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CONSIDERATIONS ABOUT SAFETY AND EFFICACY IN THE FIELD OF DESIGNING CHILDREN'S CARS

Abstract: *Electric cars for children may seem dangerous to some, but they are quite safe compared to other toys. They are made of non-toxic materials, which have good impact resistance and are lightweight. Due to the manufacturing processes, their components are not small and cannot endanger children. The main objective of the paper is to study the optimal orientation of the construction of a children's car from ABS material processed by injection molding.*

Keywords: *toys, safety, analysis, 3D model, improvement, simulation.*

1. INTRODUCTION

Plastic toy cars are part of the light industry. The light industry usually requires less capital than heavy industry and is more consumer-oriented than enterprise-oriented. Light industry installations do not have too great an impact on the environment compared to those associated with heavy industry. The plastic used to make the largest components, for example, the body and the seat, which make up a large part of the structure of toy cars are made of polyethylene (PE) and polymers derived from styrene, especially acrylonitrile butadiene styrene (ABS).

They are used in the manufacture of toy car components due to their most interesting properties, which surpass in applications many other thermoplastic materials, such as their resistance, superior impact even at low temperatures, excellent stretching behavior, chemical resistance high and very low weight of the finished products [1].

The shape of the products depends mainly on the chosen training technique. Vacuum formed products can be identified by models that have an internal and an external shape, but which follow the same shape. Injection molding is used for solid components in a toy car where the parts require different internal and external shapes.

Components made using this technique may also have attachment points. An injection molding machine is a combination of three machines: the laminating and injection machine, the press, and the mold. Injection molding is one of the essential commercial methods for transforming thermoplastics into useful products. A thermoplastic polymer can be reheated and remodeled many times. During the injection molding process, the plastics need heating until they reach a fluid state. Subsequently the fluid plastic is injected with a certain pressure through a nozzle into the mold which is cool. The plastic takes the shape of a mold while its temperature drops enough to be quite hard. After the plastic has cooled, the mold opens, and the product is released from the mold [2].

Most of the time the final result, ie the finished product is no longer needed retouching. The parts made by this process have one or more of the following characteristics: lateral parting lines or glued portions created by the two parts of the mold, sharp corners, fine and precise details. Blow molding technology has been adapted from the glass industry to model empty containers made of thermoplastic materials. The most famous objects cast by blowing are bottles, jars, etc. Other blow-molded objects include toy car wheels.

The working principle is based on:

- Power supply: This is necessary to supply power to the entire operation and to allow all parts to operate. In a remote-control car, the power supply is the battery.
- Engine: The engine is the one that fulfills everything moving all necessary parts and performing the basic function, including turning the wheels, steering, and applying acceleration or braking.
- Transmitter: The transmitter acts as a remote control and is the thing you hold in your hands and with its help and radio waves you can dictate the commands of the toy car.
- Receiver: This is locating in the RC machine and has an antenna and circuit board that allows it to receive signals that the transmitter sends and move the necessary parts.

Although not accepted by any recycling machine/installation, ABS is part of the category of plastics that can be recycled only once.

ABS is one of the many types of thermoplastic and with applications in other fields such as biomedical; thus, injection molded components are the easiest to manufacture for a single use [4]. The main method of sterilizing ABS is performed using gamma radiation, or ethylene oxide (ETO).

2. THE NEW MODEL

In this chapter of the paper, I will talk more about my ideas, methods, and contribution concerning the improvement elements of children's toy cars. The model I will talk about below is designed for a child aged between a minimum of 4 and a maximum of 6 years. This model is designed based on a list of requirements (Table 1).

The design of a product involves a set of activities and processes that allow the transition from the idea of a new product/an existing product (or improving an existing product) to information (drawings, programs, etc.) that permit the launch in production and exploitation of the product.

Table 1

Requirements list

No.	Requirements
1	Safety
2	Ergonomics
3	Easy to handle
4	Powerful battery
5	Adjustable speed
6	Have different accessories / interactive buttons, with sounds and lights
7	Be colorful
8	Easy to use both indoors and outdoors
9	Durable material
10	Do not have small parts
11	Cheap
12	Easy to transport
13	Double control (with remote control)
14	Comfortable
15	Silent

The 3D model was made in CATIA 3DExperience (the latest version of Catia software) (Figure 1). This model can be made from the materials we presented in the previous chapter, where we talked at length about the multitude of plastics and different manufacturing technologies of these materials with an application, especially on children's toy cars.

