VALUE ENGINEERING FOR ENVIRONMENTAL CONSERVATION

Yasumichi Koizumi, CVS

Yasumichi Koizumi is head Environment Commission of Fujita Corporation, Tokyo. He is a consulting engineer (qualification similar to PE of U.S.A.) registered at the Science and Technology Agency of Japan in the construction and the managerial engineering. He is a member of some environmental conservation activities such as WWF-Japan. Mr Koizumi has been in charge of a number of tasks with management of dam construction. He has applied VE to tasks with fruitful results. He became the VE Section Chief of Civil-Engineering Division in 1985 and has led VE in the civil-engineering work sections, and in 1991 was appointed to his present position

ABSTRACT

Aimed at effectively applying VE suitably to the yet hard-to-solve subject of global environment, this paper proposes a new concept of "Affluent Life with Wisdom" based upon the proper attitude to be assumed by any enterprising citizen. To accomplish this conceptual conversion, we select four basic factors for VE promotion in view of conserving the environment and propose incorporation of them into VE Job Plan together with 12 keywords for environmental conservation. This discussion is followed by an analysis of previous examples of VE applications and also a description of the Life Cycle Assessment (LCA), and how to apply VE to LCA.

INTRODUCTION

In 1989, the subject of global environment rose as a major social problem, and many enterprises set up a new organ in charge of environment. The year was called the first year of environment, and the following 1990's have become an important decade for deciding whether the mankind can survive to the 21st century soundly.

The assaulter of the present environment problem is mankind, and the scope of the influence has widened to the earthly scale. The damage ranges from destruction of the ecosystem to the matter of the whole mankind. Now is the time to stop the environmental destruction and make protect the ecosystem over national boundaries in cooperation of the administrations, enterprises, and citizens. Among others, the enterprises bear a heavy responsibility because of their having progressed based upon mass-producing and mass-consumption.

From the viewpoint of environmental conservation, the production in the past involved three problems. Firstly the marketing strategy of pushing forward mass-producing, sales, and consumption has amplified bad economy externaly and brought about environmental detriment owing to mass scrap etc. and also unevenness in the economic share. Secondly excessive pursuit of comfortableness and convenience has increased the environmental load. Thirdly the chemical substances which were adopted for accomplishing the high quality and low cost, constituted a cause of environmental destruction.

ATTITUDE AS ENTERPRISE CITIZEN

The Charter of Global Environment (published on May 23, 1991) of the Federation of Economic Organization of Japan sets forth in its fundamental concept:

> We endeavor to achieve a society in which all constituent members work in cooperation for the environmental subject. The society herein refers to one which can make continued progress on the earthly scale, one in which the enterprises and the district inhabitants/ consumers live together in mutual trust, and one where free and vital enterprise activities are pushed forward while the environmental conservation is well secured. Enterprise must

also be a "good enterprising citizen". It must acknowledge that its dealing with the environmental subject is the essential condition for its own existence and activities.

This signifies that the circumstances of the enterprise management have revolved to a great extent, that the conventional way of thinking with the effectiveness placed in priority can no more meet the needs of the customers, and that the management's idea with the customers in priority and the view of society and environment have become inevitable.

Many enterprises which have such a concept of enterprizing citizen as stated, are contributing measures to districts and the general public such as partial giving-back of the profit, human and financial support to district activities, and original cultural activity and district contribution. To share the responsibility for the environment, they use recycled products domestically such as regenerated paper and wrestle with decreasing or strictly controlling the amount of the waste. There are many cases where enterprises deal with product development and/or services in which the processing after the use by users is taken into account.

Then the Ministry of International Trade and Industry requested the major 87 industrial societies over which the Ministry has jurisdiction, that they should make a "Voluntary Plan about the Environment". Some time later (Nov. 12, 1993), the Organic Law of Environment was enacted. The fundamental concept of the Law consists of "conserving sound and affluent environment", "structuring an economic society capable of lasting and with lesser environmental load", and "positive promotion of tackling with environment internationally". Article 8 of the Law prescribes liabilities of each enterprise - for example, to prevent pollution, conserve the natural environment properly, devise proper processing capable at scrapping, and use regenerated resources.

