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MANUFACTURING COST ESTIMATION OF PROCESS PLANNING USING THE ABC METHOD

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ABSTRACT
This paper presents a manufacturing cost estimation of process planning using Activity Based Costing (ABC) methods. Since major manufacturing cost is determined in early as possible in early design, it iscritical to be able to assess manufacturability and cost as early as possible in the design is critical to enable these analyses. A literature review of the current status of Computer-Aided Design (CAD) and Computer-Aided Process Planinng (CAPP) software technologies revelas the lack of interface standards to enable the integration of these system. In order to develop interface standards, information models have to be first devolped t odefine interfaces. An inital information model for conceptual processs planning has been devolped. This model includes an object model for manufacturing process selection, and cost and time estimation. Manufcturing cost and time estimations have been built into the object model
Keywords: activity based costing, cost estimating

1. INTRODUCTION
Activity Based Costing (ABC) is a method for developing cost estimates in which the project is subdivided into discrete, quantifiable activities or a work unit. The activity must be definable where productivity can be measured in units. After the project is broken into its activities, a cost estimate is prepared for each activity. These individual cost estimates will contain all labor, materials, equipment, and subcontracting costs, including overhead, for each activity. Each complete individual estimate is added to the others to obtain an overall estimate. Contingency and escalation can be calculated for each activity or after all the activities have been summed. ABC is a powerful tool, but it is not appropriate for all cost estimates. For many years, construction firms and industry trade groups have collected cost data from a multitude of different construction projects. The amount of work associated with that cost was also collected with the cost data. ABC methodology is used when a project can be divided into defined activities. These activities are at the lowest function level of a project at which costs are tracked and performance is evaluated. Depending on the project organization, the activity may coincide with an element of the work breakdown structure (WBS) or may combine one or more elements of the WBS[1]. However, the activities must be defined so there is no overlap between them. After the activity is defined, the unit of work is established. All costs for the activity are estimated using the unit of work. The estimates for the units of work can be done by performing detailed estimates, using cost estimating relationships, obtaining outside quotes for equipment, etc. All costs including overhead, profit, and markups should be included in the activity cost. Figure 1. Show all activity included in process planning.

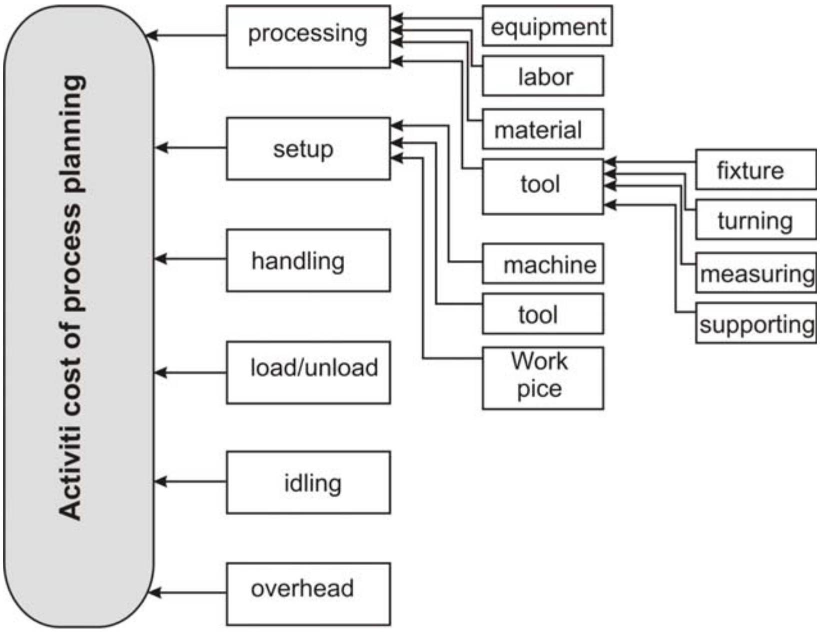

Figure 1. Activity which defination on total cost for process planning

2. MANUFACTURING COST ESTIMATING

Manufacturing cost and time estimations have been built into the object model. Activity Based Costing (ABC) methods and results from research [2] based ABC are adopted to form the basis for estimating cost and time described in this paper. Each manufacturing activity can be one of many processing activities, such as setup, load/unload, handling, processing, and idling. Each processing activity involves cost of using any resources and overhead cost. Cost and time estimating equations are described in the following equations.

$$C_m = \sum_{i=1}^{N} C^i_{activity} = \sum_{i=1}^{N} \left(C^i_{processing} + C^i_{handling} + C^i_{load\_unload} + C^i_{setup} + C^i_{idling} + C^i_{overhead} \right)$$

i – is an index;
N- is the total number of manufacturing activities applied to manufacture an artifact;

processing cost:

$$C^i_{processing} = C^i_{equipment} + C^i_{labor} + C^i_{material} + C^i_{tool}$$

tooling activity cost:

$$C^i_{tool} = C^i_{fixture} + C^i_{cutting\_tool} + C^i_{gauge\_tool} + C^i_{accessory\_tool}$$

setup activity cost:

$$C^i_{setup} = C^i_{s\_machine} + C^i_{s\_tool} + C^i_{s\_workpice}$$

manufacturing time estimating:

$$t_m = \sum_{i=1}^{N} t^i_{activity} = \sum_{i=1}^{N} t^i_{processing} + t^i_{setup} + t^i_{handling} + t^i_{load\_unload} + t^i_{idling}$$

