A New VE Approach to Variation in Products

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ABSTRACT

Most of the specifications for small-sized automotive parts are determined in a late stage of vehicle development, which tends to cause parts to proliferate for parts to meet constraining conditions in relation to the layout of adjacent large-sized parts, and to meet additional performance requirements for a new model. Parts suppliers conduct VE and parts commonization activities to improve their products, which, however, is prevented by the afore-mentioned tendency, and thus little effect is produced. This paper proposes a new practical VE method not only for optimizing the cost of overall product variation, but also for reducing the number of variations.

INTRODUCTION

VE processes are used to save costs and improve functions of a product. If a product has no variation, efforts are easy to focus in achieving goals. However, in the case of a product with multiple variation groups ('variation' is a variant of a product differing from a standard one for some reasons, and 'variation group' is a group of variations including typical variation), another possibility of parts commonization should be studied.

Currently variation tends to be widened to meet additional functional requirements or constraining conditions. Therefore, reduction in the number of variations is considered as an improvement. Parts suppliers have been conducting VE activities on a group of variations, but they are not satisfied with the results they obtained in the following points;

- ✧ Some variations can be improved, but the others can not.
- ✧ New part specifications are set, but old specifications cannot be replaced with the new ones, which causes parts proliferation.
- ✧ Products are improved, but the cost of overall product variation is not reduced.
- ✧ VE proposals are made, but accepting the proposals takes time, or in the worst case, the proposals are not accepted because a different engineer takes the responsibility for carrying out VE proposals.

In investigating a group of variations, typical variations are selected for applying VE processes, considering the production volumes of the variations or the commonality in the structure. In the first stage of information collection, VE team members are conscious that all kinds of the variation should be improved, but, as VE job steps proceed the members tend to think that only the typical variations are to be made the same, and the thought is developed in the team activities. As a result, the members fail to obtain satisfactory results, and have no way but to go back to the original design, or have little time to review design. In this sense, the current VE method is not provided with a process which can be used on all the variations until goals are achieved.

VE POLICIES FOR VARIATION GROUPS

VE activities can be conducted on variations by solving all the afore-mentioned problems.
Basic policies for modifying the conventional VE process are:

- ✧ All the functional requirements should be met in any job step:

  If functional requirements are specified for some of all the variations, the other variations may lack functions, and thus the functions can be ignored in the further steps. In order to avoid this, the functions of all the variations should be understood.

- ✧ Functions which cause parts proliferation should be identified:

  Little effect is produced if proposals for parts commonization are made without identifying functions which cause parts proliferation.

- ✧ Potential for improvement in the functions of all the variations should be precisely determined:

  In some cases, we are not sure that proposals considered effective for some variations are also effective for the other variations.

- ✧ Constraining conditions which prevent embodiment of ideas should be re-examined every time re-examination is considered necessary:
  Making proposals should not be readily given up just for the reason that proposals do not meet the constraining conditions.

- ✧ Relationship between parts commonality and cost saving should be determined:

  If an engineer who has not been involved in VE activities is assigned a job of carrying out VE proposals, and has not received any help from VE members, he/she may be discouraged from accomplishing the job. Therefore, VE proposals should be made in a form of options.

APPLICATION TO VE PROCESS

VE activities have been conducted in order to confirm the effect of the afore-mentioned VE policies on a sample of variations. The following sample case is explained, including items changed from/added to the conventional ones (variation is abbreviated to 'V' in the illustrations, figures and tables below):

1. Outline of Sample of Variations
   - ✧ Sample
     Control link assembly for a light-duty truck
   - ✧ Production Volume
     A total of 17,764/month for all the variations
   - ✧ Number of Variation
     8
   - ✧ Purpose
     Control engine power
   - ✧ Improvement Targets
     (a) A total of 30% cost reduction for all the variations
     (b) 30% reduction in the number of variations