DIFFICULTY IN GLOBAL ENVIRONMENT PROBLEM

To solve the global environment problems is an urgent subject to be settled before 21st century comes for mankind to survive. The Environment Agency of Japan gives the following nine items as typical phenomena which might be detrimental to the earth and have commitment seriously to the health of the mankind and securing of their food:

1) destruction of ozone layer,
2) the earth being turned warmer,
3) acid rain,
4) decrease of tropical forest,
5) turning into desert,
6) pollution in developing countries,
7) decrease of wildlife species,
8) marine contamination,
9) over-boundary movement of detrimental waste.

These phenomena are closely related to one another and difficult to solve because of involvement of complicated factors. The major points to be noted are:

(1) A plurality of phenomena are complicatedly related to one another to form a group of problems - for example, one phenomenon constitutes the cause of another.

(2) Even though the principal cause is known, the causal substance(s) has intruded into every corner of life while its shape has been changed.

(3) A long time elapses untill appearance of the phenomenon since the causal substance was emitted.

(4) Even though one has an environment conserving consciousness, he tends to pursue convenience and/or comfortableness and does not act.

(5) Scientific knowledge is insufficient, and unsolved academic subjects and opposing opinions still remain .

(6) The problems involve factors of international political and economic matters such as national system, amount of resources possessed, economic power, and technical power.

CONVERTING INTO AFFLUENT LIFE WITH WISDOM

To protect society where mankind live lastingly and a sustainable development takes place, it is required to change the conventional life style and aim at an Affluent Life with Wisdom based upon a new sense of value.

Among the environmental loads, carbon dioxide which constitutes the cause of the earth being turned warmer, is put on discussion by way of

example. Mankind has sought more comfortable and more convenient life. This way should be held on to live as a human being. However, a more comfortable and more convenient life requires more energy. Its dependence upon fossil fuel has resulted in waste scattering of carbon dioxide in the atmosphere to bring about crisis of the earth being turned warmer in exchange for comfortableness and convenience. Anticipation of the energy consuming amount in future is given in Fig. 1.

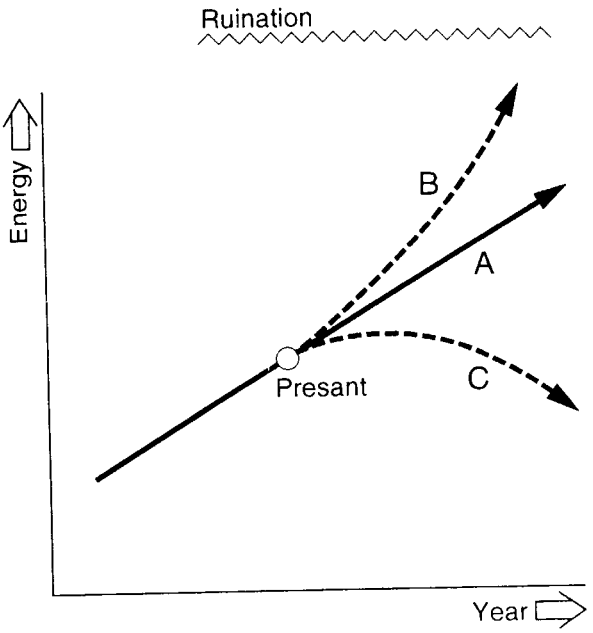

Fig.1 Prediction of energy consuming amout in future.

If mankind continues living in the same manner of thinking as before, the energy consuming amount will also increase steadily. The extension from the time gone is drawn as Line A, provided that the populations are unchanged and that a majority of the energy consumption in the whole world is shared by the developed industrial countries while the energy consumption in the developing and underdeveloped countries is held as it is. However, the population of the latter countries are rapidly incremental. Because the nations of these countries also possess the right to live more conveniently, it is considered that the energy consumption of these countries is going to increase to a great extent. As a result, the energy consumption of the whole world will appear as Line B, which signifies the ruin is reached more quickly than according to Line A. The figure to be attained is as Line C. Now the subject is how Line C can be attained while the increase in the population is taken into account. Saving or the theory of patience as returning to the old time will hardly gain the social consensus. Even though it succeeds in gaining consensus, the substantial effect will be poor as not opposing the pressure of rapidly incremental population. There is only one way - i.e., turning into an Affluent Life with Wisdom. For this purpose, a reform of the social system and the technological innovation should take place simultaneously.