3. DETERMINING MACHINING CONDITIONS AND MANUFACTURING TIMES

Having specified the workpiece, machine too, and question is what can be controlled to reduce cost and increase production rate. The controllable variables are cutting speed (v), feed (f), and depth of cut (d). Jointly, v, f, and d are referred to as machining conditions. There are a number of models for determining the optimal machining conditions. In this paper we present simple models. The average cost per piece to product a work piece consists of the following costs: [3]

Cost per component, C_u = nonproductive cost per piece
+ machining time cost per piece (1)
+ tool changing cost per piece
+ tooling cost per piece

Mathematically, this can be expressed as

$$C_u = c_o t_1 + c_o t_c + c_o t_d \left(\frac{t_{ac}}{T} \right) + c_t . \left(\frac{t_{ac}}{T} \right) \quad (2)$$

The tool life equation as function of cutting speed (v) is expressed as

$$vT^n = C \quad (3)$$

where:

c_o= cost rate including labour and overhead cost rates (km/min)
c_t= tool cost cutting edge, which depends on the type of tool used (km)
C=constant in the tool life equation, $vT^n = C$
v= feed rate (m/min)
f= depth of cut (mm/rev)
d= exponent in the tool life equation (mm)
n= exponent in the tool life equation
t_1= non-productive time consisting of loading and unloading the part other idle time (min)
t_c= machining time per piece (min/piece)
t_d = time to change a cutting edge (min)
t_{ac}= actual cutting time per piece, which is approximately equal to t_c (min/piece)
T= tool life (min)

Consider a single-pass turning operation. If L, D, and f are the length of cut (mm), diameter of work piece (mm), and feed rate (mm-rev), respectively, then the cutting time per piece for a single-pass operation is

$$t_c \approx t_{ac} = \frac{\pi LD}{1000vf} \quad (4)$$

Upon substituting these values as well as the tool life equation in the cost per piece equation (2), we obtain

$$C_u = c_o t_1 + c_o \left(\frac{\pi LD}{1000vf} \right) + c_o \left(\frac{\pi LD}{1000vf} \right) \left(\frac{v}{C} \right)^{1/n} t_d + c_t \left(\frac{\pi LD}{1000vf} \right) \left(\frac{v}{C} \right)^{1/n} \ldots\ldots \quad (5)$$

The feed rate and depth of cut are normally fixed to their allowable values. Therefore, the cutting speed v is the decision variable. Upon partially differentiating C_u with respect to v, equating to zero, and solving, we obtain the minimum unit cost cutting speed v_{opt} as follows equation (6)

$$v_{opt} = \frac{C}{\left[\left(\frac{1}{n} - 1\right)\left(\frac{c_o t_d + c_t}{c_o}\right)\right]^n} \tag{6}$$

On figure 2. Showed graph function cost per component, we obtain minimum unit cost with cutting speed v_{opt} .

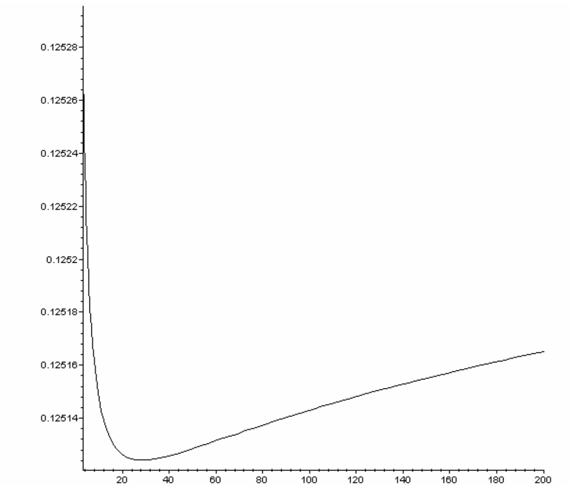

Figure 2. The function cost per component with v_{opt}

4. CONCLUSION

This paper has described a process planning activity model and manufacturing cost and time estimations have been built into the object model. . Activity Based Costing (ABC) methods and results from reasaech based on ABC are adopted to from the basis for estimating cost and time described in this paper. Each manufacuring activity can be one of many processing activities, such as setup, load/unload, handling, processing, and idling. Each processing activity involves cost of using any resources and overhead cost. Cost and time estimationg equatuions are described in the following equations. The actiity model set sets the contex in excange. The object model defines classes used in process planning. The main purpose of developing this model is initiate the devolpment of standard interface specifications that are neccessary for design and process planning integration.

5. REFERENCES

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