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**VE'S ROLE IN TARGET COST MANAGEMENT AT THE
PRODUCT DESIGN STAGE IN JAPANESE COMPANIES**

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ABSTRACT

In this paper we describe Target Cost Management (TCM) at the product design stage and VE's role in it, using results based on our survey of big manufacturing companies in Japan.

DEFINITION OF TCM

Various opinions have been expressed as to what TCM at the product design stage is. A conclusive definition has yet to be reached. The origin of the concept can be found in cost engineering and cost management but it is a dynamic growing concept and today more and more implementations and interpretations are evolving.

TCM is a management technology using scientific principles and technologies to establish a cost target, make breakdown of the cost development and design phase to realize product specification design, manufacturing, distribution, sales, usage and disposal costs. TCM can also be called a management methodology and technology tool to make new products at a "reasonable cost" that should be achieved through product development and design activities to meet all the required target costs in the company.

OUTLINE OF TCM

The development of TCM has five stages: planning, concept design, basic design, detailed design, and manufacturing preparation. The necessary step within each stage are outlined in the following.

STEP 1. PRODUCT PLANNING

New product planning is summarized in a document/table which defines and clarifies the design to requirements. Usually the following items for the new product are shown in the document/table:

1. Outline of the mission and concept of the product.
2. Primary performance specifications and design schedule, manufacturing and marketing activities.
3. Cost target, selling price, sales volume and profitability study for the product.

STEP 2: CONCEPT DESIGN

In this stage, we formulate the basic concept, normal selling price and attainable cost target of the new product on the basis of

the design to requirement. Usually, it is composed of:

1. Formulation of main function areas.
2. Assignment of the cost target to the top level function areas
3. Designing the basic concept of the product under the assigned cost target.
4. Using a rough cost estimation, ascertain whether the basic concept of the product is designed to fit the cost target.
5. Profitability study of the product.

STEP 3: BASIC DESIGN

The focus of this stage is to construct a general drawing of product based on the cost target. In many cases it is composed of:

1. Assignment of the cost target to the top and middle function area or main components.
2. Framing a general drawing under the cost target.
3. Using a rough cost estimation, ascertain whether the general drawing of the product is designed to fit the cost target.

STEP 4: DETAILED DESIGN

In this stage, we draw up the manufacturing specifications on the basis of the framework of the general drawing and the cost target described in step 3. Usually, it is composed of:

1. Drawing up the detail of design manufacturing specification under the cost target.
2. Using a detailed cost estimate, ascertain if the manufacturing specification of the product are designed to fit the cost target.

STEP 5: MANUFACTURING PREPARATION

In this stage a manufacturing system and variations of the product are design, manufacturing method and processes, determined under the cost target.

MAIN ACTIVITIES OF TCM

Setting cost target in TCM

In a new product's design phase, the cost target, as well as performance and schedule target, should be established. Design activities must be carried out accordingly. They are complete only when it is possible to design the new product within the established cost target.

We must establish the cost target so that new product profitability is ensured. In addition, it is necessary to establish a cost target that can be achieved through the designer's extra efforts. The cost target should be established for all activities of a new product's life cycle. This means that the designs of the new product are accomplished only when the target cost is achieved.

As the most important cost target is manufacturing, methods of establishing the target will be discussed. The manufacturing cost target is established by two methods: the subtraction method and the addition method.

(1) Subtraction method

The cost target is reached using the following formula:

$$\text{manufacturing cost target} = \text{selling price} - \text{gross margin}$$

The cost target varies with the type of required margin. If the required margin is gross profit, the cost target is for the full manufacturing cost. If the margin is marginal profit, then cost target is for the variable cost of the product. The cost target reflecting the full manufacturing cost is by far the most popular in Japanese companies.

(2) Addition method

In the addition method, there are three ways to determine the cost target on the basis of the normal current cost of the product or components:

- (1) A normal current cost graph
- (2) A single primary design parameter
- (3) Multiple primary design parameters.

Target costs established by this method, can be achieved relatively easily. This is because the cost target can be defined from historical data bases on costs reflecting past manufacturing experiences.

DETAILING COST TARGET IN TCM

There are two methods used to assign the cost target to components of a new product. The first is to assign the cost target to component blocks, composed of sub-assemblies of the new products. The second is to assign the cost target according to the product's functional area.

(1) Component block method

The component block method is usually applied to new products that are similar in design to other, previously manufactured products. Generally such products allow very narrow room for adoption of new technology, or else they are subject to a tight design schedule. This method is not recommended for innovative products. If cost target is assigned to component blocks, designers tend to be materials-oriented rather than function-oriented. To create a function assigned design that can satisfy consumer needs, the cost target should not be assigned to component blocks, but instead to functional areas of the new product.

(2) Functional area method

Three steps are involved in assigning the cost target to functional areas. First, the functional areas are defined based on the results of functional definitions. Second, each functional area is evaluated. Third, the cost target should be assigned to each functional area based on the monetary value or relative important ratio of evaluation for each functional area.

When evaluating functional areas, the decision should be done whether the evaluation is from the customer's or the manufacturer's view point.

MAKING DESIGN PROPOSALS AND COST ESTIMATES

Designers create the concept and basic designs of the new product based on the cost target assigned to the functions or components. First they make trial products to satisfy the given cost target. A cost estimate is then carried out for the trial products to evaluate the new product's profitability.

To confirm if the costs of general drawings and manufacturing specifications are within the cost target, rough and/or detailed cost estimations are adapted at the design stage. Unless the costs of general drawings and manufacturing specifications are achieved within the cost target, the designers may have to alter the designs to achieve the cost target. This procedure must be followed at each of the stages of concept, basic, and detailed design.

