INTERNATIONAL CONFERENCE ON ENGINEERING DESIGN
ICED 03 STOCKHOLM, AUGUST 19-21, 2003

# PROCESS BASED RESOURCE-ORIENTED CALCUALTION OF THE RELATIVE COSTS OF PRODUCT CONCEPTS

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## Abstract

The choice of the most promising product variant concerning its manufacturing cost at an early development phase belongs to those factors that have a decisive influence on the later success of a product. Hence, a cost evaluation of product variants in the early development phases has an immense influence on a successful concept choice.

A cost-evaluation method for prototype industrial products in the "late" conceptual and "early" embodiment design phase will be presented. Based on a systems engineering analysis of the elements, the interrelations of the parameters causing manufacturing costs as well as on the fundaments of the process-based costing and the resource theory, the relative manufacturing costs of concept variants can be estimated. Therefore, the method utilizes data concerning the company manufacturing resources and critical product concept parameters. The product designer is encouraged to develop possible manufacturing scenarios and estimate several critical parameters. The goal is to enable a reliable cost evaluation under an integrated product-process-view, based on a transparent and based-on-use cost allocation.

*Keywords: Evaluation of design, design-for-X, engineering analysis, optimization technique, relative costs*

## 1. Introduction

The economic success of manufacturing firms depends on their ability to identify the needs of customers and to create products that meet these needs and can be produced at low cost. Achieving these goals is not solely a marketing problem, nor is it solely a design problem or a manufacturing problem; it is a product development problem involving all of these aspects [1]. Besides, due to the market situation the product innovation and development time must become shorter [2, 3, 4] which imposes less loops and efficiency increase in the design process [5]. Thus, the general task for design engineers can be summarized in the fast development of cheaper products of higher quality that meet the required functionalities and specifications in the highest degree. Therefore evaluation methods in product development are indispensable. Their function is to lead the designer as fast as possible to the best design-solution. The most important criterion in the concept evaluation procedure is cost [1]. A key point for a successful cost evaluation in the early development phases is to apply a reliable and "easy to use" method to measure the cost-effectiveness of concept variants. These prerequisites are accomplished when cost evaluation methods utilize transparent procedures and "objective" facts as well as the – at this phase – limited available data without involving the product designer in unjustifiable (considering the application benefits) time-wasting operations.

## 2. Cost evaluation in design

The phase model for product development suggests concept and design evaluation (incorporating also a cost evaluation) in the end of the conceptual and embodiment design phases. This is valid regardless of the phase model considered (i.e. those of *Pahl & Beitz, Koller, Hubka, French, Pugh, Ullman, Ulrich & Eppinger, van den Kroonenberg & Siers*) since they have principally similar structures [6, 7].

Considering the cost evaluation in the phase of the embodiment design, there are several analytic, statistic, based on similarity and heuristic methods as well as software models, which can estimate a possible absolute value for material, manufacturing or other costs (see [2, 4, 8, 9, 10, 11, 12, 13]). These methods utilize the main advantage of this design phase, which is that form, shape, dimension, material and production data are more or less concrete and so they allow the calculation of a cost value.

In the phase of the conceptual design the cost evaluation of concept variants is included as a partial criterion in general concept *evaluation methods* (Technical-Economic Rating, Value Analysis, Analytic Hierarchy Process, Datum Method, etc.) or it is separately conducted on the basis of *estimation models* (Parametric estimates, Engineering Built up, Analogue Systems Estimates, etc. [4, 9, 10, 11, 13, 14, 15]). In the first case the cost (as a total or split into its components like materials, manufacturing, etc.) undergoes a score/index-type estimation usually through the comparison between concept variants. Such a "relative cost" consideration can accelerate the evaluation; moreover, in case of "cost-splitting" into sub-estimations and partial comparisons the evaluation's precision can be further enhanced [16, 17], which is also implied through the influence of the error compensation effect [4, 16]. However the evaluation's precision can be negatively influenced through its strong dependence on the limits of the estimator's experience, the possible influence of his favourite variant and/or other decision making factors [1, 2, 4, 5, 8]. In the second case, the use of parametric estimations, knowledge-based or fuzzy and neural systems promises the estimation of absolute cost values through the consideration of several objective cost factors; However, the usual prerequisite for application of those models is the consideration of a significant amount of cost data of numerous past products, which can require a lot of time and cause high costs in order to introduce the model to the company and keep it up to date [4, 9, 13]. Additionally, a lack of transparency on the cost generation processes can also be noticed in those models [4, 9, 13].

