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CONSIDERATIONS REGARDING THE CURRENT STATE OF COMPUTER SOLUTIONS USED IN DESIGNING AUTOMOTIVE PARTS

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Rezumat. *Odată cu dezvoltarea tehnologiilor prezente într-un automobil soluțiile de proiectare au fost și ele forțate să evolueze. Dacă acum 100 de ani apogeul privind soluțiile de proiectare erau reprezentate de planșetă, riglă și creion, acum au fost înlocuite de calculator și aplicații CAD. Atunci doar ne puteam imagina complexitatea din designul unei piese, dar azi o putem materializa. Noi cerințe și provocări apar odată cu descoperirea de noi materiale și tehnologii noi de prelucrare.*

Abstract. *With the development of technologies in a car, design solutions have also been forced to evolve. If 100 years ago the design solutions were a drawing board, ruler and pencil, they have now been replaced by computer and CAD applications. Then we could just imagine the complexity of the design of a piece, but today we can materialize it. New requirements and challenges arise with the discovery of new materials and new processing technologies.*

Key Words: develop aided design material plastic

1. Solutions and trends for materials used in the automotive industry

1.1. Evolutions in automotive designs

The car was born out of a brilliant idea. Everything that followed after it meant progress. It started from the idea of replacing the conventional method of transporting people in cities at the end of the 19^{th} century, that is, the horse drawn carriage. This idea has grown with the emergence of the internal combustion engine, still used today.

The first car sold by Karl Benz (1885) was equipped with a 3-wheel gasoline engine of 0.75 hp. The tires were solid rubber and the body concept had not yet appeared, but the body of the car was made of steel and wood [1].

Some of the most important factors behind the evolution of the car design were: the implementation of new processes and technologies with high productivity and the control of the car mass [2].

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All the day-to-day equipment on a car appeared due to some necessities. At the beginning of the 20th Century racing pilots were the mechanics and engineers who worked on the development of the machine. Thus, the manufacturer "Marmon" earned the Indianapolis 500 in 1911 inventing the rear view mirror, replacing the rear-seat co-driver (massive weight reduction). Today, rear-view mirrors have also been fitted with a video camera mounted behind the car and a monitor on the dashboard to increase the viewing angle, especially when driving backwards. The next step would be to completely replace the rearview mirror with a wide angle camera and monitor, thus removing those dead angles of visibility [3].

The look of the car has also undergone changes due to a specific need. With the increase in engine capacity, hence the developed power, the speeds of the car have also increased. At first they were inspired by aviation design. It has been noticed that your aerodynamic shapes also have an impact on the cars that are related to the ground [4].

If at first the cars were as square and corner as possible, it is no longer the case. After the robust initial forms, more harmonious and curved shapes of the body lines were researched and implemented. Now the design has been divided into two main categories. A complex design is featuring a sum of contours and boldest lines for serial machines. The other category is the minimalist design for futuristic concepts [5].

1.2. Evolution of materials used in automotive industry

The evolution of materials used in the automotive industry has been determined for several reasons. Among the most important are: reduction of car mass due to consumption, and car design.

