ECONOMIC EFFICIENCY OF THE TOTAL COST OF OBTAINING THE PRODUCTION BY MODIFYING SOME CHARACTERISTICS OF THE INITIAL PREFORM (I)

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Abstract. *This paper presents a real situation in which a manufacturer of parts used in the car industry has tried to honor an order coming from a customer by optimizing the total cost of producing output. Based on the analyzes performed on the two categories of cost components, it can be concluded that just obtain a reduction from the total cost of raw material optimization.*

Keywords: *costs, production, economic efficiency, semi manufactured*

1. INTRODUCTION

A manufacturer of parts used in the car industry has received an order from a client to achieve a number of parts 300 000 per year, pressed parts. To meet this order, the manufacturer has initiated production process design.

The first step was to design product - process, which aims feasibility of the final product – that pressed piece – which includes the design pressed piece of operations necessary to obtain the final shape and optimize quality and cost objectives of the range of drawing [4].

This process browse the following steps:

- Simulation cupping;
- Develop fiche of manufacture;
- Agreement process for molds;
- Agreement for the piece technical drawing prototype.

Manufacturing fact file is a document that provides the information necessary to develop a pre-game and marks before the molds design, observing the number of operations allowed on the manufacturing line presses.

Archiving files and study process is the GDG (geometric data management) – using Catia software.

Writing fiche manufacturing is done using a format A0 plan, which describes the operations to be completed in sequential order transformation of the raw material - of steel sheet – in finished piece.

To achieve the finished piece – a workpiece that was analyzed – it obtain the following namely:

1. A deep drawing operation.
2. A cutting operation + perforation.
3. A cutting operation + hemstitching + perforation.
4. An operation of bending + calibration.

Technological line is obtained the landmark study includes a total of four presses, that is one press DE and three presses SE.

The blank the initial used to obtain a reference point in the order by the customer is in the form of an isosceles trapezoid with dimensions of 970 x 1550 x 1360 [mm] - Figure 1.

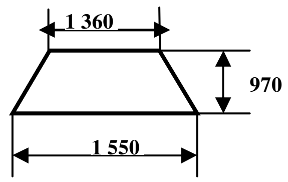


Figure 1. The initial blank used

Mechanical presses used in the deep drawing taking place in the pressing section are of two types:

- Mechanical presses with simple effect – marked symbol SE,
- Mechanical presses with double effect – marked symbol DE.

Shaping is processing operation by cold plastic deformation performed in order to transform a blank piece cava plan, in order to increase the depth and transverse dimensions decrease.

Deep drawing matrix is composed them - Figure 2:

- a piercer – which is fixed to the ram pres,
- matrix itself - that comes on the press table and which is provided with centering holes for quick attachment masspress,
- prestabla – which is fixed to the upper plateau of mobile press and representing the upper subassembly, the roletightening material to cupping. The support may include inferior matrix, as in the case of unitary construction.

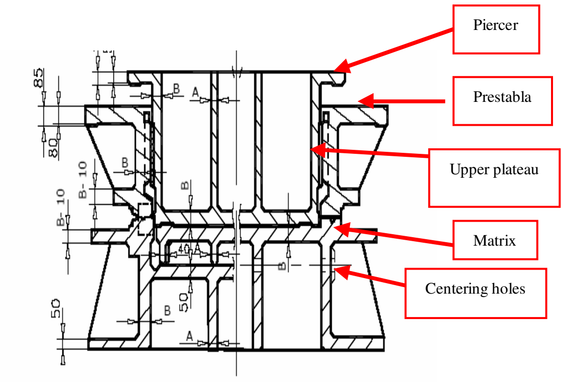


Figure 2. The principle scheme of matrix deep drawing

Pruning is the operation by cutting material detachment after open or closed exterior contour and resulting change its shape and size in order to obtain a piece.

If workpiece studied cutting operation will be performed on a mold trimming-perforation as in Figure 3, which has in its composition:

- a punch,
- the frame upper and inferior support frame,
- a presser (removed) - between it and the upper support frame there is a game guide,
- brooches holding presser,
- blades superior trimming.