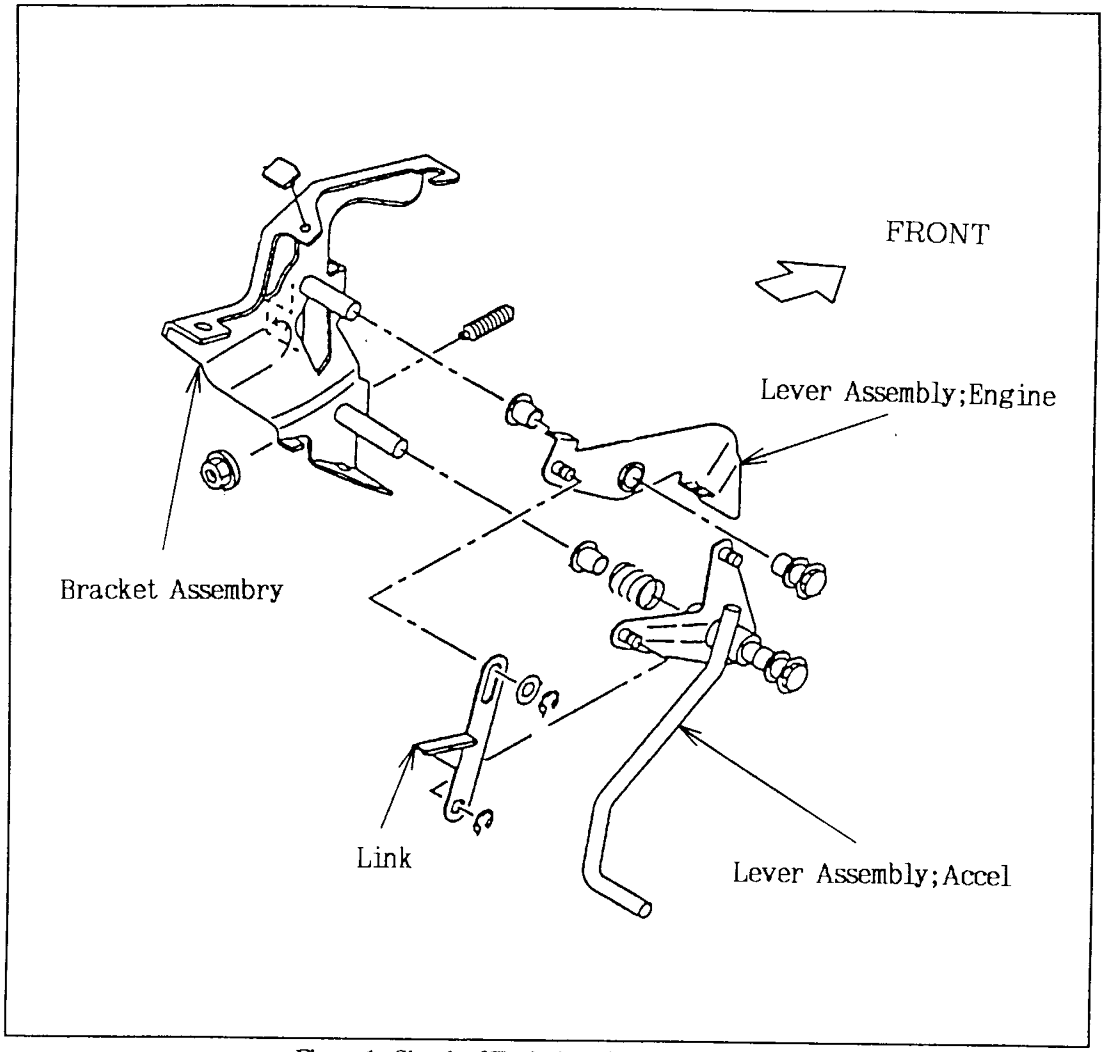
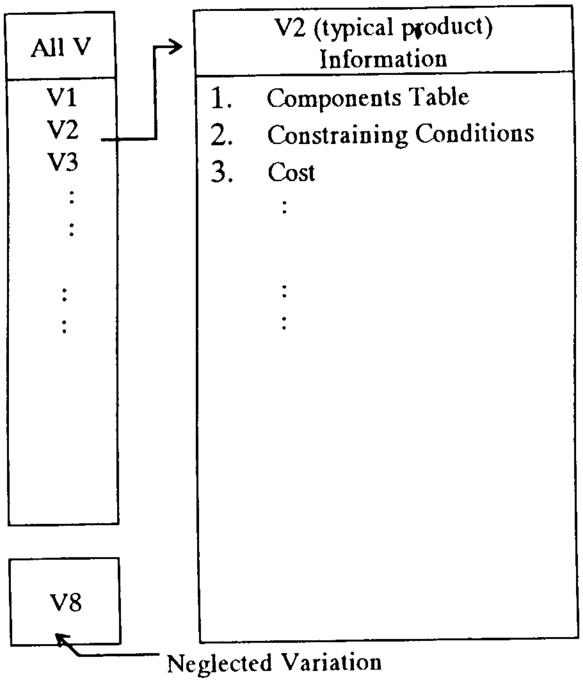


Figure 1 Sketch of Typical Variation

2. Information Collection

Information collection is a VE process essential for conducting VE job steps smoothly. Conventionally, information is collected about typical variations selected, and the other variations are checked against drawings only in terms of shapes. As a result, the other variations are neglected in the other VE job steps (Figure 2).

In this sample, information required for the entire control link is collected in terms of evaluation standards for each variation, components, and combination of the components in the variations. Also specifications and constraining conditions tables are prepared for every VE team member to understand the component dimensions and combinations.