Herein carbon dioxide was taken up by way of example, but other problems must be treated alike, for example the problem that sulfur oxide and nitrogen oxide as emitted in association with combustion of the petroleum fuel give a cause of acid rain.

The enterprise must achieve the change of the social system in cooperation externally with the citizens, administrations, fellow enterprises, and his mating parties in business while promoting domestically the technological innovation with his own, original force.

5. FOUR ITEMS OF VE AIMING AT ENVIRONMENTAL CONSERVATION

The enterprise must live together as an enterprise citizen under mutual trust with the citizens and aim at achievement of a society which allows vital activities while he endeavors conservation of the environment. For an enterprise, the environmental subject lies in the first priority for enterprise management. The global environmental subject involves in entanglement difficult and complicated factors both in technical and economical terms. Achievement of the Affluent Life with Wisdom is possible first with simultaneous pushing forward of the technological innovation and the change of the social system. A difficult and complicated subject such as global environmental problems is just a new field to which VE can suitably be applied.

As a matter of fact, the enterprise must conform to the environmental countermeasures prescribed in the laws. After now, products in which considerations about environmental conservation are incorporated, will contribute to distinction more than what the laws prescribe.

To create a value of product in which environmental conservation is taken into consideration, first the original function of the product is maintained while the manufacturing cost

is sunk, and then it is important to suppress the cost for environmental conservation likely to be incremental.

Favorable examples are those products which require less resources and energy in manufacturing and which emit less detrimental substances and discharge less waste. Also those which require less energy in transit, service, and maintenance, which involve less environmental load in association with scrapping, and which present a long lifetime as product. The life cycle cost becomes low if any product despite its high product costs involves a lesser environmental load and presents a long lifetime as product.

Here the following four items are proposed for effectively and thoroughly promote the VE which is to develop a product having a high environmental value:

(1) Strengthening of VE members

Add experts in the environmental subject to the members and collect the latest technical information thoroughly.

(2) Way of thinking about the fundamental formula
Incorporate the level of the environment in F in the fundamental formula "V=F/C" of VE and enhance the environment. Consider C as the load for the environment and strive for lowering the load. Otherwise, it is also acceptable that the enhancement of the value is attained through expressing as "V=E/L" which is easy to understand.

Table 1 Twelve Key Words

H	Health
	Human
	Harmony
E	Ecology
	Environment
	Economy
R	Reuse
	Recycle
	Reduce
S	Save Energy
	Save Resource
	Save Man Power

(3) Incorporation of Twelve Keywords in VE job plan Incorporate the Twelve Keywords common to different problems in the VE job plan. The keywords are grouped in H, E, R, S as exhibited in Table 1.

At the Step of the functional definition, the functions associate with the keywords given in Table 1 are dug up consciously. Because the scientific knowledge of the environmental subjects are still insufficient, it is important to endeavor to find concealed functions.

At the Step of the functional evaluation, the costs concerning each keyword are evaluated objectively. As this task is difficult, it is required to put as much effort as possible and to make the evaluation objectively.

In idea conceiving, questions about keywords are placed and ideas effective for conserving the environment are induced. Ideas which allow heightening of the environmental level with the same action and those which enable lowering of the environmental load, are to be sought in as many pieces as possible.

At the Step of merit/demerit investigation, all possible merits and demerits associated with each keyword are listed. Here in particular, it shall be noted that omission of any demerit listed is to be suppressed to the minimum. The reason therefore is because the environmental subjects are so complicated and a large part is left unsolved in scientific terms. Because a minor mistake causes ill influence out of anticipation or any damage may come to the surface when people will have forgotten the matter. Before people evaluated quick performance, easy execution, and comfortableness one-sidedly and considered them as merits, but we now should not ignore the increase of the environmental load which lies on the back of the matter.

