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Analytical cost estimation model in High Pressure Die Casting

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Abstract

The present paper aims at the definition of an analytical model for the cost estimation of the High Pressure Die Casting (HPDC) process. The model is based on two main pillars: (i) knowledge formalization and (ii) cost estimation algorithms. The novelty of this approach is the link between the analytical model (algorithms) and the geometrical features of the product under development. The relationship between geometrical features and cost items gives an accurate result in terms of cost breakdown, supporting designers for the application of Design-to-Cost rules in HPDC sector.

Keywords: cost estimation, High Pressure Die Casting, analytical cost model, knowledge formalization.

1. Introduction

The use of product/process-related data and information throughout the product lifecycle is a key aspect of the Intelligent Manufacturing. During the design phase, designers establish up to 80% of the product cost, even included the manufacturing cost. The process-related information sharing within the enterprise is a solution for improving the manufacturing flexibility. Moreover, the availability of big data from production plants may support designers in

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finding best solutions in terms of feasibility and cost. Analytical manufacturing cost estimation methods and systems, based on the calculation of the manufacturing process, allow designers to get the manufacturing cost of a product by considering accurate scenarios. Among the different methods developed for cost estimation at the design stage, the most used are those ones based on knowledge, features, operations, weight, material, physical relationships and similarity laws. The paper aims to define a structured analytical model for the cost estimation of High Pressure Die Casted (HPDC) components. HPDC is a casting process characterized by forcing molten metal under high pressure into a die cavity. The method is based on two main pillars: (i) knowledge formalization and (ii) cost estimation algorithms. The first pillar is the exact characterization and classification of cost items involved in the HPDC process including the knowledge collection and its formalization (both internal-from companies and explicit-from literature). The second pillar is the definition of algorithms and equations for predicting HPDC manufacturing costs. The relationships between the HPDC cost items and the product attributes (e.g. roughness, maximum thickness, etc.) have been developed for the analytical model definition. By using this model, designers can estimate the cost of a product during the early design stage with the aim to provide the most competitive solution.

The novelty of this approach is the definition of the analytical cost estimation model in the field of the HPDC starting from the geometrical features of the product under development. The relationships between geometrical features and the cost items will give a more accurate result in terms of cost breakdown and it can be used by product designers as a powerful tool for the application of Design-to-Cost (DtC) rules in HPDC sector.

2. State of the art on cost estimation methods applied to manufacturing processes

HPDC is an important process in the manufacturing of high volumes and low cost components for the automotive, household appliances and electronic industries [1]. Liquid metal, generally aluminium, magnesium or zinc, is injected into the die at high speed (30-100 m/s) and under high pressure through complex gating and runner systems [2]. The HPDC process consists of several steps, from the release agent spraying out the die to the opening and closing of the die [3]. Fig. 1 highlights the overall HPDC process cycle.

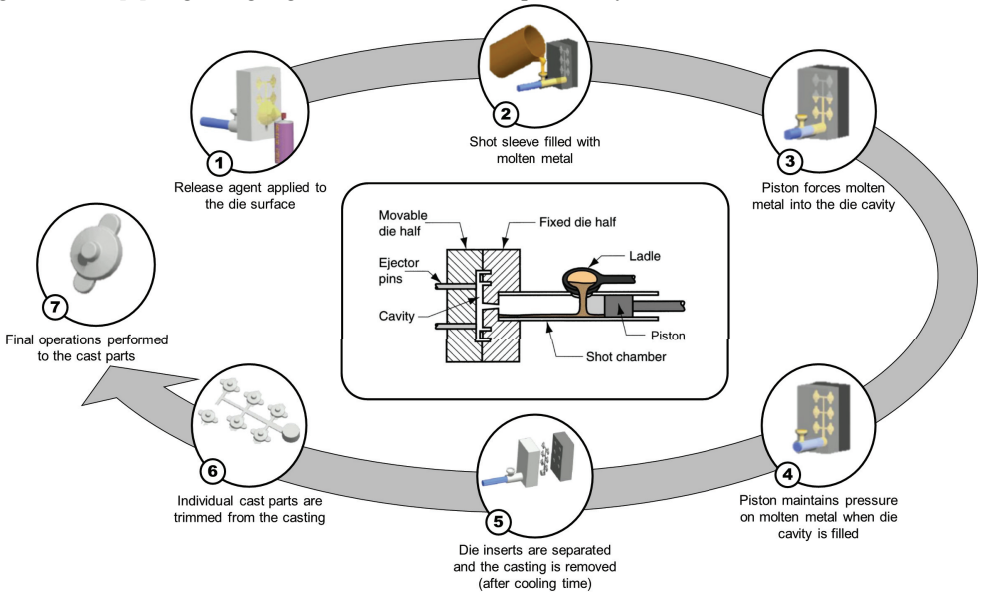

Fig. 1. HPDC process overview.

Cost estimation is a preparatory activity that must be done as a basis for the design activities (e.g. Design to Cost) [4]. The cost estimation is an activity carried out at different stages of the product-process design (e.g. conceptual