

# Parametric Cost Model for Deburring Processes

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## Abstract

Manufacturing of mechanical components often requires an edge finishing operation. Deburring processes have been the prime objective for many researchers and companies, as the cost can add up to 30 % of the total manufacturing cost [1]. Several studies have laid out deburring cost estimates for different deburring processes [2 - 6]. However, a model for parametric cost estimation for deburring processes has never been developed in detail. This study therefore focuses on the development of a computerized model that estimates the cost of a deburring process.

## Introduction

Parametric cost modeling is an extension of engineering process modeling, with particular emphasis on capturing the cost implications of process variables and economic parameters. A review of the comparison of traditional cost accounting and parametric cost analysis can be found in Park and Kim [7]. By grounding the cost estimates in engineering knowledge, critical assumptions, such as processing rates and energy and materials consumption, interact in a consistent, logical, and accurate framework for economic analysis [8]. Using this parametric cost model, a decision such as whether sanding or robotic deburring can be investigated without extensive expenditures of capital and time. This parametric cost model can establish direct comparisons between processes, it can access the ultimate performance of a particular process, and it can be used to identify limiting process steps and parameters.

## Parametric Cost Model (PCM)

To achieve the most accurate comparison between the different deburring processes the total lifecycle of the elements is taken into consideration. The conceptual basis of the parametric cost modeling method uses an approach in which each of the elements that contributes to total cost is estimated individually (Figure 1). The target of the model are the four levels after design in the five levels of integration defined by Stein [9].

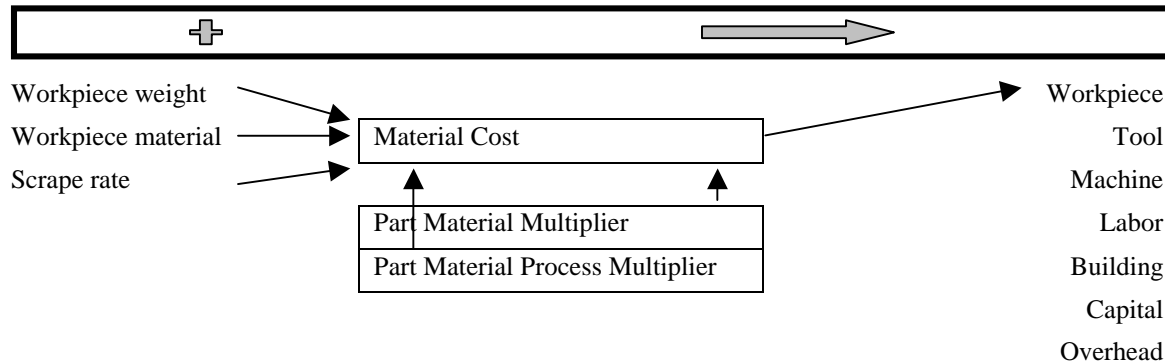
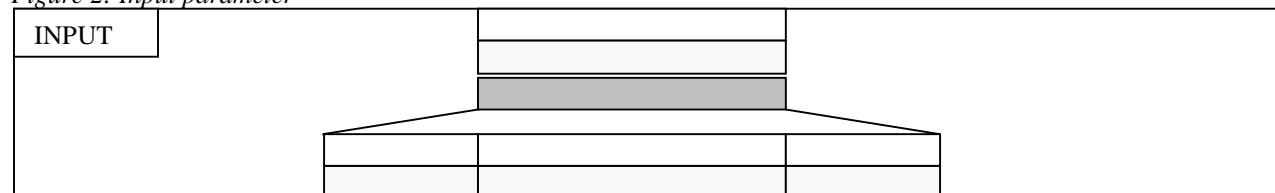


Figure 1: Conceptual basis of Parametric Cost Model (PCM)

The inputs to the Parametric Cost Model form the basis for cost estimation (Figure 2). They define the component, the economic environment, and the technical nature of the burr process.

Inputs	Materials	Geometries	Outputs
Part Burr optional input Production parameter Production parameter workpiece Burr creating process Process tool cost Machine Personal Reference parts Burr input reference part Production parameter reference part			Variable cost Fixed cost Additional information

Figure 2: Input parameter



LEVEL	
LEVEL	
LEVEL	
OUTPUT	

Figure 3: Parametric Cost Model (PCM) overview

In level 1 those deburring processes are selected with the decision strategy, which are capable of deburring the chosen part. In the Second level the cost of the different processes are calculated. Finally in the third level the selection algorithm determines the four processes, which have the best cost, best time, best quality and best compatibility.

