Value Engineering in the Product Development Process: an application in automotive industry"

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ABSTRACT

This paper presents an application of value methodologies. The discussion of the case study points out the innovative aspects of this project, a real experience done during the concept and the preliminary design phases of the development process of a new car.

The application, fitted to the specific industrial environment where it occurred, deals with the following aims:

- analysis by functions of the competitors' products, based on costs and on the voice of the customer;
- description of the best alternatives with respect to customer satisfaction and target cost achievement.

INTRODUCTION

The application of methodologies for the Value Management in such an industrial environment as the automotive one, characterized by a product that presents a high number of functions and components, is a complex process that involves all the company roles and requires that everyone shares the decisions taken.

The experience presented in this paper refers to the activities done with Fiat Auto in the last two years, during a project of innovation related to the development process of a product (specifically a new car) by means of an approach that could integrate several Value and Cost Management methodologies. To this aim, ISVOR and CRF, as FIAT group companies addicted to training and methodological innovation, have provided Fiat Auto with advice both for methodologies development and customization and for company diffusion.

The application context of the project for Fiat Auto has been the existing development process of the product (that is a new model of car),which, as well as being clearly defined and established in company procedures, was also in progress, and therefore strictly bound in terms of time, assets and human resources. From this point of view, the project has been set up choosing between the completeness of product and approach (that is an integral application of the methodologies in each development phase of the entire product "car") and chance of a future use for the suggested procedure.

Since the contents introduced by these methodologies have an high strategic relevance, it's been assumed that the approach could even be imperfect, because of not considering all the sub-systems of a car, provided the chance of implementation was very high.

Therefore, the activities, mainly concerning with Value Engineering, have been carried out in the organizational context of the existing process, and they have been focused on systems which had a great impact on the customer to be installed on two different new models of car. In particular, our experience has considered the system "inside car", consisting of the dashboard, the door panels, the rear and front seats, the carpets and the steering gear.

PROJECT ORGANIZATION

The main purpose of the project developed with Fiat Auto in 1997-1998 has been directed to experiment, in this specific company environment, with the ideas acquired by a strong benchmark activity throughout the international experience and the various approaches used by many enterprises, automotive or not, in the world. But international experience cannot be simply transferred in a company just like it has been acknowledged. To achieve significant results both in short and in long term, in fact, it is necessary that each firm develop his own methodologies, on the one hand holding in due consideration his characteristic way of working, on the other hand able to enhance at the top level every skill and information available in the company.

The attempt to work out one's own methodology, even though based upon international experience, has determined the choice between the different kind of possible approaches: the decision to take into account single sub-systems of the car, instead of the entire product, is a direct consequence of the organizational framework of Fiat Auto and his product development process.

From the organizing point of view, Value Engineering activities has been done by some workgroups specially established, each dedicated to a sub-system (that is there was a workgroup for the dashboard, another workgroup for the seats, and so on). In each of them are present all the main company roles involved in the development process: technical function of Design, together with Product, Marketing, Value Analysis, Technologies and Purchasing. Other company roles have been asked from time to time as needed.

Therefore, to assist the others, another workgroup has been established, constituted by few experts with methodological competence, having different aims: first of all, they have to co-ordinate each activity in order to assure the integrity and homogeneity of the information collected and processed towards the different company roles (i.e. V.O.C.) and the product development core team; secondly, they have been required to formalize and spread throughout the company every procedural adaptations suggested by the workgroups during the application itself.

A fundamental organizational characteristic of this project has been to involve at least one supplier, in advance with respect to when provided for; each supplier has taken part in all the phases, sharing the results and the estimations. This choice of involving soon at least one supplier is first of all inspired by codesign logics, which are more and more followed in automotive industry. In particular, the fact of making aware the suppliers about both the methodological tools and the benchmark results raises the significance of strengthening the relationships between clients and suppliers.

Such an action, however, isn't so banal. Generally, in fact, it must be taken much care of involving well-skilled suppliers, able to give an effective support even to evaluate technologies not directly well-known by the company or to propose and develop innovative technical solutions. Moreover, the confrontation between client and supplier as for cost information is typically, not only for italian enterprises, a delicate matter. This kind of activity only yields best results in case the supplier feels fully motivated to take part, making available his own competence and know-how during each phase of the analysis process; this presence, obviously, has to keep when discussing the developing alternatives for the new model.