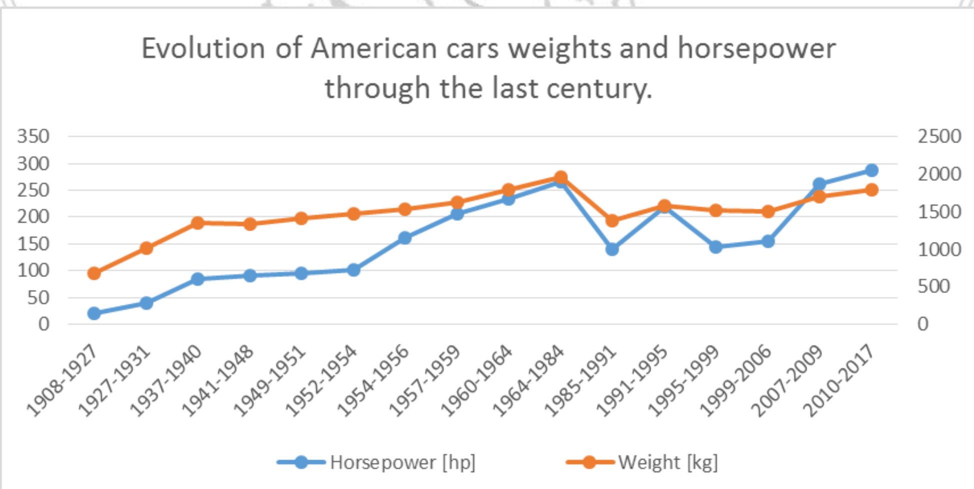

Fig 1. Evolution of American cars weights and horsepower through the last century.

2. Manufacturing solutions for plastic materials products in automotive industry

2.1. 3D Printing

3D printing is a form of additive manufacturing technology where a three-dimensional object is created by laying down successive layers of material. Also known as rapid prototyping, it is a mechanized method whereby 3D objects are quickly manufactured on a reasonable size machine connected to a PC that contains the 3D data for the object. The 3D printing concept of custom manufacturing is exciting for almost everyone. This revolutionary method saves time and cost by reducing design times. Such a printer is exemplified in Figure 2 a) and an example of a type internal structure made by 3D printing 2 b).

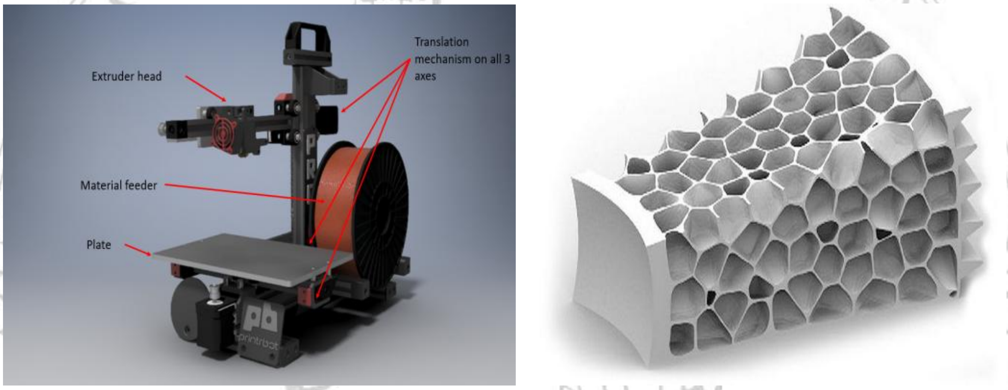

Fig. 2. a) 3D Printer; b) Internal comb structure.

For automotive industry, low productivity does not bring any benefit. In order to be able to handle plastic applications, a vendor will need 1000 such 3D printers. 1000 3D printers translate into 1000 operators and 1000 computers to control each printer, plus a large enough space to accommodate the above mentioned ones.

But this aspect of the process is not the head of the automotive industry. The possibility of rapid prototyping brings many industry benefits on the design side. To reduce engineering costs, these 3D printers have been introduced to create plastic parts and check the assembly long before making the piece's mold [6].

2.2. Plastic injection and molding

The injection procedure is especially applicable to thermoplastics and, rarely, thermosetting materials. This processing process is extremely important in plastics processing technology, and it is possible to obtain parts with complex shapes, with different uses (in machine building, in the consumer goods industry, in medical applications, etc.) and with a mass of to a few grams up to 20 kg. The productivity of injection machines is high, for the heaviest objects the cycle of an injection is max. 1÷2 minutes. After the construction of the mold used, one or more injected parts can be obtained at one injection cycle, which leads to a very high productivity of the process. Plastic injection technologies have made it possible to replace a wide range of parts. Interior accessories, exterior accessories, tanks, fasteners are the most common plastic parts in a car assembly. Figure 3 shows some of the outer plastic accessories.

