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# STUDY AND ANALYSIS, THE PARTNERSHIP THAT REVEALS THE BEST SOLUTIONS

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**Abstract**

*The field of engineering is a complex and well-developed one and thus offers various opportunities to students. Design engineering is a branch of this field that has several categories. The field of engineering involves logic and reason and imagination. The strength of 3D and 2D design is the engineer's ability to see in space. This skill is cultivated over time and requires practice and work. Time management in favour of effort is also a very important aspect of engineering tool. Design develops with technology because nowadays everything is designed in 3D/2D CAD and CAM space. Thus, technology is the basis of computer-aided design and manufacturing. Automotive design engineering involves continuous study and analysis of the CAD working environment (programs such as CATIA, NX Siemens), the processes to be performed (welding, marking and checking stations) and the materials that can meet the project requirements (such as C45 and PA6).*

**Keywords**: materials, projection, communication

## 1. Introduction

Nowadays, the extremely rapid development of technology is the main factor driving people's increasing desire to include its use in various industries. The purpose of involving technology in various productions, such as car manufacturing, pharmaceutical industry and chemical industry, is to streamline manufacturing without the active participation of human resources that can perform other activities, for example quality improvement. Another important aspect driving these changes is people's desire, on the one hand, to diversify production processes and, on the other, to find new ways of facilitating industrial processes [1].

The automotive industry is one of the most diverse industries today. The demands on human resources in this field are for greater attention, constant logic and imagination and the ability to solve problems quickly. The diverse emergence of car models is also driven by the evolution of technology. At the same time, the multitude of vehicles leads to constant innovation in the methods of assembling and managing them in the field of design. In this regard, the entire manufacturing process needs to be constantly simulated and verified, both theoretically and practically.

The aim of the present paper is, on the one hand, to provide an overview of the field of design, starting from the most important piece to the completion of the manufacturing process, covering also the entire process of its realization and operation; on the other hand, the paper is intended as a guide for young design engineers [2].

Certainly, the most important experience that can be gained during the university years is the voluntary participation in the various practical competitions. This will make the choice of which field to go into much clearer and safer. Such research has helped one of the authors to combine practical reality with the logic and theory the author has learned during the years of study. Surely, just the practical results will prove the skill, proficiency and commitment of both student and engineer to the work. Communication remains the

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main step in the successful realization and completion of any project.

## 2. Methodology

In this direction, the first step to start the project received is to carefully read and recognize exactly what the client's requirements are for the product and, of course, the possibilities to realize it. The concept to be able to complete the process of bodywork realization is established in the first level of design, called Simulation. Once the simulation establishes the steps of the process, such as determining the welding points and the types of robots used, the actual design stage is reached. Communication is the main positive factor for smooth running and avoiding errors throughout the production process.

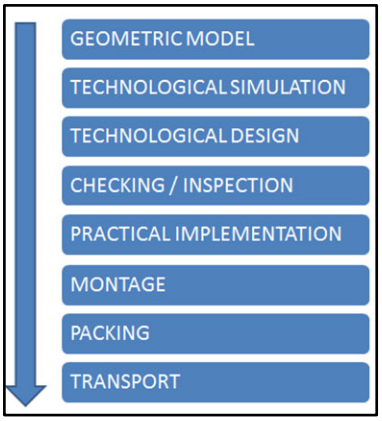


Fig. 1: Step by step

However, there are some aspects that are only references from one project to another because they may differ from client to client. The data referred to are often lists of standard and commercial materials and parts, which are supplied from different manufacturers, and the different colors, where parts are painted. The most important provisions are related to the customer's requirements on how to work, organize and plan the project, go through the stages gradually and avoid errors in all respects, from the 3D level to the production.

Do we need automated lines for car production? The answer is affirmative because the demand for vehicles has increased, especially in the early 20th century. So in 1913, Ford was the first plant in the US to make the first automated assembly line. So, along with people's desire to create and diversify came the field of engineering called Design. However, let's remain realistic because it took 60 years of studies to move from the use of the computer to perform engineering calculations to the use of the computer in graphics, which marked the beginning of the CAD era ("Computer-aided design" is a process defined as the activity of using a computer system in the design, modification, analysis and optimization of design). This version allowed the user to draw objects in three dimensions, giving him the possibility of obtaining three projections [3].