## 3. Goals and Methodology

The method to be presented enables a *cost evaluation of concept variants for prototype industrial products based on the estimation of their relative costs*. The goal is to combine the main advantages of evaluation methods and estimation models while ensuring the method's profitability against introduction and updating costs and time. Thus, the method should:

a) associate fundamental product concept, manufacturing and economic features (in order to increase the reliability and transparency of the evaluation),
b) "split" the total evaluation to sub-estimations (whereby the error compensation effect is also exploited) and utilize comparisons of parameters between different variants (in order to promote the precision of the evaluation),
c) concentrate on core activities (in order to keep the implementation time and updating costs on acceptable levels),
d) relay on company resources (thus allowing an "inter-company" and product independent adaptation as well as to reduce its dependency on cost data of past products).

Therefore, elements of the Systematic Design Theory will be used for the product analysis, elements of the Activity Based Costing and the Resource-Oriented Cost Calculation Model will be used for the cost analysis of manufacturing processes. Finally, elements of the Systems Theory will be utilized in order to integrate the product and process aspects in a cost evaluation method for concept variants based on the estimation of their relative costs.

## 3.1 Fundaments and general structure

Due to the limited extend of design and production data in the early design phases, the consideration of relative ranges provide more reliable values than the estimation of absolute values. The product designer should be able to conduct a quick and reliable evaluation based on the "working structures" (*Wirkstrukturen*) of product concepts (Figure 1). Having this goal, he will be encouraged to consider a limited number of shape, dimension and material parameters – that can be foreseen in this stage – as well as core processes to be initiated and main resources to be consumed (by estimating the value of their driving parameters) for the manufacturing of each variant in a possible extend (goals "a", "c" and partly "d"). At this point crucial cost affective parameters will be taken into account. Resources and production processes can be considered for *present or new production facilities* (which are expected to be necessary for the manufacturing of parts or sub-groups of the new product), since there exists no relevant restriction in the method. Such a procedure will result in the decomposition of the total estimation to partial estimations (goal "b"). Besides, values for the parameter estimations will be basically based on relative range and comparative considerations (goal "b"). On the other hand only driving parameters (of the concepts, processes and resources) will be used in order to maintain a low number of partial estimations (goal "d").

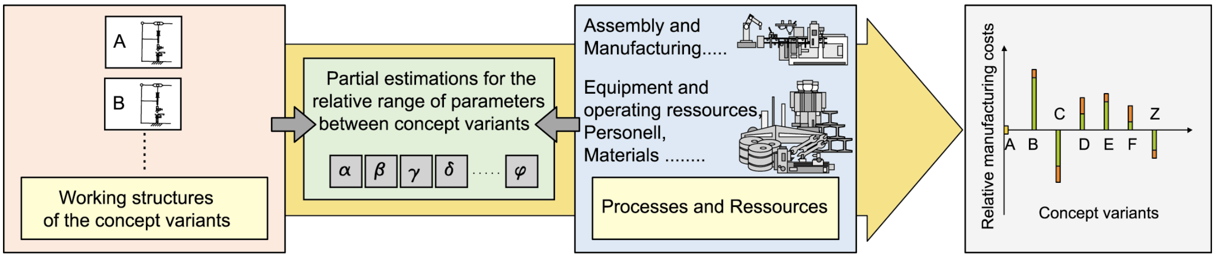


Figure 1. General concept and parameters for the relative cost evaluation.

The Process Cost Calculation Theory (see [18]) or Activity Based Costing (see [19]) claims that the cost calculation can become transparent, and thus more precise, through the allocation of costs to the sub-processes causing it. On the other hand the Resource-Oriented Cost Calculation Model (see [20]) increases the cost estimation accuracy through the allocation of the resource consumption on each product unit. Since costs are generated from the initiation of manufacturing processes and the consumption of resources throughout those processes, the combination of the stated methods could allow a fair cost allocation for each product unit. This approach is also suitable for relative-cost based comparisons [20]. Both methods take into consideration the costs of the "direct and the indirect sector".