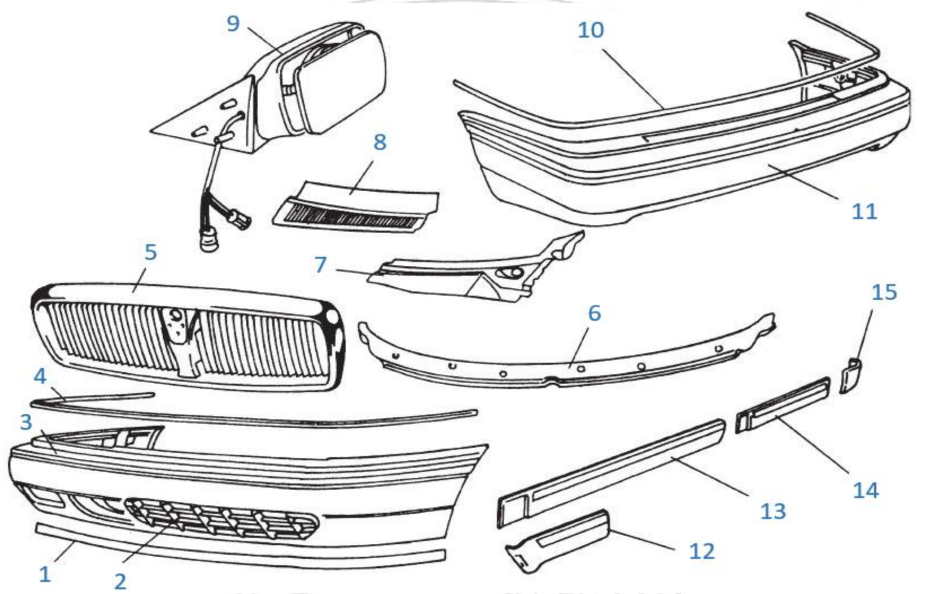

Fig. 3. Legend: 1- front spoiler, 2-lower front grill, 3-front bumper, 4-front bumper insert, 5-front grill, 6-lower screen molding, 7-scuttle molding, 8-scutlle grill, 9-door mirror assembly, 10-rear bumper insert, 11-rear bumper, 12,13,14,15 waist moldings.

Including protective parts can be made from plastics. We can take the following example as a shield for the oil bath [figure 4 a).] Original it was made of steel by drawing a 1.5 mm thick sheet. Subsequently, it was discovered that a shield with a similar geometry but made of polypropylene with a thickness of 2.5 mm will behave similarly to steel. Furthermore, being a non-visible piece, the polypropylene used can be recycled, having a density of 0.95 g/cm^3 compared to 7.8 g/cm^3 steel.

By measuring the mass for each of the two cases using a computer solution we obtain the values shown in Fig. 4 b). It can be seen that the mass of the polypropylene shield is about 5 times less than the mass of the shield made of steel. In theory, we can reduce by at least half the mass of steel parts replaced by plastic parts. This is not only favorable for automotive manufacturers, but plastic injection processes are much cheaper, cheaper parts because the raw material is much cheaper [7, 8].

