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## Analysis and review of different tools to calculate the production economics in injection molding

M.A. Sellés<sup>a\*</sup>, S. Sanchez-Caballero<sup>a</sup>, E. Perez-Bernabeu<sup>a</sup>

<sup>a</sup> *Universitat Politècnica de València, Pza Ferrándiz i Carbonell, s/n, 03801 Alcoi, SPAIN*

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### Abstract

The purpose of this work is to make a small review of computer-aided software based mainly on the calculation of the injection molding cost. Only a representative portion will be discussed in this paper.

An injection molding machine can produce thousands of pieces per day, depending on many factors. A small improvement in the cost per piece can have a significant impact on the industry. These factors have to be carefully considered by the software in order to make accurate estimations.

A total of 5 programs are fully analyzed in this contribution, and this is useful to achieve good cost estimation for the injection molding process. The main characteristics and/or features of each of them are also described.

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### 1. Introduction

The injection molding process is used worldwide in plastics industry. Basically all kind of polymers, known sometimes as resins, can be used. This includes all thermoplastics, and some elastomers and thermosets. The quantity of polymers that can be used in this process is growing up every year.

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\* Corresponding author. Tel.: +34-966528468

E-mail address: [maselles@dimmm.upv.es](mailto:maselles@dimmm.upv.es)

The plastics industry is of enormous scale worldwide. The companies are very competitive and want calculate with precision the cost of producing a single piece to millionths of a cent because of the high production rate.

The mold (sometimes known as die) refers to the tooling used in injection molding. The molds are mostly made of steel, but aluminum can also be used. Aluminum molds cost much less than steel molds. The cost of manufacturing these molds depends on several factors: size, number of cavities, surface finishes, complexity of the pieces, etc. The cost is big at the beginning, but the cost per piece is low, so with large quantities, the unit price decreases.

The whole injection process cost involves many other variables, not only the cost associated to the mold. These are, for example: the material used, labor, power consumption, cycle time (including the flow rate, pressure, temperature, time of cooling,...), etc.

## 2. Previous research efforts on cost estimating calculation

Some authors have focused their cost studies on the design stage, and this can be erratic in further cost analysis. Chen and Liu [1] made a classification of product design concerns. They proposed a procedure for computer-aided design for cost effectiveness, dividing the design stage into three parts: feature design, preliminary design and detail design. Injection feature evolution in these continuous stages can lead to the modification of cost-related parameters, which include materials, technologies and mold manufacture. This procedure was implemented using the C++ as programming language, but the problem was how to quantify all the variables and aspects considered.

An extended review of a total of 19 programs was made by Maier [2]. Some of those programs are no longer available and others have new improved versions. His study separated the designers and manufacturer's needs. The "Kazmer Injection Molding Cost Estimator" (a Java application) from the University of Massachusetts Lowell and Boothroyd Dewhurst's "DFM Concurrent Costing" were used as good examples of products done basically for the design stage.

Maier analyzed the software sophistication and program delivery providing some examples of programs. His study finished considering that the developing of appropriate models for cost estimating is an art, since they have to be simple and precise; and gave also some advice for a possible new product development.

Pearce [3] focused only on the mold cost estimation. He developed a procedure based on artificial intelligence and heuristic methods. The knowledge based constructed for this purpose was achieved using statistical survey analysis, rather than interviews with experts.

The artificial intelligence (using an ANN) was also used by Wang et al. [4] to develop a cost model for the mold manufacturing, including variables such as tax costs and general administrative costs. Case representation, case retrieval, case indexing, case adaptation and the case learning mechanism are also studied in detail.

Gupta [5] has at his personal website an interesting study on single and multi-material molding cost. For the single material case, Gupta proposes the use of Bryce's empirical method, Rosato's Method, Boothroyd's Method, Poli's Method and Kazmer's Method. He explains all those methodologies as well. On the other hand, the cost analysis made to the multi-material molding is exhaustive, and Gupta uses a model that considers input variables (CAD model and company specifications) and as output data shows a graph that compares the quantity vs. the cost.

## 3. Programs

In this short contribution, we show a total of 5 programs that can be useful to achieve good cost estimation for the injection molding process. The main characteristics and/or features of each of them are also described.

- *Injection Molding Cycle Time Estimator (Freeware).*

The license of its calculator software is also free. The purpose is to calculate cycle times, that can be used for a rough cost estimation. It's a very simple software, and has the following features:

1. Different estimation data based on resin type.
2. Allows machine setting overrides for temperatures.
3. Two types of estimation methods (centerline and average cooling of wall stock).

4. Easy Windows Forms interface.
5. Error Checking

- *ProMax-One™ PLASTIC PART COST ESTIMATOR (InjectNet).*

This is also a free option. It calculates the total cost per part and can show a breakdown window with the detail of all cost results.

It considers the materials used, project information, labour, mould cost, machinery, maintenance, cavity information, etc.

The Plastic Part Cost Estimator is more complete than the Injection Molding Cycle Time Estimator Freeware.

- *CostMate® (IDES Inc.).*

Costmate is a moulding part cost estimator that have been integrated into an online plastics search engine (Prospector®). The basic version of this engine is free.

Costmate considers costs due to shipping and packaging as well.

- *DFM Concurrent Costing® (Boothroyd Dewhurst, Inc).*

This is a commercial cost software designed mainly for the design stage. It's possible to customize the cost estimate by changing the defaults and entering a new part geometry and other variables from the own injection molding machine.

This software also includes a geometry calculator. It gives the possibility to compare alternative processes and materials for the piece manufacturing.

- *CalcMaster® Software (Schouenberg & Partners).*

CalcMaster is a powerful program that can be used not only as a cost estimator but also as a good design assistant.

It calculates the most economical number of cavities, and takes into account the project hours cost (design and manufacturing).

#### 4. Conclusions

Despite the low number of programs described above, results indicate that the paid software options are more accurate and offer more options for make decisions on which is going to be the final cost of manufacture an specific piece using an injection molding machine.

The free software options are more restrictive in considered variables. ProMax-One™ can be a good choice, since it makes calculations on several parameters, such as the cavity data and project information.

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