For example, the problem of carbon dioxide increasing which is said to be the cause of the earth turning warmer, has resulted from a large consumption of the energy due to seeking for the convenience and comfortableness. Methane gas and freon gas bring about a greater greenhouse effect than carbon dioxide, are considered as giving ill influence remarkably in the following two or three decades. Plastics such as foaming styrol, empty bottles, and wood splinters afloat in rivers and oceans are mostly due to seaking for the

convenience and easiness. The same Will apply to the causal substances for water turbidity and atmospheric contamination.

At the step of overcoming the demerit(s), so-called upstream countermeasure should be pushed forward positively such as suppression of consumption, conversion of the raw materials, etc. The upstream countermeasures require lesser costs compared with any downstream countermeasure such as removing causal substance(s) immediately before the exhaustion, dissolving after exhaustion, etc.

At the step of detailed evaluation of the improvement plan, enhancement of the environmental level, protection of the resources, reduction of the major causes, etc. are evaluated quantitatively and qualitatively, followed by checking the environment conserving effect. Some are, however, difficult to undergo quantitative evaluation while others can not be described satisfactorily with any partial qualitative evaluation. Because it is necessary to accumulate scientific information and perform works for the future, we should collect data having high accuracy objectively as much as practicable. It is also important to incorporate other managerial techniques such as QC and to conduct evaluation scientifically.

(4) Proposal of Affluent Life with Wisdom provide a place of Affluent Life with Wisdom for citizens and strive for attaining coincidence of the consciousness with the action.

ANALYSIS OF PAST EXAMPLE EXECUTED

The Environmental VE Institute of Tokyo Division of Japan VE Association (SJVE) classified the environment conserving effects into the nature, resource, life, and other, followed by fine classification and rearrangement, see Fig. 2.