The activities included in a manufacturing process are structured in several sequences, which constitute the different manufacturing flows. The kinds of flows depend on the observers' position and the object observed. In this case it seems that the most appropriate flow to describe the manufacturing cost generation is the *material flow*. A manufacturing process is initiated with the materials (row, finished, semi-finished and purchase items). Under the effect of a set of activities the row materials undergo manufacturing processes (incl. assembly), which lead to the complete product at the end stage of the flow. During the execution of these activities numerous resources are consumed. Their consumption rate is basically different depending on the kind of activity, the manufacturing stage and the type of material object (item, component) processed. Hence, it is now necessary to determine the terms "material", "activity", "resource" and "resource consumption rate" and their combination in the material flow in a general "inter-company" context. The latter is a prerequisite for the adaptation of the method in different manufacturing and product cases. Moreover, it is mandatory for the analysis to consider possibilities, characteristics and restrictions resulting from the concept description data usually available on this early product development phase.

## 3.2 Parameter clarification

*Material*

Considering the Systematic Design Theory, working structures of concept variants consist of "working elements" (*Wirkelementen*). These elements are generally characterized by their "working place" (*Wirkort*), "working geometry" (*Wirkgeometrie*), "working motion" (*Wirkbewegung*) and their "working material" (*Wirkmaterial*) [8]. For this method it is necessary to enhance the working elements with some attributes, which are crucial for the cost estimation. These attributes concern geometry, shape, dimension and material. Hence, the working elements obtain a limited physical dimension. This can be regarded as a step entering the embodiment design phase, however without regularly initiating it. Thus, concerning the material, the material class is significant (i.e. high/low strength construction steel, tempering steel etc.); concerning the "dimension", volume and a crucial area or dimension is important (especially for finished or purchase items like bearings, couplings, etc.); for the "shape" and "geometry" significant are complexity factors and attributes ranking i.e. their pile or entanglement capability as well as factors describing the shape and surface quality. These elements (which included extended characteristics) allow the construction of the concept variants in a way that a relative cost estimation can be conducted. An element, which has such attributes, will be considered as a separate entity, the *construction element,* since it can neither be classified to the classical working elements nor to the classical machine components (*Bauelemente*).

In order to implement the process-resource model for a relative cost evaluation, concept variants consisting of such construction element, principles of the Systems Engineering Theory will be used. In particular, each construction element can be seen as an element with *parameters* and *states* (Figure 2)*,* which can be changed through the interaction with its environment [21]. Special *functions* define the outcome of this interaction. In this case, the *parameters* are the element geometry, shape, dimension and material attributes as described above. The *states* concern the basic production sectors and the activities taking place there during the material flow, which concern the element. The *relations* connect the element with the states as well with other elements in order to "activate" the proper *functions* for the "interaction" with the parameters of the elements. The *input(s)* are the activity dependent resources consumed during the manufacturing process on each *state* as well as other activity related data. The *output* is the cost caused in a certain *state* as the result of the interaction of these factors according to the defined functions. The sum of these costs is the "equivalent" concept manufacturing cost, which will be used to build a ratio giving the concept relative cost.

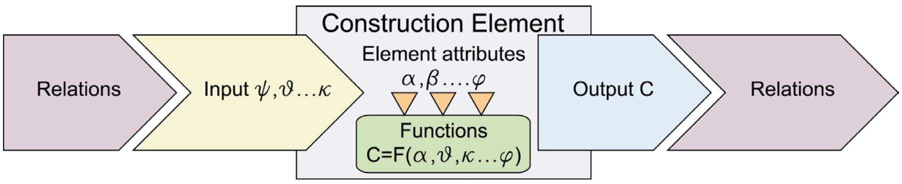


Figure 2. Structure of the construction element for the concept variant modelling

*Activities*
The analysis of the sub- and elementary manufacturing processes (incl. assembly) for a product allows the definition of several activities taking place. Oriented on the material flow, the abstraction of the activities that materials are involved in the different manufacturing departments and stages, enables their categorisation in the generalized functions “control”, “handle”, “transport”, “store” and “process” (Figure 3). Depending on the manufacturing context, the functions can be concretised and describe a certain elementary process. For instance, the function “process” can correspond to a sub-activity like “drilling” for the fabrication or “welding” for the assembly. The material flow consists of sequences of such functions for each “material component”. The definition and use of those functions is essential for the process-based character of the cost evaluation.