With this brief history in mind, let's continue with the analysis and realization of the design. The image below shows the steps to complete any project. The most important aspect is the analysis of any solution that can be implemented. Every step needs confirmation and approval.

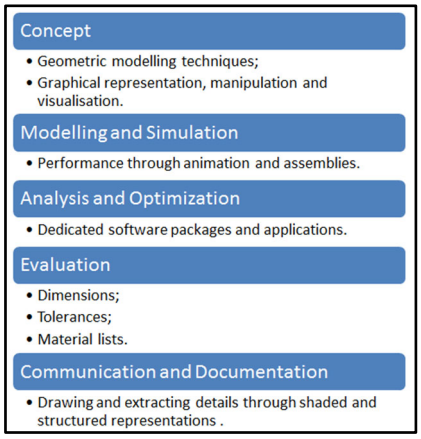


Fig. 2: Discussed steps

## 3. Discussion

“Young engineers”, the authors will tell you a secret: nothing is impossible to do, both in 3D and in real life. The difference between possible and impossible, from a design point of view, is between solutions that involve high implementation costs and short deployment time and methods that involve low costs and long deployment time: this is the basis of the job of a design engineer.

The strength of all the information presented is the locator. In the following lines I will present all the information involves these pieces, followed by an analysis that focuses on this topic. In order to get to the information about the locators the following notions have to be presented, namely the station concept and the gripper concept.

A station is one that holds the part in a certain position so that it can be welded, glued or bent. So, on the one hand the most important stations are: welding, gluing or bending stations. On the other hand, the secondary stations are those for transport, checking or marking.

A general and very important rule is that any part of the bodywork to be welded or glued must be sensed by a sensor. The station is always checked by the simulation engineer and the design engineer with the gripper to avoid collisions and to ensure the process runs smoothly. In order to avoid excessive use of the word “bodywork”, “part” has been used as a synonym for it.

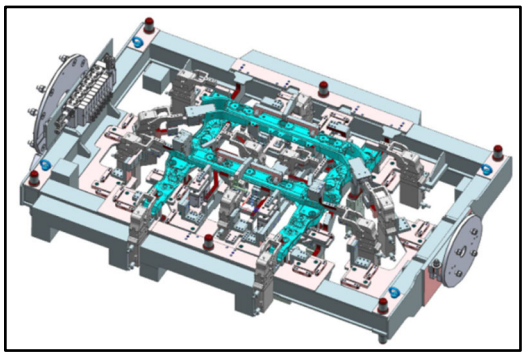

Fig. 3: Welding station example

A gripper can perform several part handling processes because it has several gripping faces, as in the following figure.

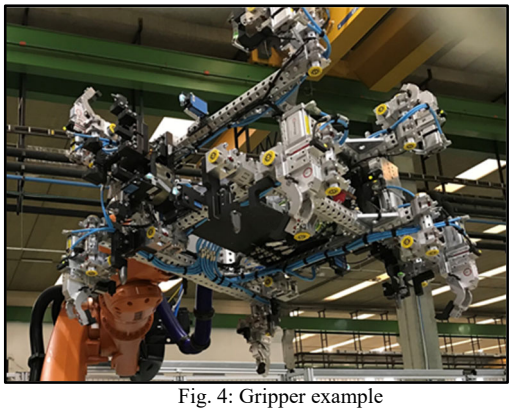

Fig. 4: Gripper example

Once these concepts are established we can state that a locator is the next most important piece after the bodywork. The starting point and always at fixed coordinates is the locator.

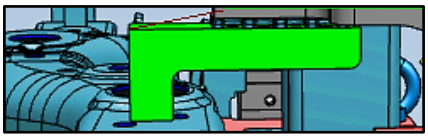

Fig. 5: Locator in 3D CAD space

The locator will always have a material that will go through all the treatment processes, on the one hand in order to protect and not damage the bodywork, and on the other hand because it is positioned closest to the welding point [4].