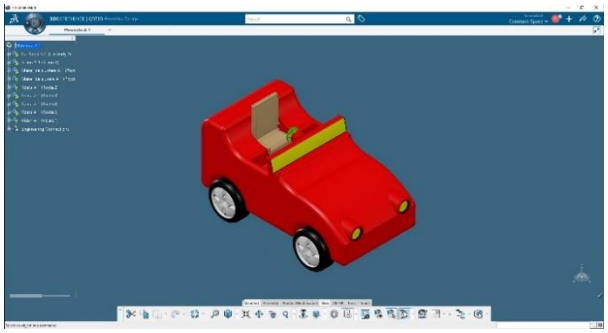

Figure 1 - Isometric view

The seat has a high back to avoid hitting the head or unbalancing, these being the consequences of a sudden departure from the place. It can be seen in Figure 2, side view, that the seat is positioned so that the position in which the child sits is a natural one.

The windshield is small, positioned low enough to allow the child driving the car to observe the territory and objects around it.

The car does not have doors that open or close because they can be a danger to the child from several points of view such as holding the hand in the door or hinge. Also, the car does not have a sharp edge, because they also have a risk of injury. The width of the car is 70 centimeters, the width of 125, and the height of 55 these dimensions within the safety standards, which provide for the overturning of the car (Figure 3).

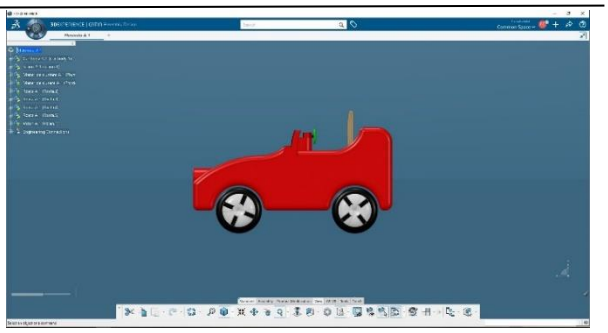

Figure 2 - Right side view

Figure 3 - Front view

The car is equipped with a green ON / OFF button, to start or stop the current in the car's electrical circuit, the accelerator pedal, and two handles for adjusting the seat (Figure 4), which moves the seat up / down and front/rear. These buttons for adjusting the seat are essential from an ergonomic point of view (Figure 5). The position that the child adopts while driving the car must be a natural one, which does not bother him and makes him feel comfortable and safe.

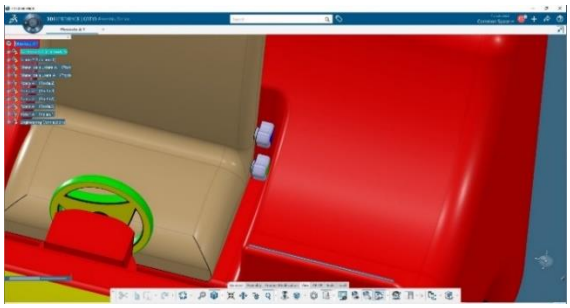

Figure 4 - Interior view

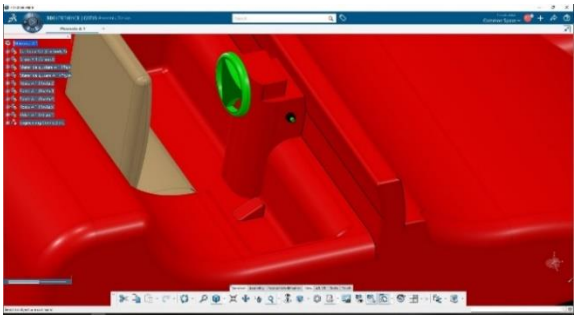

Figure 5 - Interior view (adjustment levers)

3. TESTING AND MECHANICAL PROPERTIES

The design of a product involves a set of activities and processes that allow the transition from the idea of a new product (or improving an existing product) to information (drawings, programs, etc.) that permit the launch in production and exploitation of the product.

