MANUFACTURING PROCESS OF AUTOMOTIVE SHEET METAL PARTS WITH COMPLEX SURFACES

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Rezumat. *Lucrarea are ca obiectiv analiza proceselor care au loc pentru realizarea pieselor de configurație complexă din industria auto și prezentarea fabricației unei astfel de piese.*

Abstract. *The work-paper focuses on the analysis of the processes that take place for the realization of complex configuration parts in the automotive industry and the presentation of the manufacturing process of the part.*

Keywords: Process, Complex configuration, Manufacturing, Automotive parts

1. Introduction

1.1. Manufacturing process

By manufacturing we mean the physical or chemical transformation of materials, substances or components into new products or components through a series of processes.

There are many elements that need to be considered when it comes to manufacturing. A very important factor for increasing productivity and increasing its efficiency is better communication and coordination between all the departments involved, taking into account certain terms such as: the time needed to prepare a production line, reducing production time and effectively reducing product manufacturing time.

A production process is described as the use by raw materials and materials of a type of activity which, after going through such a process, ends up being called a finished product or service [1].

1.2. Manufacturing systems

The manufacturing system is a component part of the production system, which achieves the configuration and final properties of a product. By means of a manufacturing system the chemical or physical transformation of the flows of raw materials and materials is realized by means of the information flows and the energy flows.

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The manufacturing system, like the production system, is traversed by three types of flows, these being material flows, energy flows and information flows.

1.3. Types of manufacturing

The type of manufacture of a product is defined as the relationship between the company and the customer, characterized by the type of availability and specifications of the manufactured products [2]. Thus, three types of manufacturing are distinguished: custom manufacturing, storage manufacturing and mixed manufacturing.

Custom manufacturing is represented by expensive, special products or prototypes. The finished product is not available at the time of ordering and requires a longer leads time. At the time of making such a product, various tests are added to make the piece at a higher capacity and at a lower cost, but also tests to verify compliance with customer requirements for those products. The finished products are not available in a short time, and their cost is higher being established after the product is made [3], [4],[5].

Manufacturing by storage is represented by the less expensive finished products manufactured following a higher demand in large quantities. The products are available for sale immediately, at an already established cost.

Mixed manufacturing derives from custom manufacturing and is represented by the reduction of deadlines. The products are manufactured in such a way that their personalization is carried out at the time of order, by assembling manufactured modulated subassemblies.

In the case of the machine building industry, a manufacturing system must have a minimum structure containing at least four lower subsystems, namely the logistics subsystem, the processing subsystem, the control subsystem and the control subsystem.

2. Automotive subassemblies and their manufacturing process in automotive industry

A subassembly is a group of parts or components that make up a component part of a machine or technical system acting within them as a separate functional unit.

The main processes used in the manufacture of metal subassemblies are those obtained by stamping and welding processes.

2.1. The stamping process

The stamping process is the process of plastic deformation of a sheet of small or medium thickness to obtain a body, a piece that has a cavity. Deformation without preheating the body is called cold stamping, which is used especially for relatively thin bodies. If the body is preheated, the deformation is called hot stamping, a method used especially for bodies with large thicknesses or high hardness, in order to obtain bodies with a simple shape, without sharp angles.

When it comes to stamping a part, the central part of the flat blank forms the bottom of the part, and its annular peripheral part forms its side walls.

Excess material from the annular peripheral is to be redistributed, a process related to the tensioning of the material specific to embossing, which consists of a radial stretch and a tangential compression.

According to the geometric shape following the stamping process, the parts obtained are divided into three main groups: revolution parts, parallelepiped parts (fuel tank cap) and complex shaped parts (oil bath cap).

The stamping process, depending on the type of energy used, is differentiated into:

• classic process, a process that takes place on ordinary presses where the mechanical energy developed by the press is used;

• special process or unconventional process that uses electrohydraulic, electromagnetic energy, energy that is developed by burning various explosives or detonating gases.

2.2. Welding process

The welding process is the joining of two or more materials. The materials used in this process are metallic or thermoplastic materials, using heat or pressure with or without the additional help of additives.