Another very important aspect of the project from the organizational point of view has concerned the training. In fact, each workgroups member, apart from their specific role into the teams or the company, has been specially trained during a short course two days long; this course has made them aware not only of the methodological approach, but also of the practical problems due to the application in their real context. At the end of the course, each workgroup has been immediately established and, yet in the classroom, has planned his work.

THE APPROACH

As highlighted in the introduction, the activities done with Fiat Auto have followed a particular approach, which, beyond the usually adopted definitions for the different methodologies, could integrate together Value and Cost Management logics and product analysis and development processes accepted in this firm.

In these terms, the following activity flow exposed cannot be formally led back to a definite methodology, but draws its foundations from the logical concepts that inspires some of them. In particular, our approach has integrated into Fiat Auto product development process mainly the Value Engineering activities, together with logics of competitors products analysis (*benchmarking*), cost estimation and attribution (*functional cost analysis*) and market researches (*conjoint analysis*).

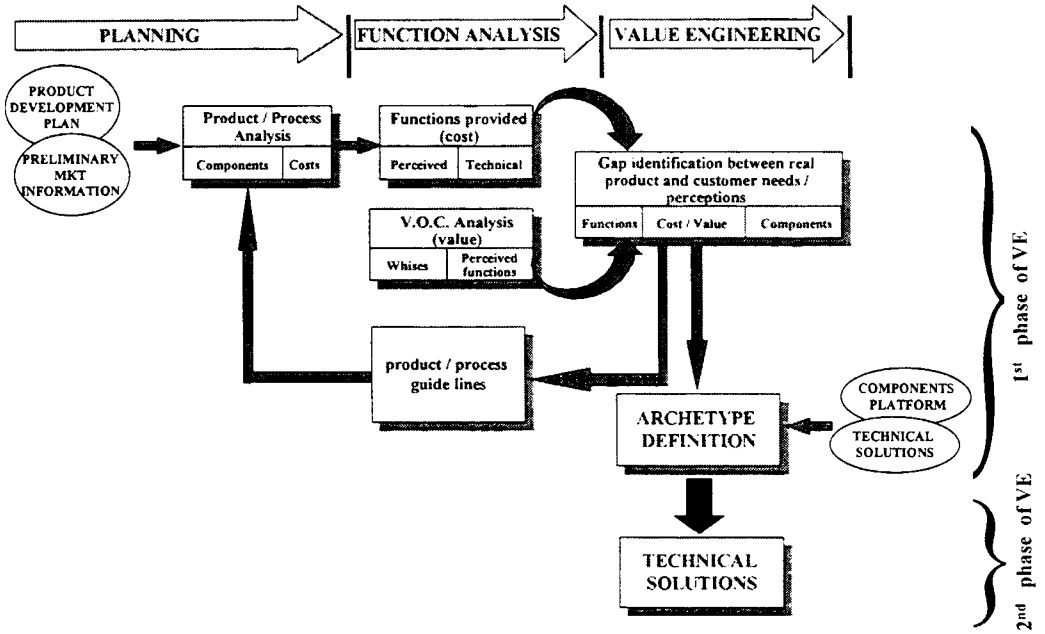

fig. 1: scheme of the approach

The methodological planned flow is described in the following steps.

1.WORKGROUP ESTABLISHMENT AND METHODOLOGICAL TRAINING

According to the analyzed sub-system's kind, are defined the members for the workgroup, and then are planned the activities for each phase, all the necessary input and the output produced, and the relative timing. As just declared, the workgroup provides for the regular presence of some of the company roles, such as the sub-system designer (who takes up the role of Team Leader), the cost analyst, at least one supplier and the corresponding purchaser, the Product role; the other necessary competencies are each time required by the team leader to the company roles. All the teams members are moreover trained on the methodologies they will use.