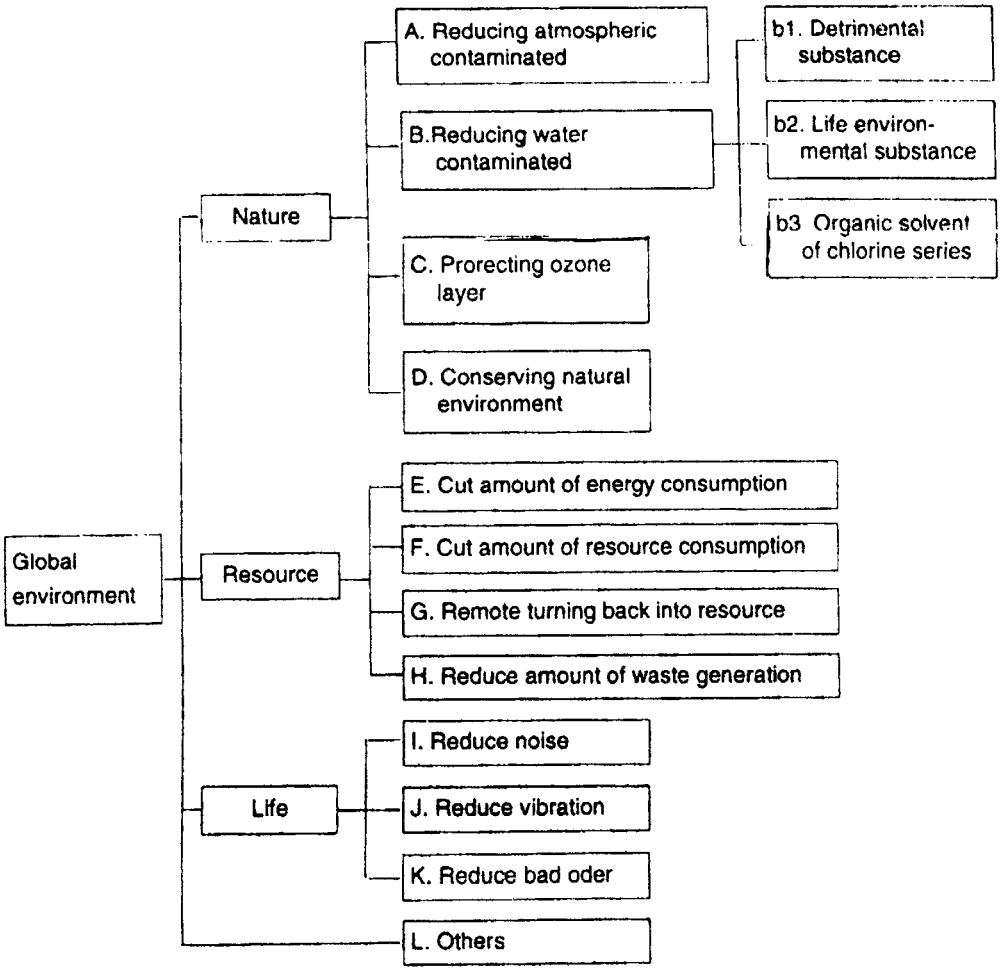

Fig. 2 Classification of environment conservation effect

Upon exhibiting this classification, the association asked each enterprise as a member of Japan VE association so as to offer the representative example(s) of "VE having Exerted Good Effect for Environmental Conservation".

Sixty-four examples were collected and their environment conserving effects were classified, see Fig. 2. Some examples gave two or more effects each. The effects that have appeared frequently were, in the sequence from the most, decrease of the resource consuming amount, promotion of turning back into resource, reduction of the waste generating amount, and decrease of the energy consuming amount. These four shared approx. 80% of the total.

The ultimate object of VE aiming at conserving the environment is to develop a commercial product of with-environment co-living type and create things with environment in priority. A majority of the collected examples, however, belong to the four categories such as the decrease of the resource consuming amount as mentioned, that can be characterized as the early stage of the environment conserving effect. Any examples of enhancing the environmental value essentially are found less.

VE APPLICATION TO LIFE CYCLE ACCESSMENT (LCA)

The problen now is to structure the Environment Management System. There is enterprise(s) promoting a review of the organization and undertaking concerning the environment and making an evaluation of its influence, while another enterprise is re-checking the sources of freon and carbon dioxide generation, compiling a program of substitute or conversion technique, and surveying the management system on a scale over the enterprise. To push forward VE for compliance with these varying economic and social environments of enterprises, it is considered that the life cycle accessment (LCA) as evaluation of the environmental impact of materials should be incorporated.

The processes from material acquisition, manufacture/processing, transport/distributor, use/reuse/maintaining, recycle, and waste processing are one life cycle of a product. About one product as VE object, materials necessary for it and a raw material as energy source are acquired, fabricated, and processed to be turned into product. The product is carried to the user and used with eventual reuse under management for service, a part being sent back for recycling, while the remainder is processed for scrap to complete its life. The research to attain minimization of the life cycle cost (LCC) of each product has a fast footing already as a theme of VE.

The life cycle accessment (LCA) is a task to evaluate the impact of any product or process, as shown in Fig. 3, to the global environment in all their processes and to make a total analysis.