When the joint is made after the phase change of the material (melting of the material), the process is called melt welding. This melting welding process is specific to the area called the thermally influenced zone, in which microstructural changes can occur which can lead to reduced strength of the welded metal product. Thus, it is recommended that this area be as small as possible so as not to affect the mechanical properties of the two materials to be joined by welding.

The joint is thus provided by the weld bead, which is a solidified material that helps to achieve the continuity of the crystalline structure of the two materials.

Thus, the welding process is a non-removable assembly between two or more parts by pressure, shock or heating.

The advantages of the welding process are:

• does not require highly specialized training;

• there are no loud noises - low price;

• complex parts can be made;

• can be automated.

Disadvantages of welding:

• the verification of the welding device is done with special devices;

• ultraviolet rays appear that attack the human body;

• sealing resistance may occur;

• internal stresses appear in the area of the welding carburetor that can give rise to cracks;

• welding machines are required.

Welding processes used in the manufacture of automotive subassemblies

a. Electric arc welding process

Electric arc welding is all the process of electric fusion welding (low pressure, high temperature), in which the welded cord is formed by the joint solidification of the base materials and the additive material.

b. SEI procedure (Coated Electrode Welding)

It is represented by the traditional welding process, which is also known as electric manual welding. Effective welding is performed using a voltage / current source.

The voltage for this process is applied to an electrode. The part to be passed through the welding process is connected to the ground pole of the voltage source. By bringing the electrode closer to the grounded part, the electrical circuit is closed by a spark.

The intensity of the electric current is adjustable and is what determines how hard the material to be welded will penetrate. In carrying out this process, the filler material used is supplied by the welding electrode. Electrode welding (originally coal) was improved by Kjellberg in 1902 and coated electrode welding was achieved.

c. Welding process automatic under flow layer

It is an automated method of electric welding, in which the existing powder coating on the surface of the electrode is replaced with a fine powder that is sprinkled before the electrode passes on the surface of the material.

d. MIG / MAG procedure

Represents the process of improving the SEI welding process. Although the welding process is similar, the welding machines as well as the welding gun differ significantly. The main difference is the introduction of shielding gas at the welding site, which replaces the electrode shell. The protective gas has the role of protecting the welding area. Due to the fact that most metals react with air to form oxides that can severely damage the mechanical properties of the joint, it is necessary that there is no air in the immediate vicinity of the welding process. This is done through the shielding gas. This gas can be of two types, MIG (Metal Inert Gas) or MAG (Metal Activ Gas). Inert gases such as argon, helium or mixtures thereof are used in the welding of reactive metals and alloys such as copper, aluminum, titanium or magnesium.

In the case of MIG / MAG welding processes, the electrode used is the so-called welding wire. This wire is pushed into the bath by a feed system. In the vicinity of the bathroom, before the mechanical contact, it passes through a current nozzle, from which electricity is taken from the current source necessary to create the spring and melt the material. The final result is welded seams that have a high quality, high deposition rates and low splashing, all at welding speeds that frequently reach 3 ~ 4 m / min. In the case of manufacturing, when welding thin sheets (2–3 mm), the TANDEM process can even ensure speeds of up to 6 m / min. When welding medium / thick sheets, the dimensions of the corner joints of up to 8 mm are obtained.

e. WIG (TIG) procedure

Welding process with non-fusible electrode in inert gas medium or Wolfram Inert Gas process is another variant of SEI welding.

This process involves the arc that burns between a tungsten electrode and the part that is being welded. This electrode has only the role of electrode and is not represented by a role of filler material. Hence the fact that it wears out very slowly compared to a coated electrode.

The WIG process melts the two components to be welded. In some cases, it is necessary to use an additive material to achieve a joint with better geometry and mechanical properties. The advantage of this process is that it can be used on most weldable materials made of carbon and alloy steels, aluminum, nickel, copper or their alloys. In order to weld such materials, an inert environment is required, in which air or specially designed protective gas nozzles cannot penetrate.

