Devising a cost management approach for product development

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Abstract: This paper discusses cost management in the context of product development. Its main goal is to present a model for measuring and controlling product development costs. The work is based on the principles of models for product development processes, costing principles (total, partial and variable), costing methods (standard-cost, cost centers, activity-based costing, production effort unit, feature costing) and costing tools (target costing and project cost management). The proposed model was developed based on the management of target costs and on the calculation of development costs. The latter refers both to project costing and costing of product introduction into the company's production structure. The feature costing concept is also used, together with the standard-cost method, activity-based costing and the production effort unit approach.
Keywords: costing method for projects, product development costs, target costing, activity-based costing, production effort unit, feature costing

1. Introduction

The increasing importance of product management in management leads to the creation and adaptation of techniques from many different areas in order to support product development (DP). One of the main arising issues concerning the product development relates to cost management requiring methodologies such as target costing and activity-based costing, to name a few, to be applied to the Product Development Process (PDP). Upon such a context this work proposes a model for measuring and controlling costs in product development based. Its complete presentation might be found in FILOMENA (2004).

The construction of the proposed model followed three main stages:

- Formulation of a theoretical model based on a literature review of PDP-structuring and evaluation models, cost management techniques and works that analyzed the application of product development (PD) cost management techniques;
- Verification of model applicability in an industrial environment; and
- Adaptation of the theoretical model based on the difficulties identified in the application phase.

Next this article presents a brief literature review, followed by the model presentation and a summary of the results obtained from its application to a company (a bus-body manufacturer).

2. Literature review

While analyzing the literature referring methodologies for the product development, it is remarkable that many authors address economical management as a critical factor for the evolution or management of PDP - ANDREASEN & HEIN (1987), COOPER (1990), PAHL & BEITZ (1996), PRASAD (1996), KOTLER (2000), DICKSON (1997), and CRAWFORD & DIBENEDETTO (2000). These authors mention many different investment analysis methods as tools for the economical management of product development.

According to IGLESIAS (1999), methods of investment analysis are effective from an economical perspective; however, the validity of the information provided by them depends on the accuracy of the data included in the evaluation. The data generated by the costing system are crucial for an adequate investment analysis, highlighting the importance of cost management on product development. Techniques such as Target Costing (EVERAERT & BRUGGEMEN, 2002; MONDEN, 1999; COOPER & SLAGMULDER, 1999), Production Effort Unit (BORNIA, 2002; KRAEMER, 1995; MÜLLER, 1996), Activity-Based Costing – ABC (BRIMSON, 1996; KAPLAN, 1988; SHANK & GOVINDARAJAN, 1997) - and Feature Costing (BRIMSON, 1998) are widely used by cost management professionals. However these methodologies are not widely used in PD.

Target costing is the most used tool for PD-cost management (EVERAERT & BRUGGEMEN, 2002; COOPER & SLAGMULDER, 1999). ABC costing (RAZ & ELNATHAN, 1998; MACARRONE, 1998) and Feature Costing (TORNBERG et al., 2002; BEN-ARIEH & QIAN, 2003; OU-YANG & LIN, 1997; LEIBL et al.,1999) are still fairly used to evaluate the PD.

3. A model for cost management of product development

The model presented in this work proposes the use of a combination of various cost management techniques. It is supposed an adequate cost management model for PD must be based on two different elements: 1) management based on target costing; and 2) calculation of PD costs, considering both 2.1) project costing; and 2.2) costing associated to the introduction of a new product into the company production system. This approach might be necessary since the total product cost must consider either the amortization of project cost and the costs associated to manufacturing and raw-materials, or a tool for monitoring costs throughout the PD stages (target costing).

A main requirement for the usage of this model is the consideration of a product in terms of its *features*, hereby defined as regions of interest for the analysis of the product constitution, a definition initially proposed in studies of design and fabrication of mechanical components as addressed by many authors as CUNHA (1996). More details on the application of the *features* concept to product costing can be found in FILOMENA (2004). Each of the two above mentioned elements of this model will be discussed next.

3.1. Target costing management

Target costing will just be used for cost control during PD, since it is not capable to enable a new product cost estimate. Target costing management is performed in a 3-consecutive steps procedure: 1) determination of unitary product development target cost (UPD); 2) determination of product target cost; and 3) breakdown of 'product insertion' target cost (PIC). Each of these steps is discussed in the following sections. Figure 1 illustrates the 3 stages, with their respective internal breakdowns.

