ECOTEST MOLD - MOLD COSTING BY PRODUCT PROPERTIES

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Summary
The quotation of injection mould is a difficult mission and it means a large challenge. The ECoTEst MOLD experimental cost estimation system focuses on this challenge. The current article shows the system's input parameters and it's influence on manufacturing cost and time.
***Keywords**: manufacturing time and cost estimation, injection mould*

1. INTRODUCTION

The quotation of injection mould is a difficult mission and it means a large challenge. The reason for this challenge is that you must estimate a mould's design and manufacturing cost which has unknown structure and complexity based on plastic product [1].

The estimated cost value has large importance from the point of view of company's profitability, because based on these data can be determinate the production price of the mould and the minimal price toward the costumer. Based on estimated time data and free manufacturing capacity the production's deadline can be defined.

During the quotation process the result must satisfy conflicting conditions: on the one hand it must serve exactly time and cost data from elements of an unknown design and manufacturing process, on the other hand we have limited time for executing this assessment process. The inaccuracy, time and resource or human expert requirement of traditional methods doesn't make possible efficient use in everyday practice.

In the beginning of the research the main properties of an ideal system was determined as follows: easy to use, short calculation time, accurate results, design and manufacturing environment oriented calculations, insensitive to user's expertise [2].

2. ECoTEst MOLD

On the based of the results of ECoTEst (Early Cost and Time Estimation) project [3] and analysis of the design and manufacturing process of injection mould making we reached a conclusion that the artificial neural network is the tool which is able to make connection between the properties of plastic part and the design, planning and manufacturing time and cost of the required injection mould. This method makes possible to learn the hidden numeric function to connect key properties of plastic products and the estimated time and cost data based on post calculated time and cost data of designed and manufactured moulds. During cost assessment this function can be applied.

The artificial neural network is a tool for computational tasks, which has biological analogy. Artificial neural networks are forms of fine-grained parallel processing designed to imitate the interactions of brain neuron and their information processing capabilities [4]. The topology, the characteristic of nodes and the learning algorithm define an artificial neural network.

3. Input parameters

One of the most important steps of the development process is the definition of the set of input and output parameters. The set of output parameters can be defined simply, because it is determined by required cost and time data.

The selection of input parameters is a more difficult problem. The reason of it, the selected parameters must be satisfied several conflicting conditions.

We can use only such parameters, which are determined based on any design representation type like 2D drawing, physical model, 3D CAD model in any format etc. Every essential propertie of products must be selected which have an effect on mould's structure, size and complexity. During quotation the concept of the mould must be developed, and some characteristic properties must be considered for accurate results. One of the most important viewpoints in the parameter selection is the clear structure, so the number of parameters are not too much.

Based on these considerations the input parameters are follows:

Overall dimensions of plastic part

One of the most significant parameter is the part's overall dimension. The part's height, which is parallel with the mould opening direction, influences the height of mould, the dimensions, which are normal to the mould opening direction, have an effect on needed closing force and the applicable injection mould machine.

Number of cavities

If the number of cavities is increased, then the productivity of mould is increased too, but the cost of mould making is also increased. The operation of a multi cavity mould requires moulding machines, which is able to insure bigger closing force so the operating expenses are increased too.

Mass of plastic part

The mass of part determines the material cost of the plastic part, and influences the mould machine selection.

Complexity of plastic part

The complexity of the part is difficult to determine and to define. Based on system's concept this parameter is determined in a scale from 1 to 10, where the 1 means the simplest, the 10 means the most complicate mould structure. These categories can mean different mould structures in each mould manufacturer, so during the installation process the case studies must be drawn up for support users. Don't use the minimum and maximum values of the scale practically, because in the future maybe we will make cost estimation for a simpler or for a more complicate mould than we have made yet.

Estimated overall size of mould

Based on above-mentioned parameters the overall size of mould is estimated, appropriate to use the standard plate dimensions of material manufacturers, in order to reduce material cost.