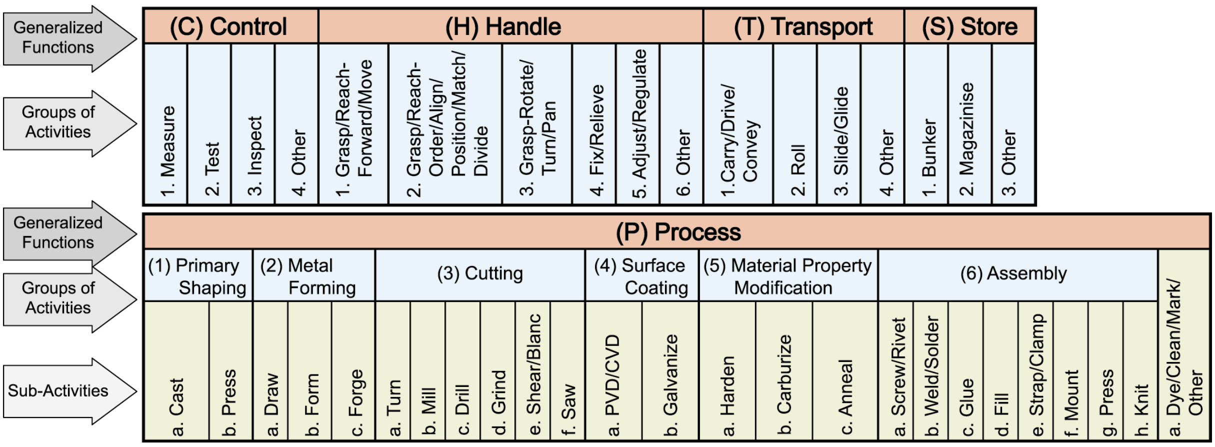


Figure 3. Generalized Functions of the manufacturing process summarizing the specific activities included

*Resources*
In the production process several resources (existent or to be supplied – like e.g. new milling machine) are involved and consumed. The analysis of the sub- and elementary manufacturing activities (material-flow oriented) allows the clarification and categorization of those resources. The first two generalized stages of the resource hierarchy may be seen in Figure 4 (next page). The third stage is here omitted since it corresponds to the definite form of a resource as a kind of cost centre (i.e. the resource “Machinery” can refer to a milling machine or to a cell of drilling machines). The consumption of a resource causes costs because it corresponds to the consumption of several *cost types*. The resource itself specifies only which cost types are involved and to which extend. Thus, an appropriate combination of the *driving* cost types for a resource will give the *cost rate* $c_{RES}$ of the resource (Figure 4). This cost rate can have the dimension of a cost unit (€) per time unit (s, min, h), per weight unit (kg), per volume unit ($m^3$) or per piece. For instance, the cost rate for a milling machine is the sum of $C_{EC}$, $C_{ED}$, $C_{EM}$, $C_{EA}$ and $C_{EE}$ (driving cost types in this case, see Figure 4) divided with the sum of the hours the milling machine is approximately used each year (resulting cost rate in €/h). For a milling tool (resource “Tooling”) the cost rate consists of its purchase price including its reworking costs till it’s useless ($C_{EV}$) divided with its total life time (cost rate in €/min).

*Resource consumption rates*
When an activity is performed, which somehow changes the state of a component, some resources are involved and consumed. In this sense, it is now important to define functions, which will give the consumption amount of a resource because of the performance of an activity. This measure can be time, volume, weight or piece number. So, in the case of the activity “P5b: Mill” (milling, see Figure 3) for a block of steel, the cost driving resources may be “E2: Machinery” and “E3: Tooling” (milling machine and milling tool respectively) as well

as "P2: Technician" since somebody must set up and operate the equipment. The consumption amount of these resources is the total milling time. The total time "t" for an activity consists of the "primary time $t_p$", the "secondary time $t_n$" and the "set-up time $t_s$ per piece". The multiplication of the total time with the cost rates of the corresponding resources yields a cost value $C_{ACT}$, which characterizes the activity.

