

Enhanced Value Engineering for Development of High-tech Product

Qingguo Ma, Professor, Business School, Zhejiang University, Hangzhou, 310027, China

Liansheng Yao, Engineer, Institute of Product Quality, Ulumuqi, 830001, China

Ma Qingan, Assistant Prof., Dept. of Architecture & Civil Eng. Shihezi University, 832003

Dong Yazhen, Agriculture Bank, Qingtian County, Zhejiang Province, 323900, China

Photo not available

Prof. Q. Ma is the director of Soft-Science Institute, Zhejiang University (ZU), China, the Vice Dean, Business School at ZU, Vice President, National Higher Institution Society of VE. Editor, *R&D management*, Editor, *Value Engineering*. His current research focuses on high-tech industry management, Finance engineering and management.

Engineer Liansheng Yao is the director of electrical device group, Institute of Product Quality, Ulumuqi, and the member of Xinjiang Electric device society, Xinjiang, China. His current research focuses on power electronics.

Abstract

High-tech products are introduced to the marketplace rapidly in recent years. It forces high-tech firms to develop new product more quickly, and at the same time, on the basis of high life-cycle-quality and lower life-cycle-cost, and in greater product variety. This paper compares VE methodology with Concurrent Engineering (CE), and discusses how to enhance VE by absorbing the philosophy of CE, and suggests use the enhanced VE to development of high-tech product to meet the requirement of quality, cost and time for winning in the high-tech markets. Finally, a case of applying the enhanced VE has been introduced in this paper.

Introduction

The competition of high-tech products in the marketplace drives the high-tech firms to bring the new products to the market in higher velocity, in order to boost their sales and market shares. So the

Concurrent Engineering (CE) which has the significant efficiency of cutting new product development time has become the very hot topic in recent years. But it is not enough for winning in the high-tech market by only reducing the product development time and the time-to-market. There are two other important factors for the competition of high-tech firms. One is the product quality (exactly, is the life-cycle-quality of product). Another is lower cost of production (exactly, is the lower life-cycle-cost of product). The high-tech firm has to have the three kinds of priority over its counterparts to win the competition in high-tech market. However, CE has not significant effect in high quality and low cost, while VE has significant efficiency in these two aspects, but has no significant effect in reducing product development time. So how to combine the principle of CE within VE framework is an interesting and important idea. This article discusses the enhanced VE by sucking up the philosophy of CE, and gives a case of using the enhanced VE to a high-tech product development.

Concept and Major Techniques of

Concurrent Engineering

The **basic concept of CE** is to overlap the product development activities that traditionally done sequentially [1], [2], [3]. The overlapping development saves time due to 1) parallel development activities, 2) reduction of the hurdles between one functional department and its downstream functional department. In the traditional product development process, if a stage of the project is done with a functional department, this department should hand off the project to the downstream department after an evaluation process. It takes a lot of time. But in the overlapping development process, this kind of hurdles is reduced.

To implement the philosophy of CE, a lot of techniques should be employed. The **major techniques of CE** are as follows:

1. Make the activities of a project parallel as possible as it can be done. To overlap the development activities, some skills are needed. One of them is to divide the activity into some sub-activities. For example, to develop a new product, the following sequential ordering is usually accepted

| PD | -- | MS | -- | MPD | -- | MSD | -- | PT |

PD = Product Design

MS = Material Selection

MPD = Manufacturing Process Design

MSD = Manufacturing System Design

PT = Prototype Testing

Fig.1. Sequential ordering of activities

If we divided the activities above mentioned into some sub-activities, we could overlap the development process as follows:

|pd1|pd2|
 |ms1|ms2|
 |mpd1|mpd2|
 |msd1|msd2|
 |pt|

Fig.2. Parallel activities of CE project

In this case, the total development time has been almost reduced by 50%.

2. Cross-functional development team. To make the overlapping development successful and the sub-activities harmonic with each other, the cross-functional team consisting of the members who represent all key functional departments, such as finance dept., marketing dept., engineering dept., manufacturing dept., is necessary. This team has start-to-finish product responsibility. The members of the team must collaborate better with each other. And they can do it better because the cross-functional team enables them to directly communicate with each other, and allow them to earlier understand the requirements and constrains about the product given by the different departments, especially, the downstream departments. So they can develop the new product by paralleling development activities, then shorten the development time.