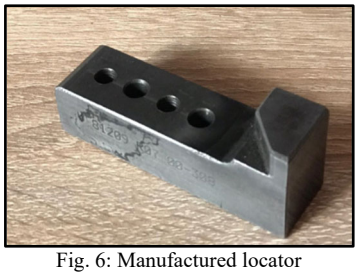

Fig. 6: Manufactured locator

In order to be able to ensure the position of the body in any environment at the required coordinates, the specific locators of the welding or soldering stations will have 2 adjustments; in difficult cases 3 adjustments are also used for this purpose.

Even if the 3D plan does not show welding spatters, one has to also look at it from the perspective of reality, of course taking into account the necessary cables, the presence of the worker or robot and any other elements that need to be fitted at the end. Of course, there are different types of locators. The classification of the locators is based on the station where they are used, that means always in welding areas locators will be used that keep the bodywork fixed and do not melt at the high temperatures determined by the welding process. On the other hand, at a check or marking station you will use a plastic material that just needs to hold the bodywork in a certain position. Of course, there are many requirements that differ from project to project regarding these parts, the information given are the basic rules that are generally valid [5].

Another important aspect is the choice of material, which must meet both the customer's requirements and the possibility of using it in the situation. Generally, in most projects all pieces are burnished to resist to corrosion as much as possible. Also, the locators and pins undergo special operations such as hardening or polishing. Browning is a chemical process that is carried out by immersion and takes place at room temperature [6].

Another important clarification is the cutting operations of the pieces depending on the material used and its dimensions. These processes are also carried out according to the cost and quality of the resulting pieces, but also in terms of cutting time. The most popular and widely used cutting methods are: flame cutting; laser cutting; water jet cutting [7].

In order to be executed in practice, every component and assembly must have a working drawing. A design drawing must meet all the requirements without which it cannot be manufactured.

Spine holes, those which ensure the exact position of any part or assembly when reassembling or modifying parts, dimensions and material-related stamps must be specified and positioned as visibly as possible for the most correct and accurate reading of the part or assembly.

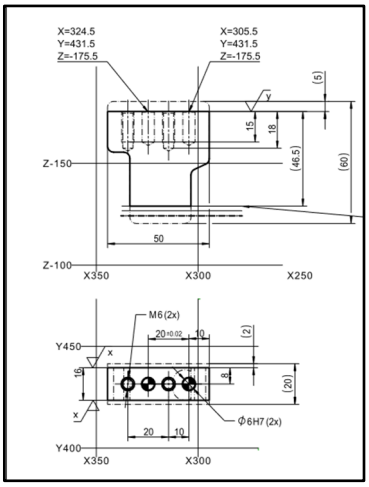

Fig. 7: 2D example

In order to support the above, a parallel analysis between 2 types of locators follows. The C45 locator and the PA6 locator are the protagonists of the paper [8].

The team has chosen the C45 material because it is a non-alloyed steel which suits the properties we need for the marking station to be built. Having this necessary quality, respectively a good machinability, we can position the locator without any problems close to the marking area. High tensile strength and high fatigue strength is one of the main purposes of using C45 material.

Another important reason for choosing this material is that we used in parallel another material called Fibroflex Red which did not prove so resistant to the low heat emitted by the bodywork after laser marking [8].

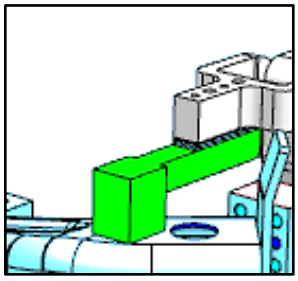
Fig. 8: C45 Locator

The team has chosen PA6 material because it belongs to the thermoplastic material category which meets the needs of the use for the check and marking station where it is going to be used. Necessary qualities such as very high stiffness and hardness; high degree of resistance to breakage and impact; high degree of vibration damping and easy processing possibility led the engineers to choose this class of material called Nylon.