| | Resource | Type of Cost |
|---|---|---|
| Personell (P) | 1. Worker<br>2. Technician<br>3. Manager | $C_{PR}$: Wage/Salary.....................€ or € / h<br>$C_{PS}$: Shift Bonus......................€ or € / h<br>$C_{PB}$: Bonus.......................................€ |
| Material (M) | 1. Raw Material<br>2. Standardized Part<br>3. Purchase Item<br>4. Auxiliary Material<br>5. Scrap Material/Item | $C_{MR}$: Cost Rate..................€ / m³ or € / kg<br>$C_{MP}$: Purchase Price...............................€<br>$C_{MW}$: Waste Disposal Price..........€ or € / kg |
| Equipment and Operating Resources (E) | 1. Plant<br>2. Machinery<br>3. Tooling<br>4. Device<br>5. Control/Measure Equipment<br>6. Transport Equipment<br>7. Storage Equipment<br>8. Other Equipment (Work planning and organisation equipment,furniture, etc.)<br>9. Waste disposal Equipment<br>10. Special Direct Costs (Prototypes, etc.) | $C_{EC}$: Capital Compound Interest.....€ / anno<br>$C_{ED}$: Depreciation..........................€ / anno<br>$C_{EM}$: Maintenance (Technician, spare parts, out of operation costs)...................€ / anno<br>$C_{EE}$: Consumed Energy (Gas, electricity, oil, water)..... € / anno<br>$C_{EA}$: Ocupied Area (Compound intereset and depreciation for buildings, rent, heating, illumination, cleaning, maintance, insurance etc.)..... € / anno<br>$C_{EV}$: Costs Value as a total.....................€ |

Figure 4. Types of costs, which are principally involved in the calculation of the cost rates of each resource

The functions for the resource consumption rate should include typical resource data (like kind of process, machine power, capacities, etc.) and component data (material properties, rough initial and end-geometry). These formulas consist usually of four terms (Figure 5):

- The first term includes the "process amount" (i.e. material volume in $mm^3$ in a forging process) divided by the required power capacity of the resource in order to fabricate the material (i.e. the power of the forging machine in W divided by the deformation strength of the material in $N/mm^2$), which results in a standardized process time.
- The second term names the influence of the change of the quality properties of the material (i.e. surface quality class IT6 causes almost the double costs as IT10 [4]).
- The third term shows the influence of the change of the geometrical complexity of the material through the process.
- The last term considers the special process restrictions concerning the process-material compatibility (i.e. the flow resistance of a casting material in the mold cavities).

Normilized process time based on „process amount" and resource capacity

Influence of the geometry complexity change

$$t_{p_f} = \frac{V}{P/k_f}(1+\Delta R)\cdot(1+\Delta K_g)\cdot\sqrt{\frac{h_{\max}}{h_{\min}}}$$

Primary time

Change of material quality properties

Process-material specific restrictions

Figure 5. Example of a formula structure for the estimation of the primary time of an activity

In Figure 6 possible formulas of functions for the resource consumption rate concerning the activity time are indicated. Time formulas given there as a function of various variants, like i.e. $t_s$=$f(L, K_a)$, can be generated from multiple regressions of the variants in brackets

| Primary time $t_{pxx}$ | Control | Handle | Transport | Store |
|---|---|---|---|---|
| | $t_{p_{op}}$ | $t_{p_a} = f(V \cdot \rho, L, K_a)$ | $t_{p_a} = (L/v_t)/n_{conv}$ | $t_{p_{st}} = t_{st} \cdot A_{ext}/A_{st}$ |

| Process | | | | | |
|---|---|---|---|---|---|
| Primary Shaping | $t_{p_d} = V \cdot \frac{p}{P}$<br>$t_{p_m} = V \cdot \rho \cdot Q_{melt}/P_{th}$<br>$t_{p_f} = V/q_s \cdot \sqrt{(h_{\max}/h_{\min})}$ | Cutting | $t_{p_V} = \frac{\Delta V}{P/k_c} \cdot (1+\Delta R) \cdot (1+\Delta K_g)$<br>$t_{p_{sh}} = \frac{L \cdot A}{P/\tau_B} \cdot (1+\Delta R) \cdot (1+\Delta K_g)$<br>$t_{p_A} = \frac{A}{A_s} \cdot (1+\Delta R) \cdot (1+\Delta K_g)$ | Assembly | $t_{p_L} = \frac{L}{v_s} \cdot (1+\Delta R) \cdot (1+\Delta K_g)$<br>$t_{p_f} = V/q_s \cdot \sqrt{(h_{\max}/h_{\min})}$<br>$t_{p_a} = f(V \cdot \rho, K_m, \Delta R, K_a)$ |
| Metal Forming | $t_{p_f} = \frac{V}{P/k_f}(1+\Delta R) \cdot (1+\Delta K_g) \cdot \sqrt{\frac{h_{\max}}{h_{\min}}}$ | Surface Coating | $t_{p_{fp}} = t_{PM} \cdot \frac{V_{enc}}{V_{f/p}}$ | Material Property Modification | $t_{p_{fp}} = t_{PM} \cdot \frac{V_{enc}}{V_{f/p}}$ |