Problems	Main Steps
V8 is left alone	Information collection, Function definition
V2 meets requirements, but V8 does not	Idea generation, Refinement
VE proposals are not accepted, and the other variations are left unchanged.	Proposals, Follow-up

Figure 2 Current Problems

3. Function Definition

As afore-mentioned, typical variations are conventionally selected for the reasons that production volume is large, or that the structure is basic. Engineers tend to achieve design for each specification, and try to avoid any waste. Therefore, if functional requirements are specified for typical variations, the other variations may lack functions. Some function groups may be missed in the step of arranging functions, which is critical for generating ideas.

Such a problem is solved by defining and arranging functions for all the variations. This is, however, impossible because of time limit. Accordingly, the best way is to select variations with the largest number of functions and the most complicated structure, as typical variations for defining and arranging functions, though a variation with the most complicated structure does not always cover functions of all the variations.

- ✧ Negligence of functions is avoided.
- ✧ Function which causes parts proliferation is identified.
- ✧ Constraining condition which causes parts proliferation is identified .

In the course of studying the sample, some variation has turned out to be added, not to meet constraining conditions, but to supplement function (secondary function), which has greatly helped to generate ideas and make proposals for parts commonization.

4 Function Evaluation

One of the objectives for function evaluation is to set targets of cost for achieving functions. Therefore, achieving production volumes and costs, as well as meeting functional requirements, are essential in this step. Conventionally, the costs and values of typical variations in large production volumes are analyzed to identify function group with a high improvement potential. In some case such function group turns out to be unnecessary for the other variations, or to make little effect because of small production volume of the other variations. On the other hand, there is a case where improvement potential of typical variations is low, and that of the other variations is high in a large production volume.

Indispensable to producing effects on the entire variation is to analyze functional requirements for all the variations, including production volumes and costs, and determine which function group has the highest improvement potential for achieving the greatest effect. In the sample, typical variations are weighted with functions, and then value is analyzed for each variation.

Improvement potential for function group is calculated by subtracting function F from cost C, (C−F), and evaluating the cost of a variation in monthly production volume (unit cost multiplied by monthly production volume) instead of the cost of a single part. This has enabled us to focus our efforts on the entire function groups, and improve products with low values.

In this sample, cost targets are determined by summing up cost improvement potentials for each function group, and priority is given based on the calculated improvement potentials of function groups before the VE step of idea generation.

5 Idea Generation

In order to reduce the number of variations, attention should be focused on the functions which are considered to cause parts proliferation in the function definition step, and ideas for achieving the functions by a single method should be patiently searched for. For example, a function of securing throttle valve operation angles A and B is required for different engines. In this case, ideas should be generated not only in terms of securing operation angles, but also achieving the operation angles A and B by a single method. The following Figure 3 shows an idea gained for the sample:

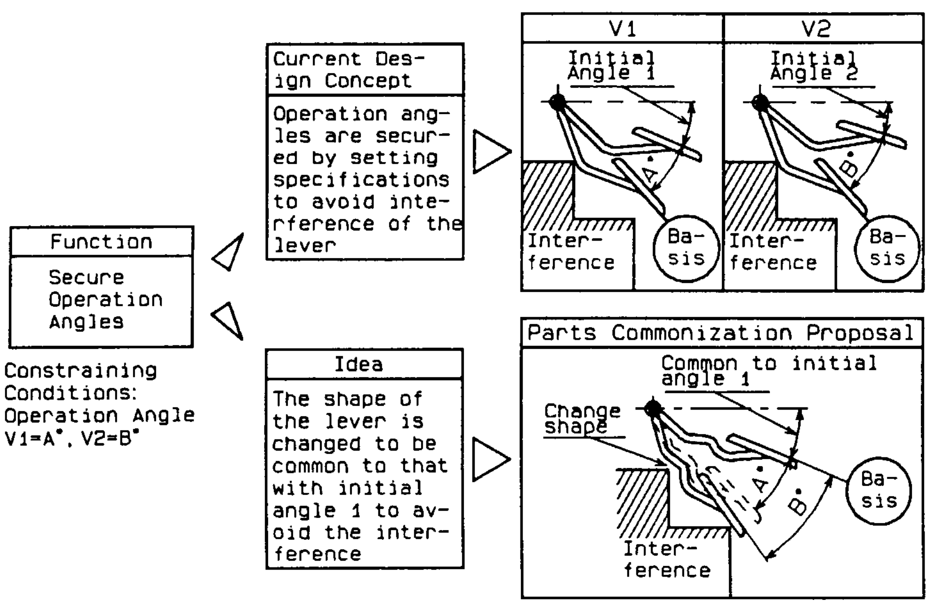


Figure 3 Example of Idea Generation

6 Embodiment and Refinement

6.1 Embodiment

In the step of function definition, typical variation is selected to cover all the functional requirements of variations in order to avoid missing any function. As the number of function groups increases, however, the combination of ideas becomes more complicated, preventing us from working out a system. Especially in the case of automotive parts, little effect is made because of small production volumes. Therefore, in this step, we should deal with specification in a large production volume, which is considered to produce the greatest effect.