3. Case Study

For the case study of the processes underlying the realization of complex configuration parts, this paper emphasize the manufacturing flow of some paired parts, which include several operations (Fig. 1, Fig. 2, Fig. 3), among which:

• stamping;

• pressure welding;
• spot welding.

The pieces represent a set of four semi-finished products joined by spot welding. Semi-finished product 1 (Fig. 3) includes pressing and welding operations. The name of the pressing operation is BUTTONING-CUTTING-DRILLING-MARKING and is carried out on an 800 t automatic press.

Fig. 1. Raw material coil.

Fig. 2. Stamping die.

Fig. 3. Semi-finished product 1.

After the previous operation, an intermediate storage follows until the next operation, namely the pressure welding of an M6 nut (Fig. 4, Fig. 5).

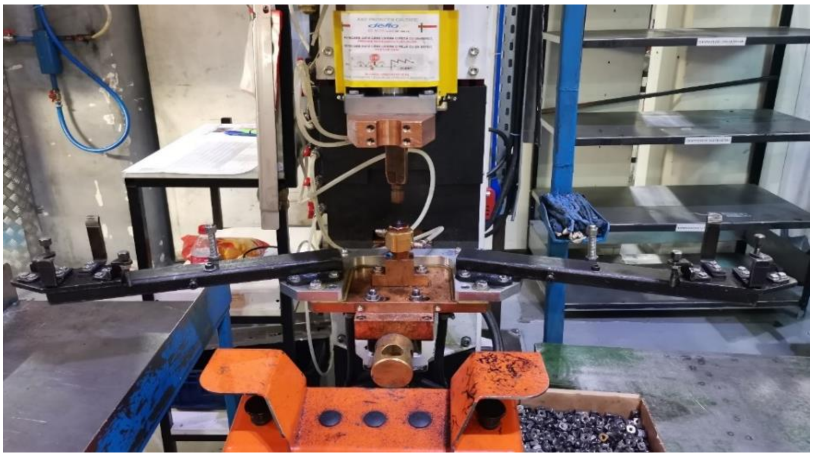

Fig. 4. Pressure welding equipment.

Fig. 5. Semi-finished product 1 with welded nut.

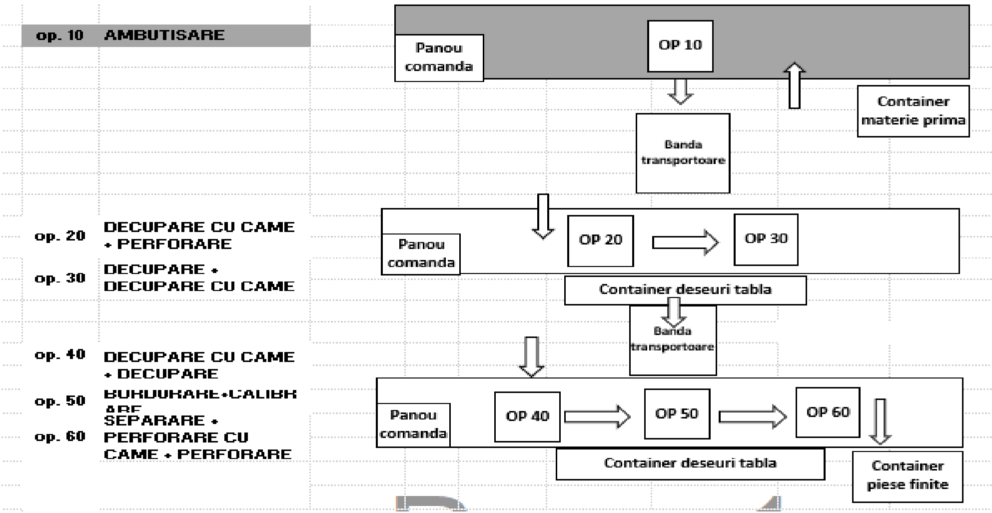

Fig. 6. Flow chart.

To obtain Semi-finished product 2 we have the following flow chart (Fig. 6, Fig. 7):

Fig. 7. Semi-finished product 2.