| Primary times for material cooling through convection or conduction | Primary time for known machine operation cycle | Secondary time | Set-up time |
|---|---|---|---|
| $t_{p\,th_{conv}} = \frac{P_{th}}{\alpha \cdot \Delta T} \cdot \frac{1}{A_u \cdot (1+\Delta K_g)}$ $t_{p\,th_{cond}} = \frac{P_{th}}{\lambda \cdot \delta_m \cdot \Delta T} \cdot \frac{1}{A_u \cdot (1+\Delta K_g)}$ | $t_{p_{op}}$ | $t_n = f(V \cdot \rho, L, K_a)$ | $t_s = f(L, K_a)$ |

| Material-process parameters | Material/item parameters | Resource parameters | Process-resource parameters |
|---|---|---|---|
| ΔV: Item volume to be processed/removed<br>A: Item surface to be processed<br>L: Total operation/process distance/length<br>ΔR: Relative quality class variation<br>$\Delta K_g$: Relative geometry complexity variation | V: Item volume<br>$V_{enc}$: Item volume ratio<br>$A_{ext}$: Required storage surface<br>$h_{max}/h_{min}$: Max/min wall thickness<br>ρ: Material density [22]<br>$Q_{melt}$: Minimum melt energy [12]<br>$k_c$: Specific cutting force [22]<br>$k_f$: Deformation strength [22]<br>$\tau_B$: Shear strength [22] | $v_t$: Transport velocity<br>$v_s$: Process velocity<br>$A_{st}$: Total storage surface<br>P: Machine power<br>$P_{th}$: Thermal power<br>$A_s$: Specific surface cut rate<br>$q_s$: Flow/cast/fill rate<br>$V_{f/p}$: Furnace/pool volume<br>p: Injection pressure | α: Heat transfer coefficient [22]<br>λ: Thermal conductivity [22]<br>$\delta_m$: Wall thickness<br>ΔT: Temperature difference<br>$A_u$: Heat transfer surface<br>$K_m$: Assembly complexity factor<br>$K_a$: Various operation factors<br>$n_{conv}$: Transported items – lot size<br>$t_{st}$: Item storage duration<br>$t_{PMt}$: Prescripted process duration |

Figure 6. Principal formula structure for the estimation of the primary time of an activity

based on data tables for assembly operations (like MTM, Working-Factor), machine standards [12] or other company related records [4, 10, 12]. Alternatively, these time-data can be chosen from spreadsheets after a rough data clustering for significant operations and part parameters. The classical material costs $C_{MAT}$ can be calculated from the material volume V or weight G, multiplied by the price of a reference material per volume or weight unit $k_{V/Gref}$ and the relative cost factor $k^*_{V/G}$ between reference and used material [4, 12]. In the case of purchase items, the material cost can be specified likewise from the multiplication of a relative cost value (taken form cost tables) by a reference price [4] or directly through its (expected) purchase price $C_{PUR}$ if known (see also Figure 8 on page 9).

## 3.3 Relative cost estimation

In order to perform the estimation of the relative manufacturing costs of concept variants a certain strategy should be pursued. In order to illustrate it, concept variants for the transmission of the lifting aggregate of a harvest machine will be used. Firstly, the most significant working elements of each concept should be chosen. These would usually correspond to “A or B product components” of an ABC-Analysis [4] in the embodiment design phase. In Figure 7 one of those concept variants can be seen. In this case the “A-components” could be the machine cell, the shafts and the gearwheels; “B-components” could be the bearings, the caps, the switch arm and the joints. Then, possible material, dimension and form attributes should be granted to the working elements in order to turn them to construction elements. Concerning i.e. the splinted shaft, these could correspond to the material class (i.e. high strength constr. steel), the shaft length L and max. Diameter $D_{max}$, the assembly complexity factor $K_m$, the relative geometrical complexity variation $\Delta K_{gi}$, the volume $\Delta V_i$ to be processed and the surface quality class increase for each “i” manufacturing process-activities (Figure 8). Afterwards, the path of each construction element in the company manufacturing-park from row material up to the end product must be assumed. Here, only the most significant activities from Figure 3 for each element concerning the cost generation must be specified (Figure 7).