2. COLLECTION OF THE CUSTOMER EXPECTATIONS AND HISTORICAL COMPLAINTS BY MEANS OF MARKET ANALYSIS

By means of market researches made on purpose or yet available, are collected and transmitted to each workgroup the early information, in terms of customer expectations, complaints and relative language, together with any market data into possession of the involved suppliers.

3.PRODUCT BOUNDARIES EVALUATION AND SELECTION OF THE INTERNAL / COMPETING PRODUCTS FOR BENCHMARKING

On the basis of the customer expectations and complaints available, it is necessary to evaluate the analysis perimeter, in case it would not be the entire product, but only a set of its sub-systems; these remarks must be oriented on the basis of the systems incidence compared with the total cost of the product and they have to take into account the perception level for the functions supplied to the customer by the sub-systems and their interfaces. This phase of the procedure is very important, because it could lead to define the necessary skills again.

According to these considerations, the models of car chosen for benchmarking are acquired and made available to each workgroup.

4. CUSTOMER EXPECTATIONS DEPLOYMENT IN BASIC FUNCTION BY MEANS OF F.A.S.T. DIAGRAM

Each customer expectation previously recognized must be deployed in detailed functions, so that they could be a meaningful reference to design technical solutions. On this purpose, it is first of all necessary to class the expectations according to the different kinds of client related (final customer, carmaker, technical assistance).

Afterwards, customer needs deployment is made, following a top-down approach to build a FAST (Function Analysis System Technique) diagram. (see fig. 2)

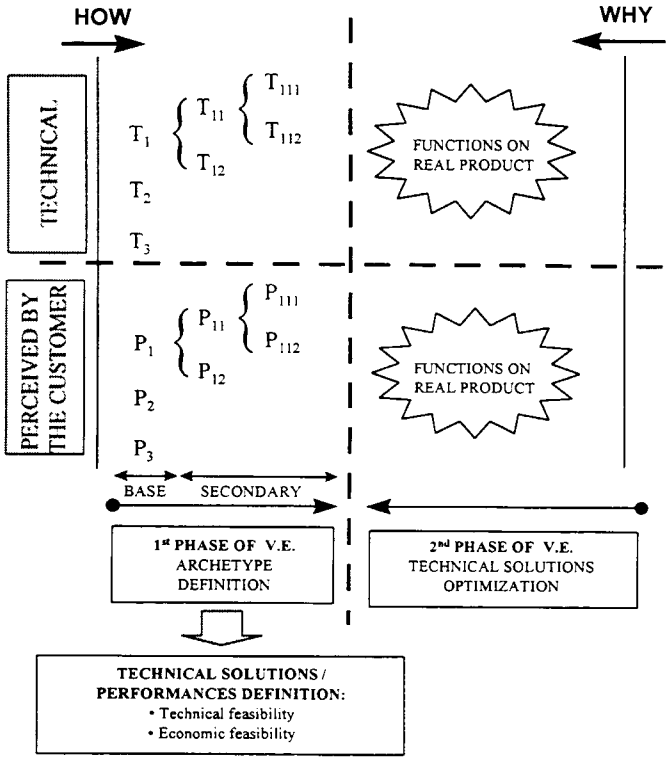

Fig. 2: FAST scheme

This analysis represents the basis to define the technical solutions and the performance levels suitable for each function, which will be adopted in the developing product. This description involves both a technical and economic feasibility analysis; on the basis of the customer value and the relative cost of the function, an archetype of the product is therefore defined, that is a description of the main features and the provisional technical

solutions that will be adopted. (*1st phase of Value Engineering*)

5. IDENTIFICATION OF ALL THE FUNCTIONS SUPPLIED BY THE BENCHMARKING PRODUCTS AND INTEGRATION INTO FAST DIAGRAM; FUNCTIONS / COMPONENTS CORRELATION MATRIX BUILDING

The list of the products elementary components is analyzed, and they are aggregated into logical groups; then, by means of activities such as brainstorming, all the functions specifically supplied are identified. These functions, put in order according to their similitude following a bottom-up approach, are compared and integrated into the functional tree previously developed, in order to take any opportunity to complete the deployment with any customer needs, even if not declared, or to eliminate functions supplied by the real products, but not perceived.