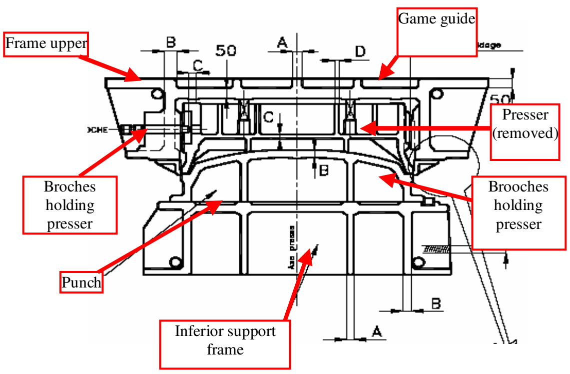


Figure 3. The principle scheme of cutting, perforation matrix

The calibration operations of bending and pulling operationsare those materials where the final radius of the finished part.

If workpiece study, calibration and bending operations shall take place on a matrix-bending calibration as in Figure 4 and is composed them:

1 – a inferior frame

2 – a lower punch

3 – a higher frame

4 – presser

5 – calibration blades

6 – bending blades

7 - a upper part of the gas springs

8 – expulsions

9 – brooches retention

10 – path of balancing the pusher

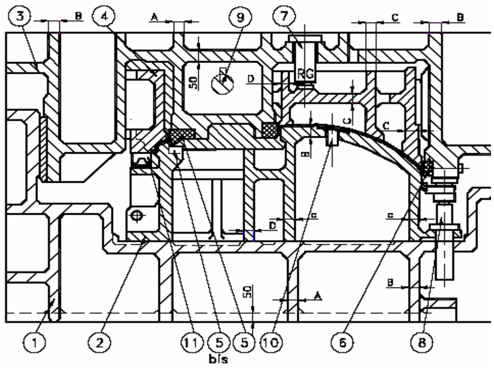


Figure 4. The principle scheme of calibration-bending matrix

2. DETERMINATION OF TOTAL COST OF OBTAINING PARTS PRODUCTION - CT

Manufacturer has to honor an order for 300 000 parts/year.

The total cost of production obtaining landmarks - denoted by CT - is the sum of the total cost of the raw material - C_{MP} and production cost of obtaining landmarks - C, according to the formula 1:

$$CT = C_{MP} + C \quad (1)$$

Where:

C_{MP} - total cost of the raw material

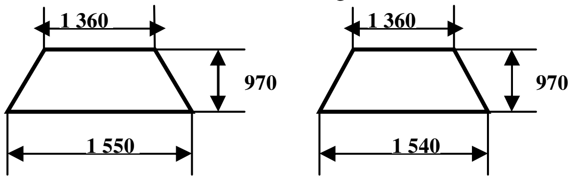
C - production cost of obtaining landmarks

In order to achieve an optimization of the total cost of obtaining the production of parts from analyzes performed on the two categories of cost components, it was concluded that only can get a discount from the total raw material cost optimization [1].

This reduction in raw material costs is achieved from optimization of workpiece dimensions used to obtain parts of the command given by the client.

Thus, the blank may be optimized by one of the size, namely the length - from the value of 1550 [mm] to the value of 1540 [mm], so that this change does not affect the obtain the final workpiece.

The dimensions of the initial preform 970x1550x1360 [mm] and the blank optimized dimensions 970x 1540x1360 [mm] are shown in Figure 5, a and b.



a. the initial blank **b. the optimized blank**

Figure 4. The blank used in the initial and optimized

Next, calculate the total cost of obtaining the production of parts in the two situations – namely of the blank non-optimized initial situation, namely the final statement of the blank optimized, in order to determine the economic efficiency of modification products.

Economic efficiency [3]change on the overall cost of obtaining goods production - denoted by K_{CT} - is calculated according to the formula 2:

$$K_{CT} = CT_0 - CT_1 \qquad (2)$$

Where:

CT_0 - the total cost of obtaining the production of parts for non-optimized blank

CT_1 - the total cost of obtaining the the production of parts for optimized blank

3. DETERMINATION OF TOTAL COST OF PRODUCTION OF PARTS FOR OBTAINING A BLANK NON-OPTIMIZED - CT_0

The total cost of production [2] for obtaining non-optimized blank - denoted by CT_0 - is the sum of the total raw material cost non-optimized - C_{MP-0} – and the cost of obtaining production landmarks - C, according to the formula 3:

$$CT_0 = C_{MP-0} + C \qquad (3)$$

Where:

C_{MP-0} - the total raw material cost non-optimized

C - the cost of obtaining production landmarks

3.1 The total raw material cost non-optimized C_{MP-0}

For the production of pieces/year - denoted by PT, the total cost non-optimized material – noted $C/_{MP-0}$ - is calculated by formula 4:

$$C_{MP-0} = C/_{MP-0} \times PT \qquad (4)$$

Where:

$C/_{MP-0}$ - unit cost non-optimized of raw material

PT - the production of pieces/year

PT = 300.000 [piece]

Unit cost of raw material non-optimized $C/_{MP-0}$ is calculated from the mass of non-optimized blank table - denoted by M_0 – and raw material price paid for a piece of metal sheet from which the blank is made - denoted by P, by formula 5:

$$C/_{MP-0} = M_0 \times P \qquad (5)$$

Where:

M_0 – the mass of non-optimized blank table [kg / piece]

P – raw material price

P = 1,43 [€ / Kg]

To calculate the mass of non-optimized blank table that are made up the landmark study - denoted by M_0, we using the formula 6:

$$M_0 = V_0 \times \rho \qquad (6)$$

Where:

V_0 – non-optimized volume of the blank that are made up the landmark study [m^3]

ρ – density of the material [kg / m^3]

ρ = 7,85 [kg / m^3]

Non-optimized volume of the blank that are made up the landmark study V_0 is calculated by formula 7:

$$V_0 = \{[(L_0 + l_0) \times h_0\,] / 2\} \times g_0\,[m^3] \qquad (7)$$

Where:

g_0 = non-optimized thickness of the blank

g_0 = 0,65 [mm]

L_0 = non-optimized length of the blank

L_0 = 1 550 [mm]

l_0 = non-optimized width of the blank

l_0 = 1 360 [mm]

h_0 = non-optimized height of the blank

h_0 = 970 [mm]

Substituting the values given in formula 7 and obtained for non-optimized initial blank:

V_0 = {[(1 550 + 1 360) x 970] / 2} x 0,65

V_0 = 917 377,5 [mm^3] = 0,917 377 5 [m^3]

We further calculate the mass non-optimized blank table that are made up the landmark study - denoted by M_0, replacing the values obtained in formula 6:

M_0 = 0,917 377 5 [m^3] x 7,85 [kg / m^3]

M_0 = 7,2 [kg]

Substituting in formula 5 and get the unit cost of raw material non-optimized $C/_{MP-0}$:

$C/_{MP-0}$ = 7,2 [Kg / piece] x 1,43 [€ / Kg]

$C/_{MP-0}$ = 10,296 [€ / piece]

Substituting in formula 4 and get the total cost of raw material non-optimized C_{MP-0}:

C_{MP-0} = 10,296 [€ / piece] x 300.000 [piece]

C_{MP-0} = 3 088 800 [€]

3.2 The production cost of obtaining landmarks - C

The production cost of obtaining landmarks C is calculated by the formula 8:

$$C = C_U \, x \, PT \qquad (8)$$

Where:

C_U - total unit cost of production of workpiece study

PT - the production of pieces/year

In a section - regardless of its specificity – department costs C_S consist of:

- direct labor costs – denoted $Ch._{DFM}$
- indirect labor costs – denoted $Ch._{IFM}$
- indirect production costs – denoted $Ch._{IP}$ – maintenance materials, for benefits outside purchases materials, tooling procurement for purchases outside SDV benefits, energy and fluids (electricity, gas, oil, water), for supplies (oil, production equipment), etc.
- amortization expenses – denoted $Ch._A$ – machinery and buildings.

Therefore, the total cost of a department C_S will be calculated using the formula 9:

$$C_S = Ch._{DFM} + Ch._{IFM} + Ch._{IP} + Ch._A \qquad (9)$$

For this case, in the manufacturing line where the landmark study is obtained, we have the following types of costs:

- its own production costs – denoted C_P – are specific costs pressing section where to get the landmark study,
- cost-support centers - these are costs divisions: fabrication – denoted C_F, quality – denoted C_C, logistics – denoted C_L, maintenance – denoted C_M.

A. Own production costs – C_P

For a number of directly staff productive ND = 34 persons and a number of indirectly staff productive NI = 3 persons, production costs consist of:

- $Ch._{DFM}$ = 12 673 137,18 [RON]
- $Ch._{IFM}$ = 871 327,42 [RON]
- $Ch._{IP}$ = 3 288 028 [RON]
- $Ch._A$ = 6 658 256,7 [RON]

Therefore, their own production costs C_P will be calculated by applying the formula 9:

C_P = 12 673 137,18 + 871 327,42 + 3 288 028+

+ 6 658 256,7

C_P = 23 490 749,3 [RON]

B. Cost of FABRICATION – C_F

For a number of directly staff productive ND = 12 persons and a number of indirectly staff productive NI = 15 persons, costs of FABRICATION C_F consist of:

- $Ch._{DFM}$ = 244 919,26 [RON]
- $Ch._{IFM}$ = 533 045,5 [RON]
- $Ch._{IP}$ = 9 370 879,8 [RON]
- $Ch._A$ = 4 274 436,4 [RON]

Therefore, costs of FABRICATION C_F will be calculated by applying the formula 9:

C_F = 244 919,26 + 533 045,5 + 9 370 879,8 +

4 274 436,4

C_F = 14 423 280,96 [RON]

C. Costs of QUALITY – C_C

For a number of directly staff productive ND = 1 person and a number of indirectly staff productive NI = 1 person, costs of QUALITY C_C consist of

- $Ch._{DFM}$ = 376 598,6 [RON]
- $Ch._{IFM}$ = 517 864,41 [RON]
- $Ch._{IP}$ = 189 061,61 [RON]
- $Ch._A$ = 213 721,82 [RON]

Therefore, costs of QUALITY C_C will be calculated by applying the formula 9:

C_C = 376 598,6 + 517 864,41 + 189 061,61 +

+ 213 721,82

C_C = 1 297 246,44 [RON]

D. Costs of LOGISTICS – C_L

For a number of directly staff productive ND = 5 persons and a number of indirectly staff productive NI =4 people, costs of LOGISTICS C_L consist of:

- $Ch._{DFM}$ = 372 726,36 [RON]
- $Ch._{IFM}$ = 2 466 602,1 [RON]
- $Ch._{IP}$ = 164 401,4 [RON]
- $Ch._A$ = 106 860,91 [RON]

Therefore, costs of LOGISTICS will be calculated by applying the formula 9:

C_L= 372 726,36 + 2 466 602,1 + 164 401,4 +

+ 106 860,91

C_L= 3 110 590,77 [RON]

E. Costs of MAINTENANCE – C_M

For a number of directly staff productive ND = 0 and a number of indirectly staff productive NI = 4 persons, costs of MAINTENENCE C_M consist of:

- Ch. $_{DFM}$ = 0 [RON]
- Ch. $_{IFM}$ = 1 150 809,8 [RON]
- Ch. $_{IP}$ = 2 022 137,22 [RON]
- Ch. $_A$ = 435 663,71 [RON]

Therefore, costs of MAINTENANCE C_M will be calculated by applying the formula 9:

C_M= 0 + 1 150 809,8 + 2 022 137,22 + 435 663,71

C_M= 3 608 610,73 [RON]

Further, the total unit cost of obtaining workpiece studies C_U will be obtained by using its own production unit costs $C_{U/P}$ and unit costs of support centers - for the unit costs of FABRICATION $C_{U/F}$, QUALITY $C_{U/C}$, LOGISTICS $C_{U/L}$, MAINTENENCE $C_{U/M}$ using formula 10:

$$C_U = C_{U/P} + C_{U/F} + C_{U/C} + C_{U/L} + C_{U/M} \text{ [RON / buc.]} \quad (10)$$

Therefore, unit costs of a departament $C_{U/S}$ will be calculated using the formula 11:

$$C_{U/S} = \text{Unit cost}/_{DFM} + \text{Unit cost}/_{IFM} + \text{Unit cost}/_{IP} + \text{Unit cost}/_A \text{ [RON / buc.]} \quad (11)$$

Where:

- unit costs of direct labor – denoted Unit cost / $_{DFM}$
- unit costs of indirect labor – denoted Unit cost / $_{IFM}$
- unit costs of indirect production – denoted Unit cost / $_{IP}$
- unit costs of amortization – denoted Unit cost / $_A$

Thus for:

A). Own unit production costs $C_{U/P}$ is composed of:

- Unit cost / $_{DFM}$ = 9,178 [RON / piece]
- Unit cost / $_{IFM}$ = 0,701 [RON / piece]
- Unit cost / $_{IP}$ = 1,949 [RON / piece]
- Unit cost / $_A$ = 3,947 [RON / piece]

Applying Formula 11, own unit production costs $C_{U/P}$ will be obtained:

$C_{U/P}$ = 9,178 + 0,701 + 1,949 + 3,947

$C_{U/P}$ = 15,775 [RON / piece]

B). Unit cost of FABRICATION $C_{U/F}$ is composed of:

- Unit cost / $_{DFM}$ = 0,047 [RON / piece]
- Unit cost / $_{IFM}$ = 0,194 [RON / piece]
- Unit cost / $_{IP}$ = 5,556 [RON / piece]
- Unit cost / $_A$ = 2,533 [RON / piece]