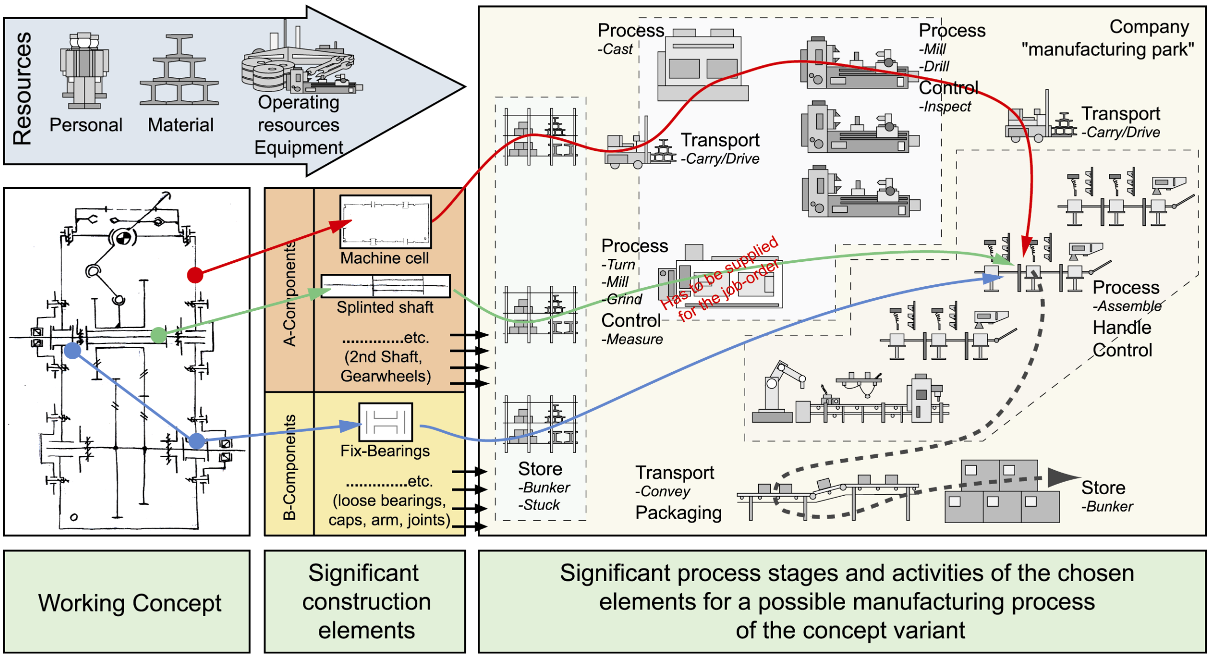


Figure 7. Definition of the crucial manufacturing activities for A- and B-components of a concept variant for the transmission of the lifting aggregate of a harvest machine

Now, for each activity the most significant resources consumed must be determined. The cost rates of the resources can be calculated from Figure 4 (for a calculation example see page 5). In a following step, min/max values for the material attributes and the process related parameters for the activities chosen must be estimated as well as capacity values for the equipment and the resources to be utilized must be determined. With the use of the formulas for resource consumption (see section 3.2, Figure 6) and the calculated cost rates of each resource, the equivalent cost values for each construction element and activity can be calculated. The matrix form (Figure 8) summarizes this procedure. The choice of a concept as a reference concept allows to get the relative costs of the concept variants (see Equation 1, for the nomenclature see Figure 8) by dividing the "equivalent cost value" of each variant ("X"-indicator) with that of the reference ("Ref"-indicator). Hence, it can be calculated that i.e. the manufacturing costs of the "concept variant Nr. 2" are expected to be 1,5 times lower than these of the reference concept, while those of the "concept variant Nr. 5" are 2,3 times higher. In the Equation 1 the factor in square brackets considers the influence of the "C-components" (i.e. screws, standard items, etc.) in the total cost value. Hence, $R_{Crel}$ denotes the costs of the "C-components" in relation to the total costs (usually 5-10%); $n_{X/Ref\,k}$ denotes the relative amount of the "k" kind of C-items (i.e. screws) between the reference and an arbitrary concept variant; $c_{Relk}$ denotes the relative cost value between C-items (i.e. between different kind of screws, between screws and bolts, etc.). Values for $c_{Relk}$ can be taken from relative cost tables (i.e. [4]) and company records.

$$\frac{C_{X}}{C_{Ref}} = \frac{\sum_i \left( C_{MAT_{iX}} + C_{PUR_{iX}} + \sum_j C_{ACT_{ijX}} \right)}{\sum_i \left( C_{MAT_{iRef}} + C_{PUR_{iRef}} + \sum_j C_{ACT_{ijRef}} \right)} \cdot \left[ R_{Crel} \cdot \sum \left( n_{X/Ref\,k} \cdot c_{Relk} \right) \right] \qquad (1)$$

It must be emphasised that through the value range that can be given for several parameters (min/max values), the calculation of minimum and maximum relative cost values is possible. Thus, a "confidence" range for the estimation can be determined.