This analysis allows to describe the way in which the specific functions of real product have been realised and it can be an incentive to creativity during the design phases (*2nd phase of Value Engineering*). During this step, the best technical solutions are recognized.

The planned global approach provides for that the two previous steps are developed in terms of the entire car.

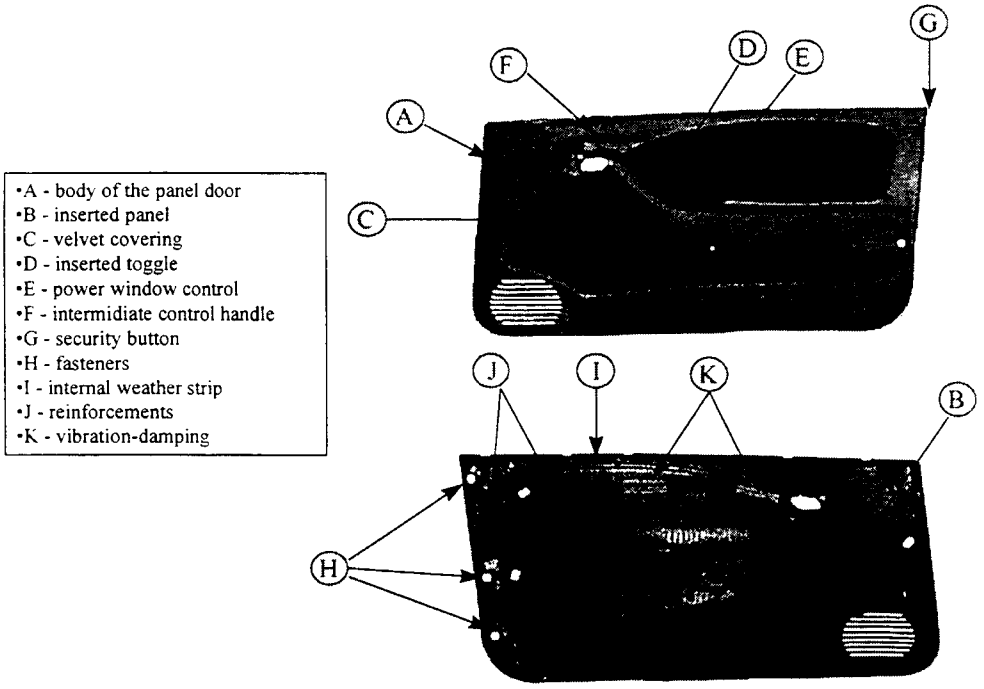

fig. 3: Sub-system example (door panel)

Finally, the correlation matrix is built, having the most detailed functions into the rows and the components into the columns; rows / columns intersections are marked, if they are corresponding to a function's supply by a component.

6. MARKET RESEARCH ON FUNCTIONS PERCEIVED BY THE CUSTOMER

With regard to the functions perceived by the customer, a questionnaire is prepared and submitted to a representative sample belonging to the market target, to get both a relative evaluation of the ideal importance of each function compared with the others, and client ratings for the real products.

The market research can be carried out following different methods according to the kind of information looked for. In general, the potential buyer expresses his own rating on the real products functions assigning marks based on a generic scale, then he outlines his ideal expectation, as if he could design the functions by himself, by means of suitable techniques that

should be chosen every time. In particular, a technique such as Conjoint Analysis might be used to create a simulation model for customer ratings, to class subsequent alternative hypotheses for the product realization.

7. PERFORMANCES EVALUATION BY MEANS OF INTERNAL TECHNICAL INDICATORS

With regards to the technical functions or anyhow to the functions related to clients different from the final user, whose effectiveness can be measured by internal technical indicators, tests are made on the real products.

8. COMPONENTS / SYSTEMS COST ESTIMATION AND QUANTITATIVE EVALUATION OF THE CORRELATION MATRIX; FUNCTION TOTAL COST CALCULATION

Each component for the considered products is analyzed and it is calculated its manufacturing cost, including both material and production costs. The specific investments, internal or external, and the development expenditures are estimated by quantity and then are turned in amortizations; only if the obtained values are very different, the items are deployed by function.