### Cost calculations

Data from the inputs, material, and geometries sections of the model are combined by a series of equations to produce a cost estimate.

Based on the overall equation in Figure 4 the costs are calculated. Figure 1 on page 1 shows the first part of the equation, which represents the material cost.

$C_{Total} = \alpha * A * C_{wb} + \beta * B * C_{wi} + \chi * X * C_{wm} + \delta * \Delta * C_{we} +$ $+ \varepsilon * E * C_{tb} + \phi * \Phi * C_{ii} + \varphi * \Gamma * C_{tm} + \gamma * H * C_{te} +$ $+ \eta * I * C_{mb} + \iota * K * C_{mi} + \kappa * \Lambda * C_{mm} + \lambda * M * C_{me} +$ $+ \mu * O * C_{lb} + \nu * O * C_{li} + o * \Pi * C_{lm} + \pi * \Theta * C_{le} +$ $+ \varpi * P * C_{bb} + \theta * \Sigma * C_{bi} + \vartheta * T * C_{bm} + \rho * Y * C_{be} +$ $+ C_{co}$	<p><math>\alpha... \rho</math> = Work piece specific parameter  <math>A... Y</math> = Process specific parameter</p> <p>First Index:  w = Work piece  t = Tool  m = Machine  l = Labor  b = Building  c = Constant</p> <p>Second Index:  b = Buying  i = Integration  m = Management  e = End of Life</p>
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Figure 4: Cost equation

### Variable cost elements

Variable cost elements are those elements of output cost whose values are independent of the number of pieces produced. For most deburring processes the important variable cost elements are:

1. Workpiece (Material),
2. Direct labor, and
3. Energy (Machine, auxiliary, etc).

### Fixed costs

Fixed costs are those elements of output cost which are a function of the annual production volume. Fixed costs are called fixed because they are typically one-time capital investments (e.g. building, machinery) or annual expenses unaffected by the number of components manufactured (building rents, administrative salaries).

Typically, these costs are distributed over the total number of components manufactured in a given time period. For most deburring processes, the main elements of fixed cost include:

1. Main machine cost
2. Auxiliary equipment cost
3. Tool cost
4. Building cost
5. Overhead cost
6. Maintenance cost
7. Cost of capital

### Process parameter

One process parameter that is usually integral to a manufactured part cost analysis is the cycle time.

The definition of cycle time depends upon the process being considered. The cycle time of deburring processes is usually measured in seconds. The cycle time for deburring processes is typically the time interval to deburr the part. Rather, processing rates are measured in feet per minute and depth of cut.

A number of factors can influence the cycle time of a given process, including set-up time, tool adjust process, and part loading and unloading. How much these factors effect the cycle time depends not only on the process, but also on the product being manufactured and the material being processed.

### Output

Figure 5 shows the result of a case study. For the selected cheapest deburring process the current workpiece cost are compared with the best practice of the different categories.

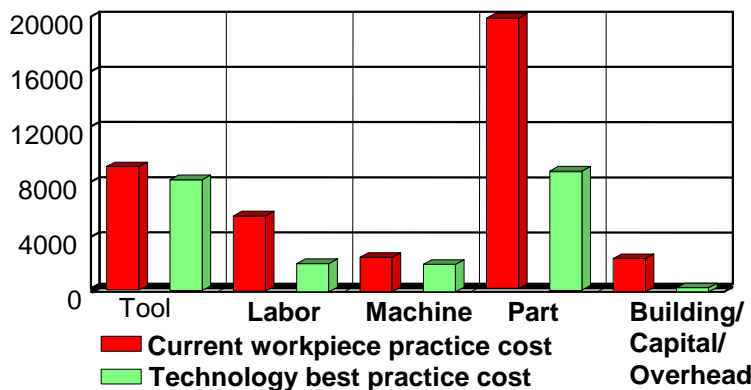


Figure 5: Cost distribution

### Conclusion and future work

The previous paragraphs introduced the strategy of variable and fixed cost elements, and provided examples of each. Many of the issues that must be considered in estimating their values were identified. Finally, the effect of cycle time was discussed.

One advantage of this approach over simpler cost estimating techniques is that it not only provides estimates of the total cost, but also provides a breakdown of the cost of each contributing element. This information can be used to direct efforts at cost reduction, or it can be used to perform sensitivity analyses.

One disadvantage of this approach is that it is time consuming to generate cost estimates in this manner, and the complexity of generating these estimates can lead to mistakes. The solution to both of these problems is the computer. While developing a computer program for performing elemental cost analysis is still time consuming and complicated, once it is developed, it can be used to generate estimates both rapidly and without fear of mistakes.

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