3.1.1. Determination of unitary product development target cost (UPD)

This stage must start from an estimated product demand. The forecast analysis referring new products has been considered by many authors, like KUYVEN (2004), who analyzed the different alternatives and presented an specific approach to this problem. Another input data may be associated to the product development project. A database using Activity-Based Costing seems more appropriate for structuring this kind of cost data. If no such database is available, project costs might be estimated using the company expertise based on the previous experience. The usage of ABC within PD projects is detailed in the section 3.2.1.

From the demand and target cost estimates, one can define the unitary product development target cost (UPD), according to Eq. (1). The importance of the latter originates from the understanding that project costs must be amortized by the respective future products, thus avoiding one product development project to be amortized by other products development projects.

$$Target\ Cost\ UPD = \frac{Project\ Target\ Cost}{Demand\ Estimate} \quad (1)$$

The output datum from this stage is the UPD target cost, i.e., the portion of the product project cost that is amortized by each product.

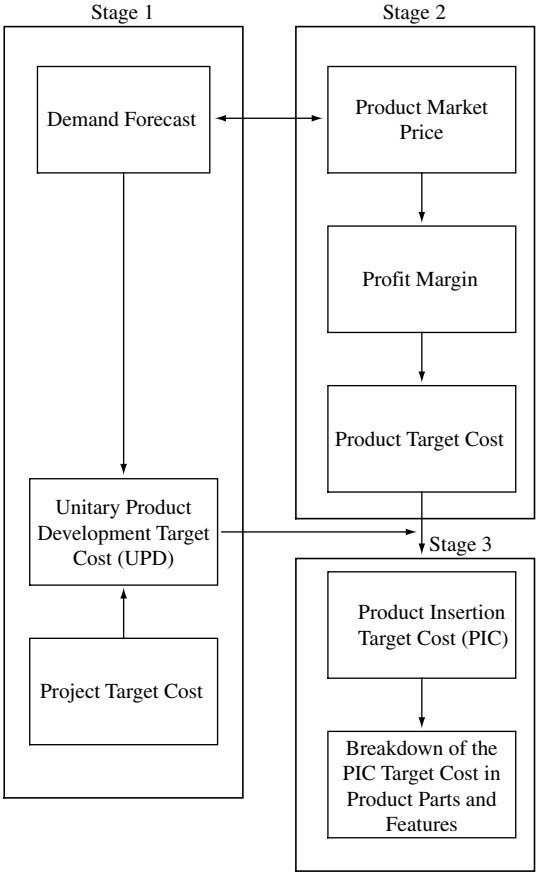

Figure 1. Stages of cost management organization using target costing.

3.1.2. Determination of product target cost

The determination of product target cost starts from the definition of product price; the price, when related to profit margin, determines the target cost.

Three approaches are suggested for the definition of product price:

- definition based on client surveys: ask clients which monetary value they would be willing to pay for a given product;
- definition based on competitors: verify which price is being practiced by competitors for similar products (to those under development); and
- definition based on the experience of the technical team: define target cost according to the price considered adequate by the technical team; the expression 'technical team' refers to both the personnel responsible for PD and the company decision-makers.

Nowadays, products with one single configuration, i.e. only one set of features, are hardly developed. Therefore, care must be taken regarding products possessing a large number of features, which may render price assignment to all configurations difficult. When data collection on prices becomes more difficult due to the occurrence of many different features, the information must be collected for the most significant ones. For the breakdown of product target cost in parts and features one must add to the cost some of the features initially discarded.

The product tax load must not be considered while determining the product market price. BERNARDI (1998) and OLIVEIRA et al. (2003) demonstrated how to evaluate the tax load and to determine product prices.

3.1.3. Breakdown of product insertion target cost (PIC)

The product insertion target cost (PIC) represents the reference frame for costing, and it already considers the unitary product development cost. Subtracting the unitary product development cost (UPD) from the product target cost generates the product insertion target cost (PIC), according to Eq. (2).

$$PIC\ Target\ Cost = Product\ Target\ Cost - UPD\ Target\ Cost \quad (2)$$

After the determination of product insertion target cost, one must proceed with the breakdown of the PIC target cost in product parts, and, afterwards, in product features. Therefore the proposed costing method no longer has the product as its object of analysis; rather, it focuses on product features, following BRIMSON (1998) who defined feature costing.

The breakdown of the PIC target cost in product parts is a critical step in the target cost process, because frequently, one is not able to know the real cost structure of a new product. Three manners of performing the breakdown are proposed herein: a definition based on the product market price, a definition based on the cost structure of a similar product, and a definition based on the experience of the company's technical team.

In the first case, if one admits that product parts can be produced by specialized companies, it is possible that the sum of the target costs

of the parts do not match the desired target cost for the previously defined product. Therefore, the target costs of the parts may probably be reviewed. In general, it is not possible to verify the market target costs of all the parts; as a consequence, one needs to estimate their target costs*.