It is possible that several hundreds people are needed to develop a new product if the project is big one. For example, the project is to develop a new car. In this case, the product development organization has to have a structure shown in Fig.3.

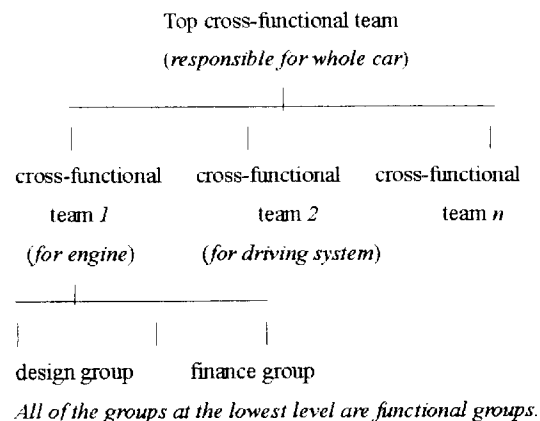


Fig.3. Cross-functional team structure

Each cross-functional team consists of members representing all the necessary functional departments, and some of them must come from the teams or groups at its lower level in Fig.3, so that all the teams and groups can do parallel researches and coordinate with others.

3. Matrix organization. If there are several projects or sub-projects in a period, the matrix organization appears. To make the matrix organization efficient, the human resource management is very important. One of the core problems of human resource management is the evaluation of performance for each team member. Because each member in the matrix organization has two leaders, one is the team manager (or director), another is the functional department manager. Which one will have the major responsibility for the performance evaluation, the team manager, or the department manager? There are different viewpoints [4]. But most of them agree that the team manager should have the major responsibility. It will shorten the development time.

Another important problem is the ratio of the dedicated members in a cross-functional team. Most researchers agree that the team core members or most of the team core members should dedicate to one project. If the most team core members worked on other projects simultaneously, the development time must be increased, because they have to take time to catch up on where they last left the previous project.

4. Communication. One of the most important problems for an efficient CE is communication. Overlapping development process needs significantly higher information processing capability than the sequential development process. For instance, the design engineer must learn earlier and more about the downstream constraints, such as process design requirements and manufacturing design requirements, and at the same time, the process designer or the manufacturing designer want to know the upstream decision to finish their tasks. Thus, the amount of information that the team members should deal with increased greatly. Therefore, the communication in a CE process must be enhanced, otherwise, it may result in the schedule delay.

Fortunately, the cross-functional team (with small size) allows its members who come from different functional departments communicate with others directly. It saves a lot of time.

But how about the communication crossing the

teams or groups? There are several ways. The first one is by means of the team (or group) members who are also the up level team members in Fig.3, to communicate with other cross-functional teams or functional groups (or departments). This is an indirect communication approach.

The second way to link different teams and groups horizontally is the inform organizations, such as the *technical clubs* which provide a kind of forum for engineers and managers [5].

The third way for cross-teams communication is by means of the computer network based on the CAD system.

The fourth way is to co-locate the project members close together to facilitate face-to-face communication. Carol Haddad [5] gave an interesting case about the co-location that the US Auto Corporation X constructed a new circular building, the technical center building, and let each team occupy an entire floor, and located the functional groups from one team immediately above or below the groups from another team.

5. Decentralization. Giving the decision-making authority to the cross-functional teams and broadening the responsibility of these teams is an important technique to make the CE successful. It saves a lot of time that must be taken for waiting for senior management approval traditionally.

6. Support of senior management. One of the key factors of team empowerment is the support of senior management. Lacking this support, the cross-functional team could not make decision in time about the product change, and result in the development delays. The support of senior management is particular important for Chinese firms. In china the product development contracts could not guarantee completely the teams' decision-making authority.

7. Time as a goal of the project teams. Setting time goals for the teams or groups is a efficient technique to shorten the development time, and helpful for the teams or groups to use the Program Evaluation and Review Technique (PERT) to assist in systematizing the whole project activities.