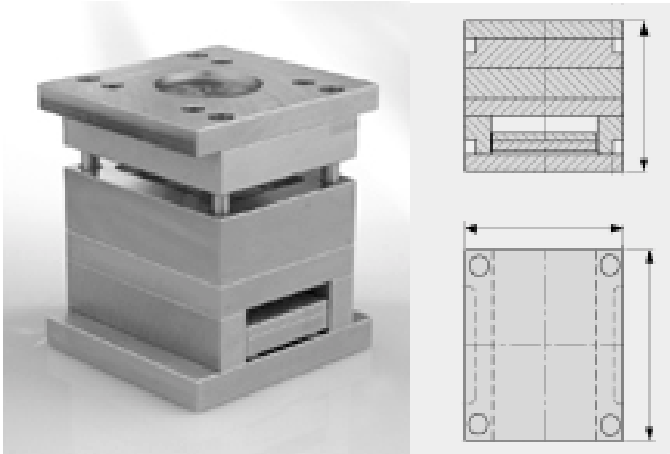

Figure 1. Overall size of mould (Meusburger)

Complexity of mould structure

Complexity if mould structure is scaled 1 to 10 based on considerations, which was mentioned in the previous parameter. A mould structure is simple if it consists of only core and cavity plates and the parting surface is flat, while a multi-cavity mould with sliders, lifters, two step ejection and threaded insert has very complex structure.

Runner system

An injection mould has a standard surface runner or a hot runner system. A standard surface runner system is simpler, cheaper to manufacture, but the time of an injection cycle is longer and results in significant material wastes. On the other hand application of a hot runner system makes shorter cycle time possible, the material waste nearly zero, but it indicates considerable cost and purchase time.

Quantity of sliders and lifters

Sliders and lifters form the undercut surfaces, which can't form only core and cavity. Application of more sliders means higher mould complexity, the mould consists of more parts, and so design, process planning and manufacturing cost will be higher. (The parameter is scaled 1 to 10.)

Complexity of sliders and lifters

This parameter characterizes the geometrical complexity of sliders and lifters in a scale 1 to 10.

Quantity of deep ribs and cavities

Deep ribs and cavities increase the cost of mould because they can't be manufactured with milling technology, so they require the EDM technology, which indicates additional cost in both planning and manufacturing. (The parameter is scaled 1 to 10.)

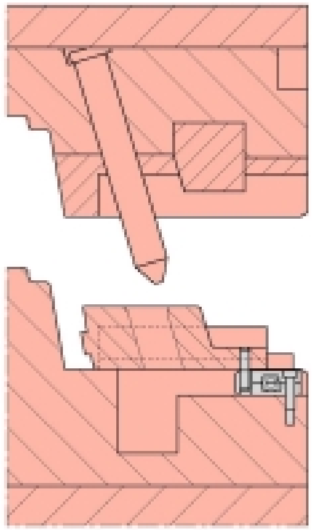

Figure 2. Slider (DME)

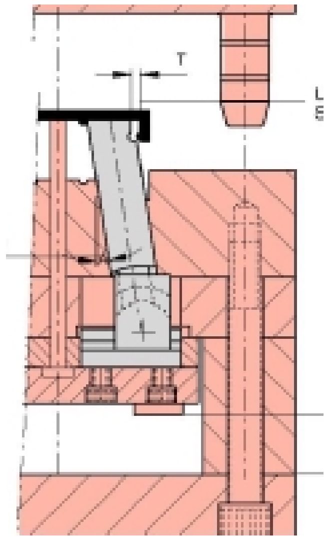

Figure 3. Lifter (DME)

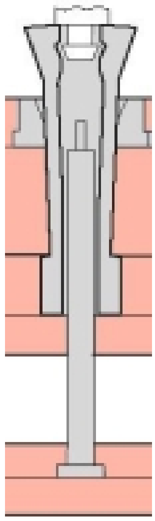

Figure 4. Lifter (DME)

Quantity of EDM-ed surfaces

You have to provide surface quantity, which can't be manufactured with milling, only EDM technology, because the shape of surfaces doesn't make the application of milling technology possible. (The parameter is scaled 1 to 10.)

There are several reasons why the application of EDM technology increases the manufacturing cost. First of all the EDM technology requires electrodes, which indicate design, process planning and manufacturing costs. Secondly the EDM process has low productivity, and thirdly if the plastic product's surface requirement don't allow the EDM-ed surface quality, the surface finishing needs several manual manufacturing.

Quality of product's surface

The product surface has to meet requirement of design, functional and manufacturability. A surface has milled or EDM-ed structure and quality follow from the mould's manufacturing process. If necessary this structure can be eliminated by manual manufacturing, however superfinished surface can be made.

In several cases the costumer required a special surface structure like leather design. This special structure in some cases may be manufactured by EDM. The natural like design may be manufactured by electrochemical machining, which needs many manual pre processes, because the milling paths or EDM-ed hard surface layer must be eliminated.

