INFLUENCE OF SHAPE PRODUCT DESIGN IN THE MANUFACTURING PROCESS

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Abstract: Paper shows how much renewing design products influence the manufacturing process. The variety of products, low manufacturing cost and high quality of products describes the market situation today and for that the competition in marketplaces requires quickly renew existing products and develop new ones. Product design has a direct effect on the cost of a product and pays an important role in the production process. There are many articles that treat this subject putting the question ‘’ How much a new product design changes the manufacturing process and the cost? ’’. In this purpose we give an example to illustrate it and to put in evidence the changes made in the production process.

Key words: design, manufacturing process, flexibility, cutting die.

1. INTRODUCTION

Design is integrated in product and is not only an aesthetics element attached. The process engineering is connected with product design. Production is a process whereby raw material is converted into semi finished products and thereby adds to the value of utility of products, which can be measured as the difference between the value of inputs and value of outputs [1]. The main objective of production is to produce the goods and services demanded by the customers in the most efficient and economical way. Market interest for firms and companies is maintained by launching new products. The change level depends on the modification and transformation scale, being placed on a product after studies, research and design activities [2].

The manufacturing infrastructure required to support production: function support, manufacturing planning and control systems, manufacturing system engineering, quality assurance and control, clerical procedures, work structuring and organizational structure [3]. Production process converts a set of inputs into a set of desired outputs.

2. PRODUCT DESIGN

Engineering design is the result of someone trying to do a task more quickly or efficiently. Design activity occurs over a period of time and requires a step-by-step methodology [4].

Industrial design is a creative activity of aesthetic and useful products which can be applied at different levels:

Surface Design - involves the coverage with ornaments, textures, decorative elements etc.

Shape product design - involves changing outside design of an existing product or one passed to a new product and that interior mechanism remains the same.

Product design - involves product conception along with the technical design. In this Process are involved all firms departments.

Radical design - involves a radical conception, a break with tradition.

Radical design products present a greater risk than the traditional ones, because users may prefer traditional products and in this context the financial risk is high.
Different disciplines start communicating and collaborating with each other to optimize their sub-component design considering the whole system design requirements [4].

They have a significant contribution in technical and aesthetic success of products. Because the product design is dictated by the market demand, in 2011, with the expansion of marketplace, ARCTIC received orders for a new product with new design, and therefore had to bring some changes to the tools of the line to process outer cabinet door. It is an important decision and therefore the company pays the effort, time, energy and attention in order to get the best results. To achieve this objective it took to change some active parts of drawing press of the line OLMA according to the new design of cabinet door.

3. SHEET METAL ROLL RECEPTION

One of the raw materials used in the manufacturing of refrigerators is the sheet metal cold or hot roll with different concentration in carbon. At the reception of raw materials is preparing a checklist of quality that is achieved by following four steps:

Step 1: Identification of the product and the provider is done by: product and supplier identification, identification data sheet, documents that accompany the product, the certificate of conformity, test certificate, the reception data sheet for raw materials.

Step 2: Check delivery. Personnel in charge checking the way it was transported, packaging integrity and check that it has appropriate label. If these conditions were not respected is announced the responsible, is mentioned in the transport document the findings and photos will be made for their support.

This step follow some characteristics which must respect a limit allowed under the technical documentation:

C1 (aspect);
C2 (dimension);
C3 (tensile strength);
C4 (elongation on break)

Step 3: Presentation of results.
If at last one control characteristic does not fall within the tolerance field, the check is repeat with a new sample. If the result is accepted, the personnel stick the green label and announce the staff that the cargo is received. In case the result is not accepted, a red label is sticks and is call the personnel of the department purchases and the provider. Denied receiving material is stored in a place specially designed and marked. Following the results obtained at the reception, raw materials are recorded in a database according to their use.

Step 4: The sheet metal rolls are arranged by category in the warehouse.

4. CUTTING SHEET

From the warehouse the sheet metal roll is transported to GABELLA line, which cuts the board to the desired format (length parameter is determining) depending on the final product design. Sheet metal is placed on drum machine were it catch and fix. After fixing and catching sheet metal, will be enter the following data into numerically controlled machine: thickness and length, smoothing parameters and the number of the sheet metal which should be cut.

![Fig. 3. Layout of the line GABELLA](image)

During all this process the raw material passes through three steps.
Step 1: Sheet metal pass through a roller system in order to remove all existing deformations.
Step 2: Cutting sheet metal to desired length.
Step 3: represents the end of the whole process were already the cut sheet metal is run-off on a band carrier and placed on special supports.

After all this debited sheet metal it is transported to the processing lines or stored in specially designed shelves. On the production lines we encountered two sheet metal processing machines, which perform the following operations: stamping, bending, cupping, all depending on the product design. Because the heading and end of roll has small defects due of transport, they are cut to a certain size and used to the parts without commercial aspects of the refrigerators.

5. FLOW SHEET METAL PROCESSING

Line processes are designed to produce a large volume of a standardized product for mass production. They are also known as flow shops, flow lines, or assembly lines. With line processes the product that is produced is made in high volume with little or no customization [5].

A process flowchart is used for viewing the sequence of steps involved in producing the product, and the flow of the product through the process. It is useful for seeing the totality of the operation and for identifying potential problem areas.