In the second case, defining target cost from the cost structure of a similar product, one can breakdown the PIC target cost on the basis of the part structure of an older product.

In the third case, a technical team will define the cost structure of the parts based on the team's experience. The team will be formed by technical personnel responsible by PD and by decision-makers.

After defining the target cost for product parts, one can define the target cost for common components, and how much each feature impacts on product cost, either through raw materials or through processing. This procedure generates the common elements target cost and the features target cost. If any common element or any feature is not significant, it need not be individualized in the model.

3.2. Calculation of the cost associated to product development

As it has been already mentioned, considering product development, one estimates the costs associated to project, manufacturing, and raw materials. The next two topics deal with project costing and insertion costing, i.e. the costing of inserting the product into the company production system.

3.2.1. Project costing

The cost of a product is directly related to the cost of activities related to its development. Project cost must be amortized during the product life-cycle, thus leading to the need for a costing method that quantifies the costs of each project separately. Individual cost quantification is required to avoid prorating costs associated to the PD of a specific product among other products.

For project costing, ABC was chosen; an option reinforced by the works of KINSELLA (2002), which proposed the introduction of ABC in The PMBOK (Project Management Book), RAZ & ELNATHAN (1998), which has applied ABC to project management, and MACARRONE (1998) and RAY (1995), which applied the ABM (Activity-Based Management) concept to product development process. The following steps are used in the application of ABC to activities of PDP:

- mapping of activities;
- verification of necessary resources; and
- estimate of activity costs.

The detailing of activities will depend on their importance to product development. For example, prototype development may be more representative in the automobile industry than in the toy industry. Therefore, depending on the characteristics of the industry, some stages will require greater detailing in order to allow a better understanding of their costs.

3.2.2. Costing of product introduction into the company production system

The cost related to the insertion into the company production system is critical for the economic evaluation during the development process. It is important to determine the impact of the new product in the company structure, which can be either directly or indirectly related to the production.

The method presented in this paper uses the product breakdown into parts and features, an adaptation of the model proposed by BRIMSON (1998). On the other hand, the allocation of costs to product features is based on the work of KRAEMER (1995). The next section will provide details on the feature costing as used in the model.

3.2.2.1. Feature costing model

BRIMSON (1998) introduced feature costing as a detailed version of the ABC method, since in his study product cost using ABC is determined focusing the product as the costing object. In Feature Costing the product cost is determined by features. However, feature costing is not limited to the use of ABC, and this work combine this approach with two other costing methods – namely standard-cost and UEP.

Feature costing does not constitute a new method on itself, but a new manner of allocating costs to products using a new costing object. When acquiring a new product, the client also acquires its features, which can vary even within the same product category.

Costs related to the insertion of products in the companies production systems were classified into three major groups: costs related to the consumption of raw materials, transformation costs, and structuring expenses (administrative costs associated to the production). Transformation costs relate to costs that add value to the product (manufacture, assembly) and to those related to the after-sales support (which indirectly add value).

In this work, the approach based on feature costing uses three costing methods: ABC, for indirect transformation expenditures and structuring expenses; UEP, for direct transformation expenditures; and standard-cost, for expenditures related to raw materials – following KRAEMER (1995). Figure 2 presents the costing system used in this work; its detailing appears in the next sections.

3.2.2.2. Stages for the implementation of a feature-costing model

Next it will be analyzed the information structure required for the utilization of feature costing, based on the three aforementioned costing methods (ABC, UEP e Standard-Cost).

Step 1 – Determination of product features

Here appears the concept of features, i.e., the interest zones existing in the product which can be identified as regions related to the production costs or to the generation of value for the consumer. Detailed applications of this concept can be found in FILOMENA (2004).

Step 2 – Relation among features and costing methods

First, it must be verified the breakdown of features performed in Step 1, thus enabling to correlate them to the costing methods. The costing object is the set of features. At this stage, the relationship standards among the costing object and the costing methods must be established. Such standards are not monetary, but consumption-related. Therefore, a variation in the cost of an activity or process will automatically update the monetary value of the costing object.

Step 2.1. – Relation with raw material costs

The relationship between features and the standard cost method is simple; it is a matrix relation between the costing object and its consumption of raw materials, including normal process losses.