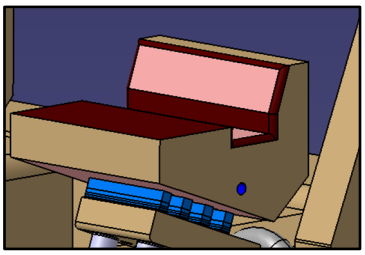
Fig. 9: PA6Locator

Because the thermoplastic material used is easy to manufacture and because the pieces are fixed with screws, we need inserts to protect the locators in adjustment situations, as in the attached figure [8].

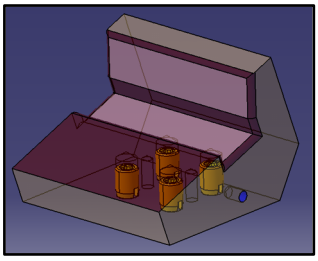
Fig. 10: Inserts example

On the one hand the purpose of the C45 Locator is to keep the bodywork in the same position until the last weld; not to damage the surface of the part and not to overheat the body. On the other hand the purpose of the PA6 Locator is to keep the bodywork in the same position until the last coordinate checked and not to damage the surface of the part that can be painted or not. Essentially both protagonists have the same important goals, but are used in different stations.

In terms of cutting materials into the desired shapes we use two totally different methods. As the name of the pieces makes clear, it is clear that steel will be flame cut [8].

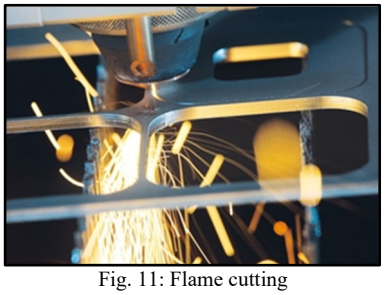
Fig. 11: Flame cutting

However, the shape of the PA6 Locator needs a "cold cutting method" in order not to deform the material. In this regard, for any slightly heat deformable material the water cutting method will be used. Both methods guarantee shapes that conform to the design [8].

Fig. 12: Water jet cutting

As far as the treatments applied to the locators are concerned, they derive precisely from the name. The PA6 locator does not need any treatment because it is a plastic material, but the C45 locator will be subjected to a burnishing treatment for better resistance [8].

Having presented this study, it is important to present the functional stations for which this study was performed.

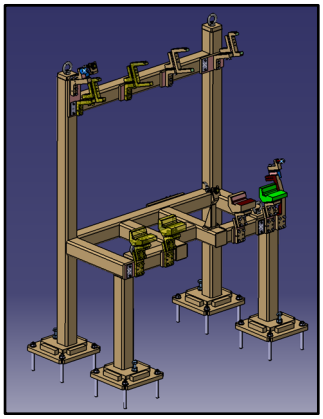

Fig. 13: Checking station

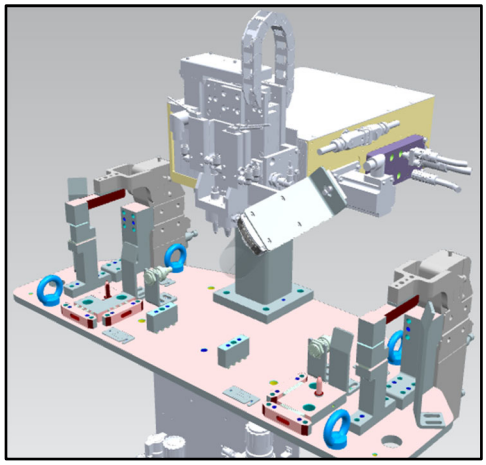

Fig. 14: Marking station

## 5. Conclusions

All the information presented in this paper is in line with reality. The data presented is a summary of several projects that one of the authors has carried out with his work team and is a real success for him as a junior design engineer. The team of engineers also had to make concepts, 3D studies, then the execution drawings of the parts and, finally, the modifications that occurred during or even at the end of the project.

The whole paper is based on the processes that are applied to the parts, starting from the raw material to the finished product to be assembled and used for building the car line.

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