Applying Formula 11, the unit cost of FABRICATION $C_{U/F}$ will be obtained:

$C_{U/F}$ = 0,047 + 0,194 + 5,556 + 2,533

$C_{U/F}$ = 8,33 [RON / piece]

Unit cost of QUALITY $C_{U/C}$ is composed of:

- Unit cost / $_{DFM}$ = 0,146 [RON / piece]
- Unit cost / $_{IFM}$ = 0,306 [RON / piece]
- Unit cost / $_{IP}$ = 0,112 [RON / piece]
- Unit cost / $_A$ = 0,126 [RON / piece]

Applying Formula 11, the unit cost of QUALITY $C_{U/C}$ will be obtained:

$C_{U/C}$ = 0,146 + 0,306 + 0,112 + 0,126

$C_{U/C}$ = 0,69 [RON / piece]

C). Unit cost of LOGISTICS $C_{U/L}$

- Unit cost / $_{DFM}$ = 0,145 [RON / piece]
- Unit cost / $_{IFM}$ = 0,145 [RON / piece]
- Unit cost / $_{IP}$ = 0,097 [RON / piece]
- Unit cost / $_A$ = 0,062 [RON / piece]

Applying Formula 11, the unit cost of LOGISTICS $C_{U/L}$ will be obtained:

$C_{U/L}$ = 0,145 + 0,145 + 0,097 + 0,062

$C_{U/L}$ = 0,361 [RON / piece]

D). Unit cost of secția MAINTENANCE $C_{U/M}$

- Unit cost / $_{DFM}$ = 0 [RON / piece]
- Unit cost / $_{IFM}$ = 0,682 [RON / piece]
- Unit cost / $_{IP}$ = 1,199 [RON / piece]
- Unit cost / $_A$ = 0,258 [RON / piece]

Applying Formula 11, the unit cost of MAINTENANCE $C_{U/M}$ will be obtained:

$C_{U/M}$ = 0 + 0,682 + 1,199 + 0,258

$C_{U/M}$ = 2,139 [RON / piece]

Therefore, the the total unit cost of obtaining workpiece studies C_U will be obtained by applying the formula 10:

$C_U = 15,775 + 8,33 + 0,69 + 0,361 + 2,139$

$C_U = 27,295$ [RON / piece] ≈ 27,3 [RON / piece]

For the studied case, we have the following values:

PT = 300 000 [piece]

$C_U = 27,3$ [RON / piece]

The total unit cost of obtaining workpiece studies C_U will be obtained at the course 4,5 RON / 1 €:

$C_U = 27,3 / 4,5$

$C_U = 6,06$ [€]

Substituting the value of total unit cost of obtaining workpiece studies C_U in euro in formula 8, will get the production cost of obtaining landmarks C value:

C = 6,06 x 300 000

C = 1 820 000 [€]

3.3 The total cost of obtaining the production of parts for non-optimized blank - CT_0

The total cost of obtaining the production of parts for non-optimized blank CT_0 is calculated by substituting in formula 3 values obtained for the total raw material cost non-optimized C_{MP-0} and the production cost of obtaining landmarks C:

C_{MP-0} = 3 088 800 [€]

C = 1 820 000 [€]

CT_0 = 3 088 800 + 1 820 000

CT_0 = 4 908 800[€]

4. CONCLUSIONS

The producing company has honored to a command to 300 000 parts / year.

In order to achieve an optimization of the total cost of obtaining the production of parts, from analyzes performed on the two categories of cost components, it was concluded that one can only get a discount from the total cost of raw material optimization.

Initially preform, non-optimized, having an initial length L_0 = 1 550 [mm] and the corresponding blank mass initially have the value M_0 = 7,2 [kg / piece]. For this was calculated the total cost of obtaining the production of non-optimized benchmarks for the blank value obtained CT_0 = 4 908 800[€].

In the second study, the economic efficiency will be calculated on the basis of the reduction of the mass of the blank used in the manufacture of the workpiece of interest.

The blank mass used will decrease from baseline M_0 = 7,2 [kg / piece] to a value optimized by reducing the length of the blank. Thus, the initial value of the length of the blank L_0 = 1 550 [mm], it will use the optimized blank length L_1= 1 540 [mm].

The final value of the length of the workpiece blank allows use without affecting its final destination at the same time but will get a reduction in the mass of raw material used and ultimately a reduction in total cost of raw material C_{MP}, which will be reflected in lowering the total cost of obtaining the production of landmark CT.

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