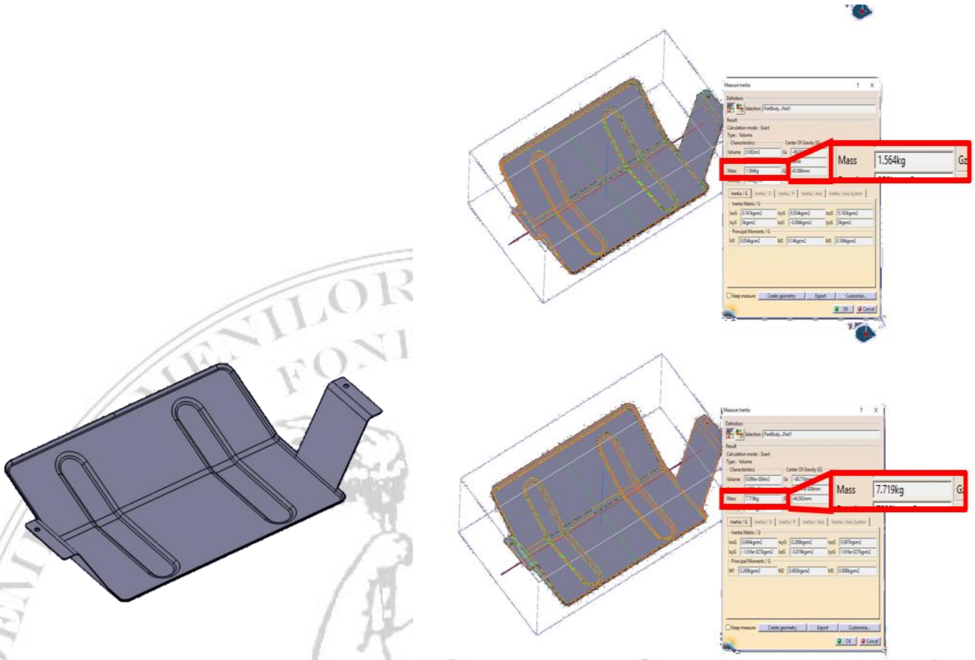

Fig. 4. a) Oil bath shield; b) Comparison between the two solutions (above polypropylene; below steel).

3. Computer solutions used for the design and validation of plastic parts

3.1. Evolution of designing solutions for the automotive industry

The term "Design" originates in English (pronounced *di-zain*) and means project, sketch, conceptual drawing and conception sketch.

The term "design" appeared in 1851, in connection with the complicated realities of industrial production. It is a concept and a method of creation that aims to ensure each product a high functional yield, accompanied by a pleasant appearance.

In all the epochs of human evolution there was a correlation between the material possibilities, the technological level, the internal and external economic relations, the spiritual horizon expressed by the artistic taste and the creative capacity.

Moreover, the technologist and the artist were confused at first in one person.

At the beginning of the 20th century, one of the most evolved forms of making a drawing or assembly drawing was the pencil and sheet of paper.

Although the cars at that time represented a mix of state-of-the-art technologies (at that time), they were also designed with these rudimentary resources.

In Figure 5 one can see such an example 1929 Ford model (Model A).

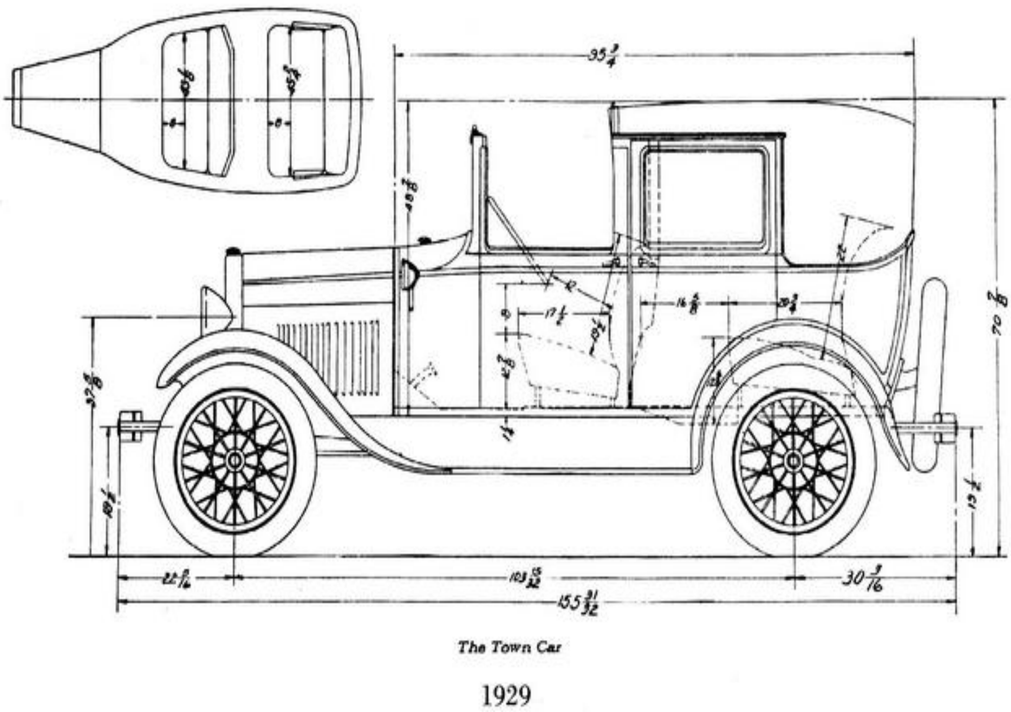

Fig. 5. Ford Model A (extracted from a complete drawing).