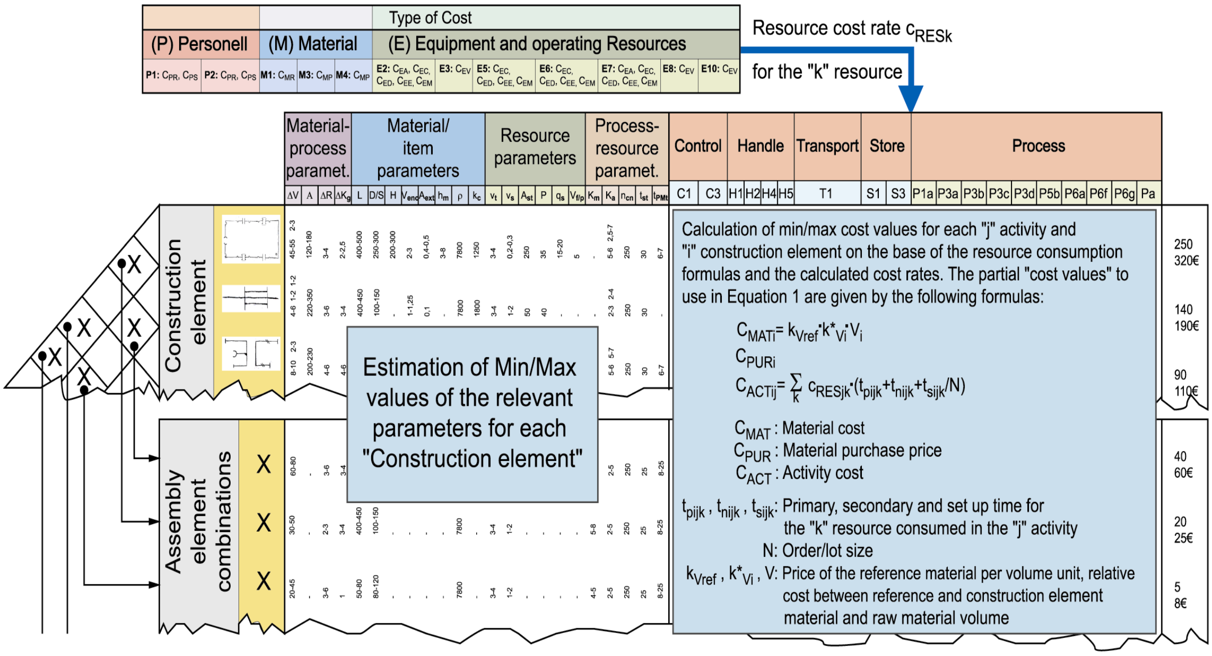


Figure 8. Process matrix for the calculation of the equivalent cost value of a concept variant for the transmission of the lifting aggregate of a harvest machine (Variable, cost and activity codes and normenclature are to be taken from Figures 3, 4 and 6 respectively)

# 4. Conclusions

The method presented suggests a process for cost evaluation of concept variants for prototype industrial products based on a relative costs' estimation. It pursues to comprise the advantages of evaluation methods and cost estimation models. Namely, the chosen way of forming partial costs considering where (sector), when (process stage), how (operation) and why (resource and order data) they are generated should contribute to a transparent and fair cost allocation. Moreover, the combination of "splitting" the total-evaluation in sub- and local estimations oriented on possible production activities while providing functions for a more objective estimation of their cost relevant factors should improve the precision of the total estimation comparing to other evaluation methods. The use of known (or under circumstances expected) facility data can principally "release" the estimation from the need of a large amount of cost data of past products. This is expected to reassure an inter-company implementation, accelerate the method introduction and reduce the updating costs, compared to other estimation models. The use of value ranges for the local estimation allows to get confidence ranges for the estimation and also to extend it for detail statistical data processing like, for instance, on the base of the Gauss distribution. The matrix structure and data content of the method allow its implementation as a software tool to support a prompt and solid concept cost-evaluation.

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