The components costs are therefore attributed to the functions on the basis of the correlation defined in the matrix previously made. The criteria for the functional distribution of the components costs might follow several approaches, according to the kind of the function and to the features of the component. In general, if it is possible, the main criterion adopted consists in recognising component's characteristics and properties, with their relative cost, that separately contribute to each function's supply.

Obviously , in order to assure homogeneity to the comparison, it's essential that the allocation criteria of the cost on functions will be afterwards applied consistently on the different models of reference.

9. CONSTRUCTION OF VALUE PROFILES AND THEIR ANALYSIS IN ORDER TO RECOGNISE THE BEST EXISTING SOLUTIONS

For each function, are built the histograms that highlight sustained costs compared with the internal performance indicators for each structural functions and the VOC evaluation for the functions, which marketing survey is made on.

Then, diagrams are analyzed, for each model of reference, by the value, that is the ratio between VOC and cost or between performance level and cost, according to function typology; that allows to recognise and describe the best solutions for each function, by a check that the corresponding performance is considered satisfactory as what regards regulations and product's mission.

10. CHOICE OF THE TARGETS OF THE CUSTOMER VALUE AND OF THE LEVEL OF TECHNICAL PERFORMANCE FOR THE NEW PRODUCT AND DEFINITION OF THE RELATIVE COST OBJECTIVES FOR EACH FUNCTION.

On the basis of the information gathered and of the analyses carried out, single objectives of the customer value and of the level of technical performance are decided for the developing product, jointly to cost targets needed in attempting to realise the previous objectives.

In particular, the definition of cost objectives on the basis of the previous analysis is inspired by the following principles:

- maximization of the value, that is the ratio between level of liking (or level of supply) of the function and cost for all the functions that a customer perceive;
- minimization of the cost, under the same performances, for the structural / technical functions.

11. DESCRIPTION OF THE PRODUCT ARCHETYPE AND ITS ALTERNATIVES; FUNCTION AND COST ANALYSIS, CUSTOMER VALUE AND MEASURABLE PERFORMANCES EVALUATION; POSITIONING OF THE ARCHETYPE AND ITS ALTERNATIVES IN THE SINGLE VALUE PROFILE.

In order to achieve the objectives defined at the previous step, the first definition of product archetype and of its possible alternatives is planned out. These alternatives can be relative to different designing solutions or to different typologies of materials or processes.

This definition coincides with the first phase of the product development process, in which a components list is drawn up and a product's cost estimate is made; this definition, in other words, occurs following the choice between the alternatives of the product's concept and it coincides with the first draft of the contents and of technical solutions that will be adopted. For the archetype planned out and its alternatives, the previous activities of analysis about given functions, customer satisfaction level, performance level and cost are repeated.

In this way, the product archetype and its alternatives can be set in the Value Profiles (see fig. 5) as they are one of the existing models previous analysed; besides the possibility of achieving the fixed objectives and their congruence can be verified.

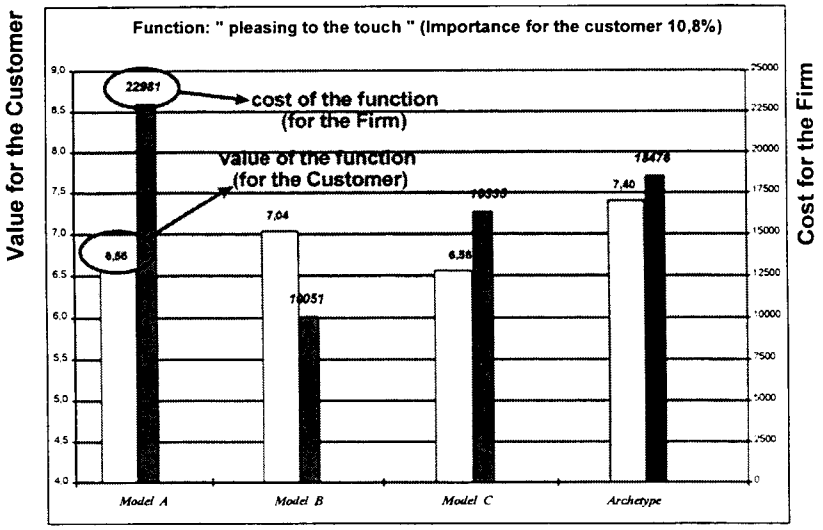

Fig. 4: Value Profile for the function "pleasing to the touch"

The methodological approach described in the previous steps is a consequence of a series of adaptations and developments that have naturally modified the project initial idea according to single problems appeared during the activity's progress.

