the road

Presenting the caravan in one of the environment for which was designed to, a camper site at the mountain (Fig 16).



Fig. 16 Presentation - caravan at the mountain

3. INTERIOR COMPONENTS - ERGONOMY OF CONCEPTION

From the point of view of functions, the caravan has to present, as main components, modules that can meet the needs of rest, hygiene, food and relaxation.

Being intended to be used by two people, the caravan provides plenty of space for using the modules independently.

As it is presented with two lines of different colours, in the caravan is enough space left for the users to move freely and make different activities in the same time, without distress (Fig. 17).

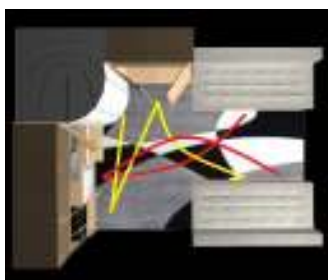


Fig. 17 The free space inside the caravan

In order to create a good concept, was took into account the ergonomic factors during the design phase, like colours, shapes, textures, lighting and so on [7].

In terms of colours, the caravan has its interior in warm, pale tones, thus achieving a visual effect of room enlargement.

The caravan is easy to customize according to the user's preferences and the desired effect, but it is possible to choose the combinations of colours, taking into account the combination of shades using the chromatic palette.

The shapes given to the furniture are both visually and securely enjoyable during use, as the contact surfaces do not have sharp edges that can cause accidents, the edges of the tops, cabinets, and sofas - beds are rounded so that there is no possibility of injury (Fig. 18).



Fig. 18 Risk of hitting fingers [8]

The furniture is also safe in terms of stability, it cannot accidentally overturn, it cannot fall, rotate, open the doors.

The handles are placed so that the doors cannot catch the fingers of the hand and the lower part of the furniture cannot be responsible for the toes.

Textures are very important to man's sense of touch, so surfaces have a small roughness.

Furniture and textiles - pillows, sheets, carpets are chosen in such a way that they do not create displeasure, being also antiallergenic.

As said in the section where the exterior structure of the caravan is presented, the concept features a panoramic window on the front of the caravan, offering natural light when needed, for example during the meal.

The window has an opaque trap that can be pulled when the sun is too strong, when extra privacy is desired, or it can be left open to see the stars in bed for a plus comfort and relaxation, adding value to the product.

Because natural light is not available throughout the day, it is necessary to use artificial light.

Artificial light can cause increased discomfort if it is not used properly.

As location, artificial light can be dispersed throughout the room when needed, or can only be used in certain areas.

With a simple push, a battery device generates enough light for the cabinet interior (Fig. 20).



Fig. 19 Light bulb for closet [9]

When the dining area turns into a sleeping area, the light above may disturb the users, so there are two sources of “light” on the wall.

At the bottom of the furniture there are “wake-up lights” in order to avoid lighting the toilet light, and not to disturb the other person during sleep.

The choice of the light bulb is also made considering the surface to be lit by the light bulb.

In order to create a pleasant and relaxing environment in the caravan, the caravan shows brightly colored light bulbs, because they are recommended in homes (Fig. 20).



Fig. 20 Artificial light inside the home [10]

The caravans small size helps eliminate the stress of finding a camping site in very crowded camps, and the camper is also suitable for camping in small places.

For added convenience to creating the necessary amount, a sound system and a flat-panel TV that can be used to rotate to the desired position have been added to the trailer.

At the door and at the caravan window there is anti-insect net to prevent it from piercing inside.

From the point of view of temperature and humidity, and because it is a multifunctional product, the caravan is equipped with an instantaneous boiler, ventilation system or air conditioning.

The heating is done through the bottom of the furniture, or directly into the floor, the heating being done with the warm air lifting.

To not generate stress due to noise, the caravan appliances such as the refrigerator and wall clock are silent.

Camper is well insulated, so that there is a good soundproofing, with a possible reduction of external noise, as the camping can be very noisy sometimes.

The caravan and furniture doors do not swing when closed, in order not to generate noise when the caravan is moving.

3.1 Modular components

In the case of the sofa-table, to accommodate the height of the users, the coffee table has extended legs, the size of the table surface provides enough space for two front-facing people to dine in optimal conditions and the optimum height of the sofa was chosen according to ergonomic criteria (Fig. 21).