After making this model I chose the material from which it should be made. As I said in the previous paper, most of the toys are made of plastic. I also argued why the plastic most frequently used by large companies producing children's cars is chosen as ABS material. Its properties are among the most suitable, in terms of resistance to pressure, traction, torque, and shock.

To predict the performance of the prototype in the real world and because the safety is given by the resistance of the components to stressess, consequently we simulated on the 3D model the behavior of the product at different loads at the estimated average weight of a child [3].

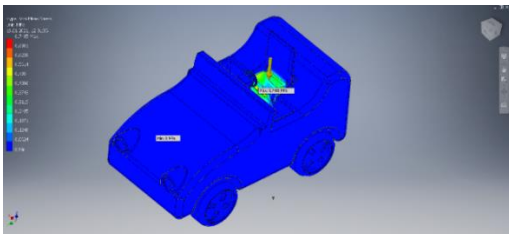

Figure 6 - Isometric view simulation

The figure above (Figure 6) shows the static structural analysis of the baby car made of plastic, ABS, and built by an injection molding technique. The equivalent stress is maximum in the central region of the seat of the car and is due to the sudden change of the cross-section near the length of the seat which leads to a high concentration of stress, as shown in Figure 7.

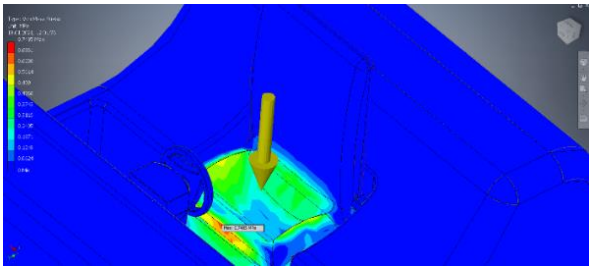

Figure 7 - Interior view simulation

The maximum value of the equivalent stress obtained after the simulation is 0.7485 MPa, this being below the value dictated by the properties of the chosen material (ABS), whose tensile stress has the value 43 MPa, or the flexural strength of 77 MPa. Thus, the piece withstands very well an average weight of about 30 kg, of a child.

4. CONCLUSIONS

In this paper, the tensile strength of a children's car was measured. The parts were tested for tension and the results were compared with the nominal values of the strength of the ABS plastic. This information is needed to know how to design functional parts with this technology, whose use is growing more nowadays.

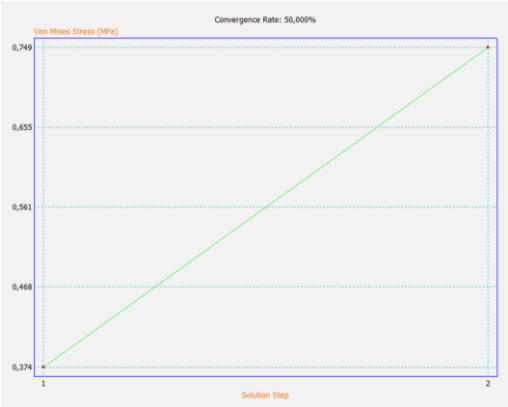

Figure 8 - The results of the tensile strength test for the car

Table 2

Typical Mechanical Properties of ABS

Property	Value
Young's Modulus (GPa)	2.28
Tensile Strength (MPa)	43
Flexural modulus (GPa)	2.48
Flexural Strength (MPa)	77
Notched Izod (kJ/m)	0.203
Heat Deflection Temperature, 1.81 MPa, (C)	81
Emission factors CO2 (kg)	3.46

The experimental result showed that the product made of ABS by injection molding has tensile strength (Figure 8). The stress distribution was investigated using the INVENTOR 2021 software. The maximum developed stress is in the edges of the seat component due to the sudden change of the cross-section which leads to a high concentration of stress, as shown in the figure. The total deformation, the equivalent stress, and the maximum principal stress were obtained (Table 2). As expected, the maximum tensile strength produced in the 3D model is lower than the nominal strength of the material.

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