The debited sheet metal is taken from warehouse and is distribute at processing lines OLMA and BERETA, were cabinet and door are machining for refrigerators.
• BERETA line. On this line are produced 3400 lateral panels per day, the time between two parts is 30 seconds. The sheet metal bending is done with two bars. Also on this line is produced a certain range of doors.
• OLMA line. On this line the sheet metal bending is done with rollers. Compared with BARETA, the line produced 1800 lateral panels per day; the time between two parts is 20 seconds. Like in the case of BARETA line and here is produced a range of doors and the upper part of cabinet from
0.4 sheet metal, with a production of 4800 parts per day.

Fig. 4. Flow sheet metal processing

Fig. 5. Layout and manufacturing flow

1. Sheet metal rolls warehouse;
2. GABELLA line;
3. OLMA processing line doors;
3.1. BERETTA processing line doors;
4. Processing line OLMA lateral panels
4.1. Processing line BERETTA
5. Electrostatic painting plant WAGNER / LEC

6. NEW DESIGN CHANGES

The request was to realize the new model GRAM/AMICA. For this it was necessary to modify the active parts of bending die display from existing OLMA line, according to the new design of door. To process OLMA door, cupping is done by means of cutting bending die. This process is necessary to achieve a cutting on the cabinet door surface for positioning the electronic display that shows the working parameters of the cooling device, respectively, the temperature in freezer and cooler. Cutting and cupping for display door is performed through some dies by bending die.

Fig. 6. The new design of door

The request for change was proposed of the department Tools Manufacturing and Design Department to be designed and executed, according to the procedure of execution tools. Following the design of new bending die, the clamping system and other elements have not been modified.

Fig. 7. Cutting die changes
The only changes that were made to give the new shape of display are: punching, bolster plate and bending dies. To execute correctly the modified parts and to avoid trouble in assembling the new die was taken into account the some necessary data that are listed in the tables below.

### Table 1. Tolerances in execute punching and active plates

<table>
<thead>
<tr>
<th>MATERIAL THICKNESS (mm)</th>
<th>MANUFACTURING TOLERANCE (mm)</th>
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<tr>
<td></td>
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<tr>
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<td>12.0</td>
<td>0.240</td>
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6.1. Conditions that must be fulfilled by cutting die

Produce the piece by cold plastic deformation consist of transforming the initial shape of the black piece in a geometric shape corresponding to the proposed design configuration.

Cutting die are complex tools, which often perform one operation or one type of piece in a certain range of production [6]. Designing cutting die involvs generally to satisfy certain conditions, as follows:

- High accuracy of the machined parts;
- Cost as low as possible;
- Execution as easy is possible in a time as low;
- High reliability in operation.

Establishing the optimal technological process requires fulfillment of all conditions mentioned earlier depending on the size and production volume proposed. In conclusion, optimal selection of constructive solutions is related to the series of manufacture which will be determined depending on the type of technological process.

In the work piece machining by cold plastic deformation it is taken into account the production time depending on the number of parts and tool waiting time between two or more uses.

Adapting cutting die to the new conditions created by modifying the geometric shape or degree of complexity of a piece is achieved by reassembling the appropriate elements imposed by the geometrical shape of the active parties.

The degree of complexity of a cutting die depends of the size and configuration parts as well the shape of the blank. Their rigidity is not affected by the system assembly and fixation of various elements because they are provided with safety systems against desassembling.

In this way is ensured a appropriate stability of exploitation conditions of cutting die with modular elements required by the parts manufacturing process. The use of modular tools is recommended when the pieces have high dimensional and shape variations and production knows a continuous fluctuation due to the assimilation of new products or modernization of production.

In the design phase of active elements it started from the size of bolster plate and punching, taking into account the fundamental sketch of the tool. After performing calculations of strength are determinate the conditions to assembly the elements.

Execution of final dimensions of the active elements is closely in line with the overall tool.
6.2. Principles of designing cutting and forming die

Designing cutting dies is based on shape and size of workpieces, being in close contact with the production volume required.

When designing punches and dies should had assured technical conditions referring to manufacturing parts precision, possibility of easily realise the all components parts or the adaptation of technological forms, high productivity, low cost, durability and high reliability in operation.

In terms of functional mode the active parts, punching and bolster plate, must have the following conditions:

- To ensure proper positioning of the punching in relation to the active area of the bolster plate;
- The construction of the two elements must be rigid and to provide stability in operation;
- To allow the adoption of reciprocal positioning and fixing the active elements, according to the conditions imposed by the scheme of cutting the workpiece;
- To allow large possibilities to assemble on the supports of punching and bolster plate elements for positioning, for stop, driving and fixing of the workpiece;
- To create favorable conditions for removing the waste material from the blanking and the elimination of this or of the piece trough bolster plate of the cutting die;
- The fits that are between body-punch and the bore of the bolster plate and punching shall be provided with processing possibilities of tolerances;
- Dimensions of the support for bolster plate and punchings have to be chosen so as to allow active elements assembly which included cross-section in a range of values determined by the group dimensions of the parts belonging to a geometric families;
- The supports of bolster plate and punching must provide opportunities for quick installation and disassembling of active elements and their own weight have to be reduced.

7. CONCLUSION

Given the new aesthetic design data for a refrigerator we will expose all the transformation processes of raw materials starting from delivery to the end of manufacturing process. Renewing product design influence some devices of line production, but not the factory layouts because a new one can be expensive and cause disruption as it is installed.

The layout consists of blocks for different departments and areas. The plan it is used as a guide to show precisely where everything goes. We will see in the same time that manufacturing process is similar to a chain composed of interconnected and well defined cells. The problem that designers must solve in this case is to redesign an existing product to satisfy the new market requirements.

11. REFERENCES