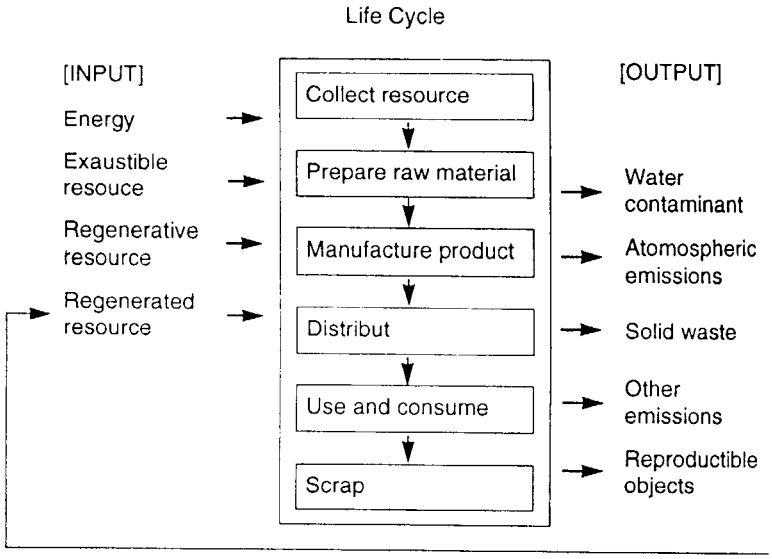

Fig.3 Concept of Life Cycle of Product

Any product in each process of its life involves the input of energy and substance to consume the geological and ecological accumulations on the earth such as fossil fuel, mineral resources, and forest resources and also the output of the green-house effect gas such as carbon dioxide and the atmospheric contaminant and water contaminant to constitute a cause of acid rains etc., and thereby contaminates the global environment either directly or indirectly.

The first step of LCA is called inventory, in which how a load is given to the environment in each process, is listed. This is followed by the impact analysis, in which the environmental loads are listed according to the flow chart (cumulated), and it is possible to find which environmental impact is largest in the whole process. An

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The role of LCA is to make comparative evaluation of a plurality of product articles, evaluate the effect of product improvement, make product check for attainment of the reference value or target value, analyze the current influence of the product for extracting the improvement target, and become a guide book for the method of use and reuse. The role which is considered as the most effective manner being used at present, is evaluation of the effect of product improvement. This is to make evaluation upon examining the change of the environmental impact in case selection of the material or improvement of the process takes place on the same process flow fundamentally. Analysis is made using process data manageable and the data acquirable by the manufacturer, and the results are reflected and processed within an extent capable of being selected by him.

This inventory analysis at first step includes defining the amounts of all of the raw material, energy, product, and waste and preparing the list in accordance with the life cycle of the product as the VE object. This may appear in two ways, i.e. by the use of the industry correlation method and the pile-up method, both however requiring a huge quantity of data. Its quantity of work becomes naturally huge.

The impact analysis consists of evaluating the environmental load amount obtained by the inventory analysis as an influence upon human being or the ecosystem. When evaluation takes place, individual environmental loads must be converted through calculation into a certain environmental load amount. At present, no such method for evaluating the total environmental load amount synthetically is yet established. There is a trial synthesizing method to be conducted through weighting or comparison upon being classified by load categories. Table 2 gives examples of the weighting factors.

Table 2 Example of Weighting Factor

Classification	Substance	Coefficent
Atmospheric contaminant	Sulfur dioxide: SO_2	1.00
	Carbon dioxide; CO	0.01
	Nitrogen monoxide NO_2	1.39
	Soot and dust	1.08
Water contaminant	Cadmium: Cd	100
	Cyanogen: CN_2	10
	Lead: Pb	100
	Mercury: Hg	2,000
	PCB	3,300
	1,1,1-trichloroethane	1

These are determined from the inverses of the allowable emission concentrations prescribed by law. This method is considered as the most reasonable, at least at present, provided that the method includes some unclarified points such as how to handle the substance(s) which should obligatorily not be sensed, and as the synergetic influence of a plurality of substances.

The improvement analysis is to promote an improvement plan of a part with large impact obtained by the impact analysis and its selection. This Step makes qualitative evaluation along with quantitative evaluation and performs synthesized examination. There is no established method at present, but this is a step inevitable for improving the overall environmental performance.

The three steps of LCA have been described above, to each of which the VE method is applicable. Many detail works in each Step will accept VE detail methods such as the ABC analysis or FD method. These will constitute a new field of VE application.

CONCLUSION

To build a society in which mankind can live permanently and make sustainable development, it is required to change the conventional life style and aim at an Affluent Life with Wisdom based upon a new sense of value. To make conversion into such a Life, a reform of the social system and technical innovation should take place simultaneously. VE includes a power to yield a new sense of value and reform the social system and also possesses a force to push forward the technological innovation and create a product having a higher environmental value. A difficult and complicated subject such as the global environmental problems is just a new field to which VE is to be applied.

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