The designers should not proceed with a design without achieving the cost target at each of these stages. To evaluate cost performance for design alternatives, it is necessary to prepare multiple cost estimating systems that suit the purpose. About 25 percent of large Japanese companies have adopted cost estimating at the function or performance level instead of physical components or parts in the design phase. This method is suitable for both the stages of concept and basic design.

A sample formula (derived from a cost table) for and overhead conveyor is shown here as a reference:

$$Y = 160.6 + 16.07 X1 + 214.4 X2 + 45.59 X3$$

Where Y = estimated manufacturing cost (1,000 yen)

X1 = length of the machine in meters

X2 = horsepower

X3 = total number of curves

This formula was derived from 29 samples and has a correlation coefficient of 0.934

Cost Improvement by VE

Designers must make design changes if the cost of general drawings and manufacturing specifications is not within the cost target. This is the general concept of design-to-cost, and the main principle of TCM. Every effort should be made to achieve the cost target. These methods, shown in Table 1, are adopted as more effective methodologies to achieve the cost target in Japanese companies.

Table 1 Effective methods to achieve the cost target [unit: %]

new product at the introduction stage		new product at the growth and maturity stage	
cost estimation	17.2	VE	15.7
VE	15.5	requirement of cost reduction for sub-contracts	13.7
design review	10.8	cost estimation	12.4
adoption of new manufacturing technology and methods	10.1	standardization of parts	11.7
standardization of parts	9.3	analysis for cost drivers	7.9
learn down	7.1	learn down	6.7

This table shows that VE is adopted to effective cost improvement activities to achieve the cost target. According to our survey most companies have adopted 1st look VE shown in Table 2, and nearly 50 % of VE activity hours are spent in the design phase shown in Table 3.

VE applied at the development and design stages are divided into the two types: problem solving type
 schedule type:
 [VE performed at each major stage
 [VE performed periodically

The problem solving type VE is used whenever a clearly defined problem emerges. To resolve this manufacturing problem or to achieve manufacturing cost target, a project team consisting of related specialists in the company, is organized on a relatively temporary basis to solve the problem. This is a symptomatic therapy and observed at companies who are in the early introduction stage of TCM.

The schedule types VE are usually employed by companies that have already established TCM. The schedule types VE inserts cost review activities as one of steps in the development and design stages. There are two application methods: First, VE performed at each major stage means that VE is performed at an important point of each stage such as, when basic drawings are prepared at the concept design stage, detailed drawing at the basic design stage, complete specifications at the detailed design stage and manufacturing specifications at the manufacturing preparation stage. The contents of reviews are mostly about economic issues (cost reduction, although technical issues are also discussed.)

Although the product designers try hard to achieve cost and value improvements, there are cases in which the cost target cannot be achieved. What then? In principal, product designers will be asked to make design changes, however, this is not always

best. According to our survey, in these cases alternative decisions shown in Table 4 are selected in Japanese companies.

CONCLUSION

It has been nearly 40 years since the first TCM were used in Japan. In the early stages, the technologies and methodologies for TCM were limited to the manufacturing cost control of a product in design phase. The very large benefits of the TCM were soon evident in the car manufacturing companies who were the first to use TCM. The concept then spread to electric, machinery and precision manufacturers, then quickly became widespread. By now, almost all the Japanese manufacturing industry uses TCM.

TCM has an essential aspect in setting up manufacturing cost targets and achieving them. For this purpose, it is necessary that manufacturing cost target and manufacturing cost estimation should be established on the same base. By being preactive with such processes, unachieved amounts of manufacturing cost target by each function and by each party become clear.

After the unachieved amounts become clear, achievement measures (cost improvement) must be created and then activities for achieving cost target should be implemented. Cost improvement can be done by those who are in a position of creating these costs. Therefore, designers take initiative and the management engineering method, especially VE for cost improvement. VE's role in TCM is most important and essential for cost improvement and for value improvement.

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Table 2 Adoptive conditions of 1st look VE (unit: %)

	electric & electronic	automobile & transportation	machinery & precise machinery	other manufacturing	total
adoption for almost of new products	37.4	45.2	32.8	23.8	37.0
adoption for main and specific new products	38.3	33.9	40.3	33.4	37.4
only main products	8.4	8.1	3.0	9.5	7.0
only specific products	12.1	11.3	19.4	23.8	14.8
under consideration	3.8	1.5	4.5	9.5	3.8
total	100.0	100.0	100.0	100.0	100.0

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Table 3 Rate of activity hours for 1st look VE, 2nd look VE and soft VE (unit: %)

		electric & electronic	automobile & transportation	machinery & precise machinery	other manufacturing	total
today	1st look VE	42.9	54.4	43.8	32.2	44.9
	2nd look VE	42.8	33.3	39.1	50.1	40.3
	soft VE	14.3	13.3	11.1	17.0	14.8
	total	100.0	100.0	100.0	100.0	100.0
near future	1st look VE	52.5	56.3	49.0	38.9	51.2
	2nd look VE	26.1	21.8	24.6	35.9	25.6
	soft VE	21.4	21.9	26.4	25.2	23.2
	total	100.0	100.0	100.0	100.0	100.0

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Table 4 Decisions in unachievable conditions of the cost target (unit: %)

Decision	year stage	1987		1992	
		introduction	growth and maturity	introduction	growth and maturity
going on forward step even if unachievable conditions		57.9	51.6	42.5	40.4
changing the cost target if unachievable conditions		11.6	17.0	15.9	21.3
continuing the cost improvement activities		21.4	23.6	32.0	29.6
stopping the development and design activities		9.1	7.8	9.6	8.7
total		100.0	100.0	100.0	100.0