The semi-finished product 3 is the result of the CUTTING-MARKING-PERFORATION operation on a 600t automatic press (Fig. 8).

Fig. 8. Semi-finished product 3.

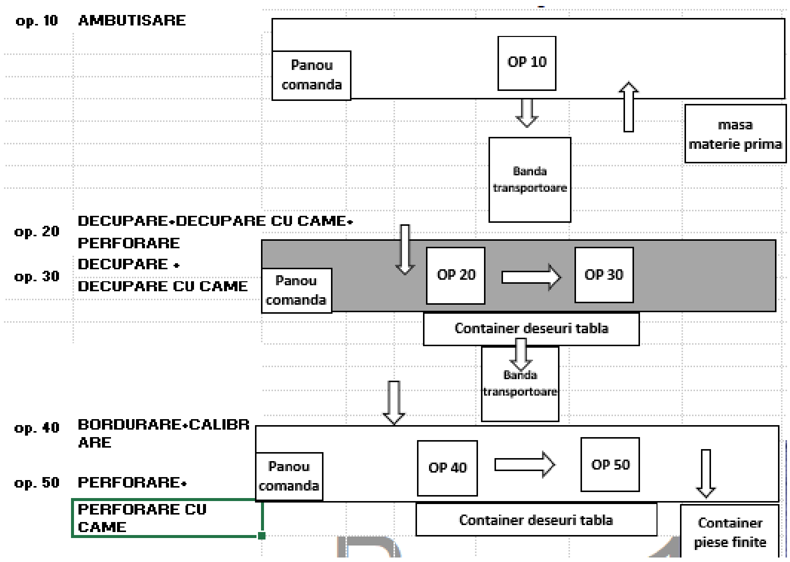

Fig. 9. Flowchart Semi-finished product 4.

After the previous operations, an M6 screw is pressure welded to the semi-finished product 4 (Fig. 9, Fig. 10).

Fig. 10. Semi-finished product 4 with welded screw.

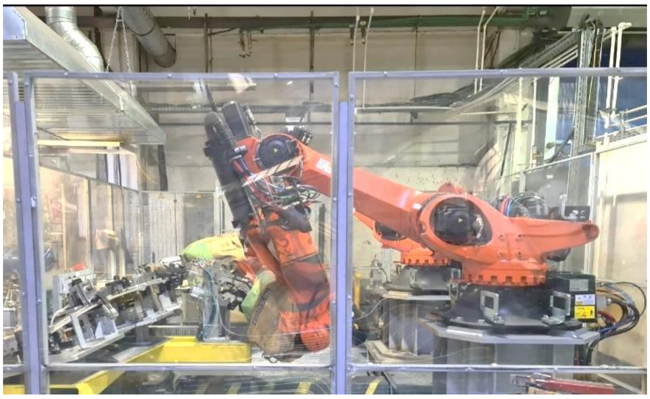

Fig. 11. Spot welding robot

Fig. 12. Finished product.

Finally, to make the assembly parts, the 4 semi-finished products are welded through 19 welding points (Fig.11, Fig. 12).

4. Conclusions

Making parts of complex configuration requires a well-developed and state-of-the-art manufacturing technology.

By focusing on technological processes, we can improve the quality of the parts made, productivity, profitability, etc.

The quality of the parts is the mirror of the well-executed processes.

R E F E R E N C E S

[1] Barbulescu, C., *Metode si tehnici de optimizare a organizarii productiei în unitatile industriale* (Ed. Politica, Bucuresti, 1978).

[2] Elmaghraby, S.E., *Proiectarea sistemelor de productie* (Ed. Tehnica, Bucuresti, 1968).

[3] Spanțu R. *Planificarea și organizarea producției* (Editura Mistral Info Media, Bucuresti, 2011)

[4] Bohosievici, Cazimir, *Strategia de fabricație* (EdituraTehnica-Info, Chişinău, 2001).

[5] Nițu E., Belu N. *Ingineria și Managementul sistemelor de producție - Organizarea sistemelor de producție* (Pitești: Editura Universității Pitești, 2015).