Heat treatment requirements

Planned number of plastic parts and the abrasive effect of the plastic material drive the heat treatment requirements. Generally known, that a non-heat treated steel part can be milled less time than a hard surface. The execution of heat treatment indicates additional cost and increases the production time, in the some way as transportation of parts, if the heat treatment process may not be executed in the mould shop.

4. A case study

This chapter shows input parameters through a case study. The Figure 5 shows the selected plastic product.

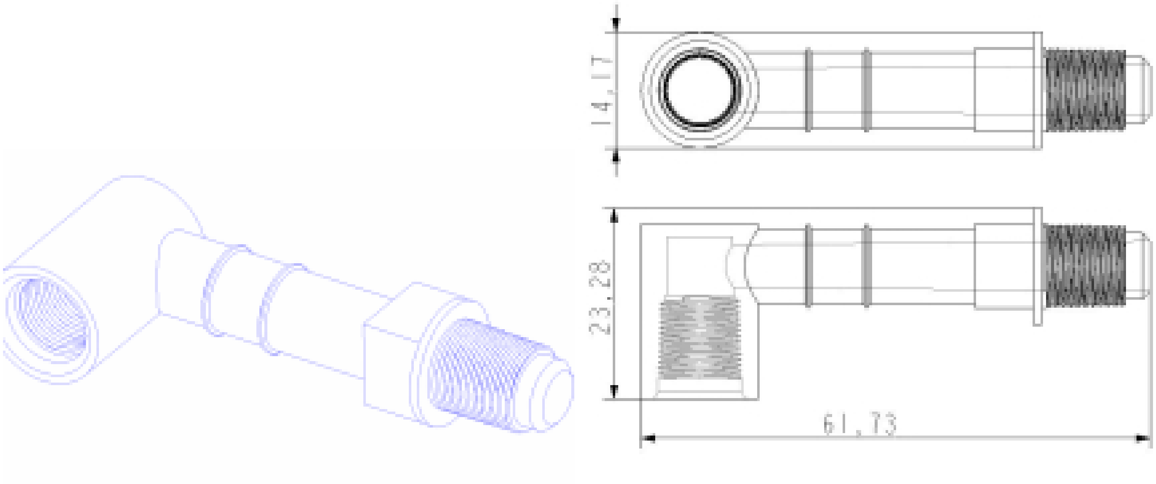

Figure 5. The plastic part

The selected product consists of two holed cylinders, which have normal axes and different diameters. In the end of the smaller diameter cylinder there is a threated surface and a cubic part. The other cylinder has a threated hole.

Based on preliminary design concept the mould has four cavities, the parting plane is defined by the cylinders' axes. The hole in the smaller diameter cylinder is created by a slider, which is moved by an angle pin, because manufacturing environment doesn't permit pneumatic operation. It follows that the bigger diameter can be found in the centre of the mould. The mould has a conventional surface runner system.

A changable insert creates the internal treaded surface, so the insert drops out from the mould in every cycle with the plastic parts, and the machine operator separates them. Because of the faster operation there are two changeable inserts for four cavities, so one insert holds two plastic product. This solution reduces the time of separation and the time of insertion between two injection cycles. Of course more inserts must be manufactured, so during the injection moulding process the operator separates the previously moulded parts.

Because of planned product number the core and the cavity plates made of hardened and tempered steel, the visible surfaces of the product should be EDM-ed.

The Table 1 contains the actual value of the appropriate input parameters according to Chapter 3 and the previous considerations.

Table 1. Parameters of the case part

Overall dimensions of plastic part	62x24x15
Number of cavities	4
Mass of plastic part	7 g
Complexity of plastic part	5
Estimated overall size of mould	350x200x220
Complexity of mould structure	5
Runner system	Standard surface runner
Quantity of sliders and lifters	4
Complexity of sliders and lifters	4
Quantity of deep ribs and cavities	3
Quantity of EDM-ed surfaces	6
Quality of product's surface	EDM, VDI 27
Heat treatment requirements	Hardening and tempering

5. Summary

The ECoTEst MOLD experimental analysis system is able to help in estimation of the design and manufacturing cost on an injection mould based on characteristic parameters of the plastic part and some design requirements of the mould. This article shows parameters which have essential effect on the cost calculation.

The development is supported by OTKA (OTKA T032732).

Special thanks to *Krisztián Czobor* for the case study.

6. References

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