Step 2.2. – Relation with transformation costs (except support ones)

Costing based on the UEP method is performed in a conventional manner. However, the costing object is not the product, but the set of

* *Other methods to estimate the target costs parts are described in Filomena (2004).*

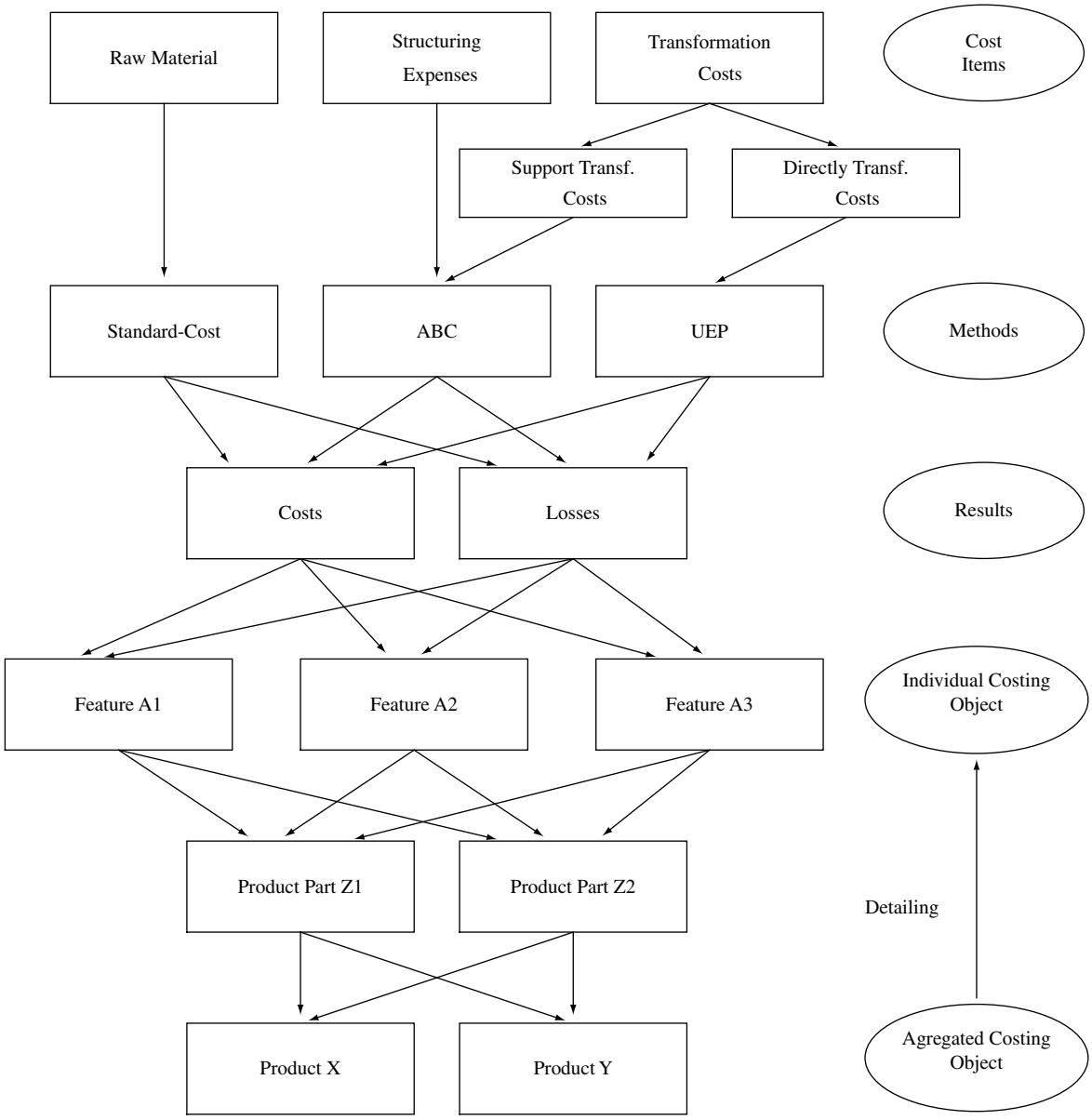

Figure 2. Feature-costing method used herein (adapted from KRAEMER, 1995).

its features. Therefore product breakdown is fundamental, because it serves as the basis for the time takings concerning the process.

In order to operationalize the UEP method, it must be required the processing time of each feature to be known at the workstation. Therefore, one can multiply the productive potential of positions by their processing times. For the definition of processing times three options are offered:

- use sub-assembly times regarding similar components;
- estimate the processing times of new configurations by talking to operators and supervisors; and
- simulate the new configurations in the productive process.

A base-configuration, i.e. one with the same attributes of the base-product, which represents the structure of the processes consumed by the features, must be used in the method. Since, in general, features consume the same processes, although in different quantities. The base-configuration must be formed by the features which are more used by products. Those changes in the method render the procedures for calculating the costs of parts and features equal to that of products.