As told before, the application was directed to the development process of two different car models. In particular, the achieved results can be distinguished in product specific results and organizational results. The product results are expressed in terms of cost reduction and customer value improvement for the developing models and are measured with respect to the model of car that they will substitute. These results are summarized in the following table:

COST REDUCTION		
platform X:	**22 %**	(max. on single sub-system: >30%)
platform Y:	**12 %**	(max. on single sub-system: >30%)
CUSTOMER VALUE IMPROVEMENT		
platform X:	**7 %**	(overall system)
platform Y:	**15 %**	(max. on single sub-system)

Fig. 5: results on the product

From the organizational point of view, the approach has led to strengthen the cost estimation

processes during the product development, and to establish data bases structured by functions concerning the various solutions adopted to realize the products, included the competitors.

But the most relevant result reached in this project has been the coding of the outlined approach into an official procedure, which establishes practically the required competencies, the responsibilities, timing and way of working for each activity.

MAIN ISSUES

From the methodological point of view, during the application it has been necessary to deal with some problems, in general due to the fact that automotive product is characterized by the coexistence of some function which are directly perceived by the customer, and others, technical, which are instead perceived only indirectly by the user or when they fail and cause malfunctions on the car.

Moreover, the logic to build the functional tree can follow both a bottom - up approach (that is to define the complete car functions going up from the components) and a top - down approach (from the system's functions it is possible to go down to those of the elements which form it).

In this procedure, it seemed appropriate to take into account both the approaches, because following the top - down logic it is more likely to understand the customer point of view, while the other approach can make come out specific functions from the real products considered and highlight eventual inefficiency in design, due to functions supplied by the product, but that are not perceived by any kind of client. The integration of these visions allows a major detail developing the functional analysis.

Another methodological issue has regarded the evaluation in monetary values of the importance assigned by the customer to the product functions. This difficulty, that is not resolved for each function, is strictly related with the fact that most of the functions supplied by a car can be characterized by different levels of performances, which often are not univocally defined.

In fact, a customer expresses his evaluation of the monetary value of a function as more confident as its supply levels are few and well recognizable. Some of the internal car's functions, instead, on the one hand in the customer perception were related each other, on the other hand their supply level wasn't determined by the only components of the considered system, but it could be influenced by the interface systems. In other cases, performances of the functions can hardly be measured and frequently their supply level correspond only to discrete point, relative to the real benchmarking models.

METHODOLOGY INTEGRATION IN THE PROCESS OF PRODUCT DEVELOPMENT

As previously pointed out, the most critical aspect during the project management has regarded the need of introducing this complex approach in an existing and consolidated framework and the overcoming of that difficulty, consisting in the codified official integration of the Value Engineering procedure in the planned product development process, certainly means the greatest success achieved.

In particular, the actually established development process provides for a set of activities, which must be developed beginning from the earliest phase of settlement for the concept alternatives, up to the "job one" manufacture; for each step of the process, are described the way of execution, the necessary resources and the timing.

An important feature of the established development process concerns with having differentiated paths for the models of car and the main components / systems that are installed on them. In fact, the development process of a particular model of car occurs within a specific "platform", which completely oversees all the design of the product and the start of production, and it continues during the all life cycle. In parallel, the main systems of a car follow an alternative process, based on the development of innovative contents and characterized by the fact of being less strictly bound in terms of time; the innovations transfer on a single car occurs in established times, during its development process.

The issue of integrating this approach in the consolidated process has been managed by means of an in-depth analysis of all the company processes, their rules and the specific requirements of all the resources potentially involved. Then, the approach's customization has been carried out with the strong contribution of the people who would subsequently have applied the proposed methodologies and the final procedure is due to a series of subsequent elaborations, which have mostly concerned the benchmarking phase and the functional cost analysis. This initial study has turned out winning and it has