The main objective of parts supplier's VE activities is to save cost. In the step of systematizing functions, parts are integrated for commonization, if possible. What is important here is to make tryout and experiment to confirm that constraining conditions are really necessary. In this sample, at first, the structure of the cable link for the right-hand and left-hand drives is considered complicated because of constraining conditions for the layout of the related parts, and thus parts proliferation is assumed inevitable. However, by studying the vehicles, a possibility of integrating parts by using a different method has been opened. As a result, our proposal has greatly contributed to the reduction of the number of parts, and thus commonization in the variations group.

6.2 Refinement

Functions and constraining conditions which are not covered by VE proposals for parts commonization are dealt with as defects in function, and such defects should be remedied in the VE step of refinement. The refinement step is final for ensuring functions, and thus if defects are not remedied, some variations are left as they are.
If no remedy is found at all, one way to open up a possibility is to carry out proposals for parts commonization on prototypes. If a specification for automotive parts is changed, tests are performed before production to confirm that new parts meet quality requirements. Problems can be identified, if any, in the evaluation processes, and in some cases problems themselves are changed to those much easier to deal with.

7 VE Proposals and Effectiveness

VE team members always try to collect information and understand functions perfectly in order to achieve VE proposals, but sometimes they are trapped by an unexpected problem. In the most serious case, something missing prevent acceptance of one item which leads to the rejection of all the VE proposals. In order to avoid this, multiple VE proposals, including options, are made in a matrix of commonization levels and cost savings.

With such a proposal matrix, the possibility of VE proposals being accepted increases, even though they do not completely meet the requirements for commonization, or the proposals are not always feasible because of model change timing. As a result, feasibility of VE proposals increases for some variations, though not for all the variations, and VE activities are conducted at different commonization levels.

Our VE activities are conducted by all the members sharing information about relation between cost savings and easiness in achieving functions, required investment and manhours to reach a consensus of parts commonization level in the final step before engineers make drawings on their own.

In this case, the VE proposal is finalized at Level 2 considering investment required by design change, and timing for minor change. As a result, total cost is reduced by 41 %. In addition, the number of variations is reduced from 8 to 4. (Table 1)

Therefore, our initial targets of cost saving VE and parts commonization are both achieved at the same time. This is considered as an example of verifying the effectiveness of our VE policies and application processes.

Table 1 Parts Commonization Levels and Improvement Effects

Variation No.	Level 1	Level 2	Level 3	Monthly Prod. Vol. (pieces)
V1	A	A	Current	11,006
V2	A	A	Current	1
V3	B	B	Current	190
V4	A	A	A	453
V5	A	A	A	5,058
V6	B	B	B	658
V7	A	Current	Current	395
V8	B	Current	Current	3
No. of Variations	2	4	7	
Savings (× ¥1,000/Month)	5,520	5,230	2,980	
Reduction Ratios	43%	41%	23%	

Specification A: Parts for manual transmission
Specification B: Parts for automatic transmission
Current : Current parts to be used
Commonization Levels:

Level 1: Common pedal angle without producing adverse effect on cable operation durability, compatible with injection pump lever angle
Level 2: Common pedal angle without producing adverse effect on cable operation durability
Level 3: Common pedal angle

CONCLUSION

Our goal is set at saving the total cost of all the variations and at the same time reducing the number of variations by grouping variations. Table 2 shows points and processes added to the conventional VE method.

VE policies so far mentioned in this paper are found particularly effective in all the VE job steps except that in the job step of idea generation, we have depended upon VE team members' skills and sense. Method for developing ideas should be standardized.

Parts tend to proliferate as mentioned in the abstract herein. We think that the method we have used this time is very effective in correcting this tendency, and thus we are willing to use this method more often in the future.

Table 2 Points and Processes Added to Conventional VE Method

Points		Additional Processes	
a.	Avoid required func-tions being left alone in grouping variations	1.	Understand dimensions and combinations of components by using specifications table
		2.	Understand differences of variations in performance by using performance requirements table
		3.	Define the functions of the variation with the most complicated structure (the largest number of functions)
b.	Identify function which causes variation proliferation	4.	Determine functional requirements for each variation by using function diagram
		5.	Determine functions and constraining conditions for each variation by using functions and constraining conditions table.
c.	Identify variation with highest potential for function improvement from among all the variations	6.	Identify variation group with the highest potential for improvement by analyzing improvement potentials for all the variations.
d.	Thoroughly verify the necessity of constraining conditions which may prevent the realization of ideas.	7.	Make an experiment to confirm the necessity.
e.	Share responsibilities for dealing with variations.	8.	Determine relation between commonization levels and cost savings to increase the possibility of VE proposals being accepted

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