Step 2.3. – Relation with structuring and transformation expenses (support to production)

Activity-Based Costing is used for the calculation of transformation costs (excluding directly transformation cost). The first two implementation stages remain unchanged - activities must be mapped and, on the sequence, costs must be allocated to the activities, according to resource drivers.

Like the application of the UEP method, in the ABC method the costing objects will be the features instead of the product. Activity drivers must be related to the features and common elements, not to

products. This is fundamental for some support areas such as product engineering, since product features are directly related to activities such as product redesign, and procurement, among others.

Step 3 – Determination of feature costs

Through the relationship among features and common elements from one side and costing methods from another, it is possible to compute feature costs. To this end, a matrix algebra is proposed: lines are costing objects and columns are activities, operations or raw materials. At line-column crossings, and using the consumption determined in step 2, it is possible to calculate the costs associated to features and common elements.

Step 4 – Formation of product cost from product features

Product cost, in feature costing, must be formed from features, thus representing a new level of cost traceability. The features consumed by products must be determined. Figure 2 displays the relationships among costs, costing methods and costing objects, as proposed by the method described herein.

The approach based on features is important not only for product development; in industries with high customization requirements, product costing can be difficult to evaluate due to many product configurations. In such situations costs are computed for features and common elements before its incorporation to products.

Figure 3 presents the information flow on the cost estimate of product development as proposed by the method. It encompasses estimates of feature costs, and project costs, thus leading to the overall evaluation of product costs.

4. Brief presentation of results concerning a case study

This work does not detail the intermediate steps before reaching the Product Insertion Target Cost and the Total Estimated Cost. Only the final breakdown for a set of seats (product) from a bus body producer is presented. Table 1 shows the Product Insertion Target Cost, Total Estimated Cost, their difference and the reduction to be achieved if estimated production costs are supposed to be in accordance with market parameters. Table 1 clearly shows that all product features should suffer some cost reduction in order to reach the target cost parameters. Some features must be reduced in about 45%. Table 1 summarizes the types of results which can be obtained by the application of the proposed model.

5. Conclusions

This work has briefly presented a procedure elaborated for the management and appropriation of costs inherent to product development. The method focused on the combination of different costing methods (standard-cost, cost centers, activity-based costing, production effort unit, feature costing) in order to cover the different aspects associated to cost management and cost generation during product development, both at the project stage and at the stage of insertion into the company production system. The approach is necessary since there is no single method which is capable of handling all of these aspects. The proposed model was based on target costing management and on the quantification of costs generated by development.

It is important to notice that, when adequately performed, cost appropriation should provide the company the information required to support decision-making regarding the development of future products, and it should become an element of support to most of the product development tasks.

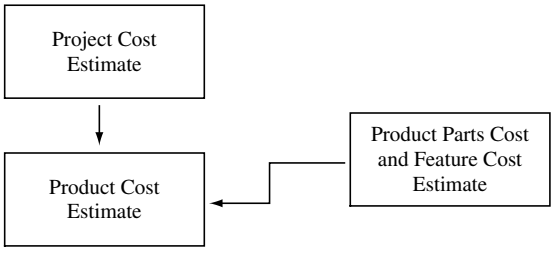

Figure 3. Information flow to estimate costs related to PD.

Table 1. Monetary and percentual reductionof each feature.

PP	Feature			(1) PIC Target cost (R$)	(2) Total Estimated Cost (R$)	(2)-(1) Difference (R$)	1-((1)/(2)) Perc. Reduction (%)
Structural Part	(2) Common structural elements			85.63	100.40	14.77	15
	Fixed arm	(21) Fixed common elements		7.05	12.17	5.12	42
		Ashtray	(2ab1) w/ ashtray	9.57	14.06	4.49	32
			(2ab2) w/o ashtray	8.06	11.65	3.59	31
	Movable arm	(22) Common movable elements		9.04	16.34	7.30	45
		Ashtray	(2bb1) w/ ashtray	20.01	21.09	1.08	5
			(2bb2) w/o ashtray	18.31	19.82	1.51	8
Finishing Part	Conventional	(31) Common conventional elements		54.79	70.59	15.80	22
		Revestimento	(3a1) Vulcouro	23.02	38.75	15.73	41
			(3a2) Fabric	54.79	76.47	21.68	28
	Soft	(32) Common soft elements		99.19	105.12	5.93	6
		Covering	(3b) Fabric	53.41	89.94	36.53	41
	Magazine holder	(4a) w/Magazine holder		13.54	15.27	1.73	11
		(4b) w/ Magazine holder		10.18	11.91	1.73	15

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