8. Supplier management. It includes 1) qualifying and selecting the suppliers as the strategic partners to get the stable quality and lower cost of product, 2) reducing the number of suppliers to decrease the development cycle time, 3) integrating the first-tier suppliers directly into related cross-functional team. In general, these efforts will decrease the development time. But qualifying the suppliers will consume a lot of time. So it is meaningful only in selecting them as the strategic partners. For short-term development process, it maybe increases the development cycle time.

9. Allocating the quality and function that the customer required to the new product. It is possible to design the quality and function that the customer required into new product by using CE techniques. The techniques of *overlapping development process* and *cross-functional teams* are helpful to design quality and function into product. But CE has no formal methods to do that.

Comparing VE with CE

The following table gives the result of comparing VE with CE.

| | Concurrent Engineering | Value Engineering |
|---|---|--|
| Major purposes | Shortening the development time Bringing new product to market quickly | Getting higher quality and function and lower cost |
| Development organization | Cross-functional teams Matrix organization | Value team, also crossing functional departments |
| Formal procedure | Has not formed yet | The mature procedure has been applied for several decades |
| Core techniques for saving time | Overlapping development process Skills for parallel activities | No |
| Core techniques for higher value for customer | No | Function-cost analysis A series of innovation methods and evaluation methods |
| Ordinary techniques for saving time | Dedicated members | In fact, covered this technique but not explicit |
| | Communication crossing teams Technique 1: co-location | Not explicit |
| | Communication crossing teams Technique 2: informal organization Such as technical clubs | No |
| | Communication crossing teams Technique 3: computer network | No or not explicit |
| | Team empowerment | No or not explicit |
| | Support of senior management | In fact, in using |
| | Time as a goal of the teams | No |
| | Qualifying and selecting suppliers as the strategic partner | Qualifying & selecting suppliers is the techniques in purchase VA |
| | Involving first-tier suppliers in related cross-functional teams | VE team may involve some suppliers. Its purpose is to get the higher value (higher quality and lower cost) |
| Techniques for high quality | Designing the quality and functions into new product, but no mature methods | A series of mature methods to design the quality and functions into product, not only for quality, but also for lower cost |

The above table shows that CE focuses on saving time, its major effect is bringing new product to the marketplace faster, while VE focuses on improving the product quality and functions the customer needed and decreasing the life-cycle-cost. Although in practice CE could improve the quality and decrease

the cost to a certain extent, and VE also could shorten product development time to a certain extent, they are not their major effects. But to win in the competitive high-tech market, the three key components (*time, cost and quality and function*) are all necessary and critical. To use VE to develop high-tech product, VE ought to be enhanced by integrating the philosophy

and major techniques of CE.

Enhanced VE for Development of High-tech Product

According to the requirements of developing high-tech product, the enhanced VE should absorb something from CE. Comparing enhanced VE (EVE) that we suggested here with the normal VE, the major changes are as follows (shown as italics):

1. Adding the *concurrent principle* and the *time goal* to the definition of EVE.

Definition: EVE is an organized effort to provide product, system, or service with higher life-cycle-quality and functions that the customer needed and lower life-cycle-cost for customers *in a possibly short time-interval*, by systematically analyzing product functions and the relative costs, creatively thinking and *overlapping the development process*.

2. Adding the *parallel activities* and the *time goal* to the job plan

Job plan of EVE:

(1) Preparation phase

A. Select object(s) that will be studied

B. Establish *cross-functional team(s)*, *involving some suppliers if it is necessary*

C. Draw up a schedule by each team, and *set up time goal*

(2) Information phase (no changes in this phase)

(3) Function-cost analysis phase (no explicit changes in this phase)

Put attention on **product function design** after the steps of function definition and FAST

(4) Creativity phase

Overlap the creative activities, such as product design, material design, manufacturing process design and manufacturing system design.

Other creative activities do not alter.