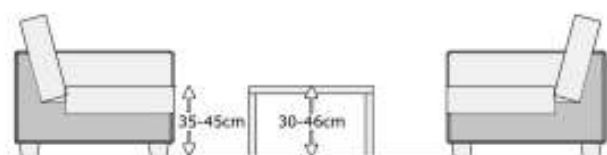


Fig. 21 Optimal height for coffee table and sofas [11]

In order for the bedding process to not create noise, a sponge for damping and reducing the produced sound is placed on the inside of the wooden surface.

The sofa cushion, which becomes the bed mattress, responds correctly to human needs both in position and in lying position because we have opted for the most suitable solution from an ergonomic point of view, namely choosing a memory mattress allows the user's spine to have a good position during sleep (Fig. 22).

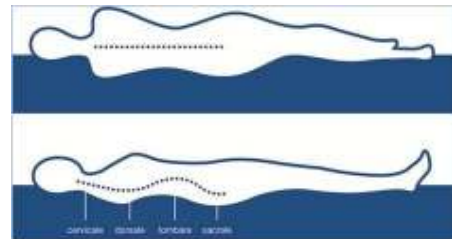


Fig. 22 Correct position of the spine [12]

Not only does the mattress have a very important role in the right sleeping position, but also the chosen pillow, which is responsible for the correct positioning of the cervical area of the spine.

For a neutral and therefore optimal position of the cervical spine, was opted for memory foam pillows.

In the kitchen's case, from an ergonomic point of view it would be useful for the counter to be adjusted in height depending on the user, but the limited space and the desire to produce a lower price does not allow this, so the users will dispose, with an adjustable seat that helps to change the working position during food preparation.

Cabinets are located at a height of 0.5m from the work surface, so there is no injury, not too much to reduce the field of vision and allow the light to reach this area (Fig. 23).

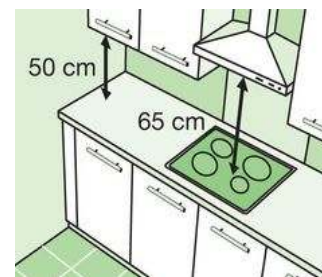


Fig. 23 Optimal height between furniture bodies [13]

The kitchen can be equipped with ergonomic utensils and even the hob knobs and sink faucets can have optimal grip shapes.

With regard to the bathroom, both the shape and dimensions of the toilet bowl, show ergonomic criteria.

In the bathroom, apart from the components, there is enough space left so that a person can move freely during various activities such as towel drying or bending to wash the face.

As far as the storage area is concerned, the 2m wardrobe has an ergonomically suitable height; most adults can get to the top shelf without the need for helping objects such as a chair or staircase.

The users are able to put a more personal touch on it, as the interior of the caravan is easy to customize in terms of changing the colours of both wood and textile or the decor components (Fig.24).



Fig. 24 Different ways to customize the interior

4. CONCLUSIONS

In conclusion, in this paper is introduced a new concept of a caravan which presents multiple benefits for consumers, being technical, social, ergonomic and economical.

Is extensively described the outer structure of the caravan and some ergonomic factors that characterize the interior of the caravan.

The advantages of this caravan are the small size, which generates low consumption of materials and implicitly a lower cost of manufacturing, realizing it on modules fulfilling specific functions and whose components consider the main ergonomic factors that make the caravan a comfortable environment but also the ability to quickly customize the interior according to customer wishes.

5. DIRECTIONS FOR FURTHER DEVELOPMENT

After establishing and adding the final attributes of the caravan, the ultimate concept will be created in which the interior and exterior of the caravan will be presented as part of a whole, by highlighting how to assemble and disassemble all the components.

The next part of the paper will present systematically all the functions of the caravan and its list of requirements, highlighting both the needs expressed by the customers and the target specifications characterized by matrix and value [14].

Regarding concept design, the components of recreational and utility systems such as drinking water, wastewater, heating, lighting, signaling, braking, and parking systems will be attached to the concept.

The cost change will be analyzed when introducing two small, open windows to see if it will increase excessively in rapport with the benefits that they will bring.

One of them placed next to the kitchen to eliminate easier the smell of cooking and another inside the bathroom, useful to eliminate the moisture after using the shower and because when are opened both windows offer natural light and allow fresh air circulation in the caravan.

To the project will be attached the execution and overall drawings made on the scale, will be presented the chosen materials and will be shown the main technological processes of getting the main components that make the caravan a great product design.

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