Industrial modeling (clay modeling) was introduced to the automotive world in 1930 by designer Harley Earl, director of the General Motors styling department.

Industrial clay is based on wax and usually contains sulfur, which gives a characteristic smell to most artificial clays.

However, largely because sulfur has interfered with some mold manufacturing processes, especially if clay surfaces are non-insulated surfaces, platinum RTV silicone rubber was used.

Sulfur-free versions are available today, which are usually much lighter than sulfur-containing clays.

More recently, clay models are scanned 3D in a digital file using laser technology. It is then opened in computer-assisted design software to be worked on.

If a negative die is required, this data is sent to a milling machine.

In Figure 6, you can see how a designer models the car's bodywork, which will then be scanned and processed using a CAD application.

Fig. 6. Modeling with industrial clay.

3.2. Basic structure and methodology of a CAD solution

From the point of view of the application architecture, the CAD solution consists of:

- - Geometry "Kernel" - responsible for generating geometric elements. The point, line, plan does not present any difficulties in representation, but these are not enough in design. The more complex the surfaces of the part are, the more complex the mathematical model behind the application;
- - Topology Layer - it is responsible for the topology of the piece (indexing of all elements represented) and for the links between the elements;
- - Functions - Each CAD application is equipped with a certain set of functionalities that allow modeling of the piece.
- - UX (User Experience) - the graphical interface and user-to-application link (buttons, menus, informative pops, data input methods).

The current systems, especially for mechanical products, are 3D systems and are now spreading their dominance in other sectors (entertainment, marketing, promotion).

3D modeling can be wireframe modeling, solid surfaces, or solid models. Most CAD systems in the mid sector mechanical sector are solid modeling systems based on parameterization and functionality.

The "Wireframe" was the first attempt to represent a three-dimensional object, but this method introduced more problems than it solved. Now this technique is an intermediate stage for the construction of a surface or a solid.

Through a model made up of surfaces, the piece's shell is modeled. If initially Fergusson and Benzier curves were used, NURBS curves are now being used to model almost any form in the automotive industry [9].

The solid model is considered to be the most representative representation of a piece.

Along with the evolution of CAD solutions, the concept of parameterization and links between features, elements and parts has also been introduced [10].

3.3. Design and Virtual Reality

The conventional method of interaction with hardware and software components in the industrial design is (currently) the mouse and keyboard for data manipulation and input, and the monitor for viewing.

After the introduction of this technology, initially in the entertainment sector (3D games and 360° video viewing), we also tried to implement in CAD applications.

So far, the current stage is limited to visualization and manipulation, but huge advances are also being made for the data input method.

Major problems present the data input method, since co-ordination between the user's hand and the application is very primitive.

The computer records and amplifies movements from an accelerometer (located on the hands and fingers) and is transformed into visual information transmitted to the VR helmet.

The VR (Virtual Reality) helmet isolates the user from the environment and increases immersion by rotating the image at the same time as the user's head.

Virtual Reality in Design is similar to industrial clay modeling to create an amazing design. In the virtual environment, it is much easier to modify and correct the model than the actual layout.

Conclusion

With the development of the automotive industry design, it was also necessary to develop design and design solutions for the design and design of the parts. From the board, pencil and ruler sheet came the mouse, keyboard and monitor.

The next step is Virtual Reality. It is a feasible alternative for economical industrial clay modeling and especially by reducing the time required for the designer to achieve a product.

Abbreviations

CAD – Computer Aided Design;

UX – User Experience;

VR – Virtual Reality;

3D – tridimensional.

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