(5) Evaluation phase

Also need to *overlap the evaluation activities and at the same time to prepare the manufacturing*

(6) Implementation phase (no explicit changes in this phase)

3. Adding some techniques of CE into VE techniques pool

(1) *Establish the matrix development organization consisting of cross-functional teams that were set up in accordance with the functional areas of the product, and put the attentions on human resource management.*

(2) *Qualify and select suppliers as strategic partner.*

(3) *Give the enough decision-making authority of the new product development and the relative responsibility to teams.*

(4) *Co-locate the team members closely.*

(5) *Set up informal organizations to assist communication among different teams.*

(6) *Use the parallel skills to overlap VE activities.*

A Case of Applying EVE to High-tech Product Development

Telecom T was founded in 1990 in X province. Now it employs about 2000 people, and reported 3.5 RMB in sale revenue last year, increasing by 88% comparing with 1996. Its R&D system is the largest division in Telecom T. It employs more than 900 engineers. The R&D system consists of four departments, Planning Department, Central R&D Department (consisted of over 700 engineers), Prototype Test Department and manufacturing process engineering department. They are in charge of development strategy and planning, product development and design, prototype testing and manufacturing process, respectively. The budget of R&D investment accounted for 10% in yearly revenue last year.

At the beginning of last year, before applying enhanced VE, they had 19 development projects being studied, such as the large public exchange system, the central control system, new rectifier for exchange system and respective software programs. Some of these projects were independent of others. The rest of these projects were related to each other.

Almost all project teams consisted of only engineers. And some of them lasted for long time, and one or two of them were nearly to fail.

Before the middle of last year, I introduced CE and VE to them and formed the idea of EVE with them together. Then they decided to apply EVE to the R&D activities.

First of all, they restructured the project teams as the cross-functional teams. The manufacturing process engineers, manufacturing system engineers, and even the staffs from sale, finance, purchasing and marketing departments were involved in these teams. So the new teams were not only responsible for the quality of new products and software packages, but also had the responsibility for cost, exactly, the life-cycle-cost, moreover, for development time. At the same time, they broadened the teams' decision-making authority, empowering them to make decisions within teams' budgets without senior management's approval.

Then, the teams revised the their job plans according to VE job plan. They overlapped some activities in these plan as possible as they can, moreover, they set up the time goals.

At the same time, the Personnel Department drew up a performance evaluation system for the team members. Because the firm planned to hire about 400 new employees who just received the Master or Doctor degrees from universities, the Personnel Department prepared a series of training programs, to avoid the firm culture being diluted.

The result of the EVE activities was

- 1) Several projects finished before the time goal and the quality exceeded what they expected at the beginning.
- 2) The new rectifier has got a lot of orders. And the production cost lowered than they expected.
- 3) Other finished projects have served as the technical store. Some of them were waiting for the success of other related projects to form new systems.
- 4) Most of the unfinished projects will be finished by the time goals within the budget (except two projects). And most of their qualities, performances will be better than the

initial goals, and the production costs will be around the initial goals.

- 5) One project has been killed because of the incorrect estimation of the difficulty in technologies.

Acknowledgement

We appreciate 1) Miss Dong Yazhen who took the result data about EVE application from Telecom T for us, and gave us some suggestions about this paper, 2) Prof. Ma qingan who revised some parts of this paper, and gave some suggestions about application of EVE in future.

References

- [1] M. R. Millson, S. P. Raj, and D. Wilemon, A survey of major approaches for accelerating new product development, *J. Prod. Innovat. Manage.*, vol. 9, pp. 53-69, 1992.
- [2] Marc J. Schniederjans and Sukki Hong, Multi-objective Concurrent Engineering: A Goal Programming Approach, *IEEE Trans. on Eng. Manage.*, Vol. 43, No. 2, pp. 202-209, 1996.
- [3] B. J. Zirger and Janet L. Hartley, The Effect of Acceleration Techniques on Product Development Time, *IEEE Trans. on Eng. Manage.*, Vol. 43, No. 2, pp. 143-152, 1996.
- [4] Harold Kerzner, "Evaluating the Performance of Project Personnel", in *Project Manage., Handbook*, David I. Cleland and William R. King Ed., Van Nostrand Reinhold, pp. 482-494, 1983.
- [5] Carol J. Haddad, Operationalizing the Concept of Concurrent Engineering: A Case Study from the U.S. Auto Industry, *IEEE Trans. on Eng. Manage.*, Vol. 43, No. 2, pp. 124-132, 1996.