Value Quality Engineering: Hybridization of Value Engineering and Quality Engineering Based on the Theory of Inventive Problem Solving (TRIZ)

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Introduction

The recent publications on Value Engineering indicate the new era in VE evolution. These publications describe different ways to modify the classical VE according to the contemporary requirements of new approaches[1]. In this article, authors consider bridging the gap between VE and methods of quality control through applying the Theory of Inventive Problems Solving.

Cost and Quality

History of Correlation between Cost and Quality

The entire history of manufacturing, since the ancient period, shows that quality and cost of different products and services are in permanent contradiction: quality improvement results in rising of cost, and cost reduction deteriorates quality. However, at different stages of technological evolution, this contradiction manifests itself in different ways. For example, during the shift from handcrafting and low-volume manufacturing to the machining and mass production the quality usually first drops; however, then the quality grows due to the advantages of the machining, mass production, standardizing and automation of manufacturing processes, improvement of machines and processes, etc.

Correlation between quality and cost depends mainly on both the general technological culture of the society and established methods of manufacturing; both these characteristics, in their turn, depend mostly on the market situation. For example, by 1950's the world market was not saturated by products and services, even in the USA, and there was a significant demand on any product. The manufacturers did not have any strong reasons neither for cost reduction nor for quality improvement. As a result, the cost-and-quality culture in product / process design did not exist or was hardly developed. Among other things:

- Poor cost-reduction culture manifested itself in the facts that:
  - The effective methods of taking cost of materials and labor into account either did not exist or were not used; the plausible cost information either did not exist or was not used for selection of manufacturing approaches, processes, etc.
  - Efforts of designers and manufacturers to reduce cost were hardly stimulated
  - Psychological inertia was directed to applying old fashioned, traditional ways and designs rather than new, often unpredictable ones
  - When designing new products or processes, the designer usually applied first imagined variant to perform necessary function, did not consider alternatives that could make the same in less expensive way
  - When selecting the materials and construction elements, designer considered only primary functioning of the system and never analyzed ways to perform auxiliary functions; however, auxiliary functions take about 90% of the product cost

[1] Jerry Kaufman. Value management

- Designer usually did not think about cost of production, and did not try to design products so that they were easy and inexpensive to produce
  - Methods of cost effective design did not exist or were not used
- Poor quality culture manifested itself in the facts that:
  - Manufacturers were not interested in "voice of customer", consumer features of product; methods to collect and analyze the "voice of customer" did not exist
  - Quality was considered as unimportant issue; inevitability of scrappage, product failure, customers' complains was obvious
  - Effective statistic methods of quality control existed, but were not used
  - Efforts of designers and manufacturers to improve quality were hardly stimulated
  - When designing new products or processes, the designer usually did not consider special ways to improve the quality
  - Methods of design, manufacturing, and testing directed to the high quality did not exist or were not used
- Both poor cost reduction and poor quality culture were mainly determined by:
  - Managers' lack of understanding the technology
  - Manufacturers', designers' lack of understanding the management, marketing, business issues
  - Lack of understanding between managers and technologists
  - Lack of well-trained managers
  - Inability to creatively solve the problems related to the management, marketing, business, etc.

As a result, design and manufacturing were not directed to satisfy the customer, in contemporary meanings. Almost all systems, products, processes, services were too expensive, complex, inconvenient, heavy, had low quality, did not have sufficient support, etc.

It means that all products and processes had many resources for both cost reduction and quality improvement, and both goals could be achieved easy, with simple methods. From another standpoint, many resources meant that cost and quality were loosely related; the contradiction between cost and quality could be easily bypassed through simple methods. The major method was to influence each characteristic separately: reduce cost without sacrificing the quality, and/or drastically improve quality without significant cost increasing.

Due to these facts, the Value Engineering[2] became a great achievement in 1950's – 60's, on the background of poor cost culture in the industry. At that period, Value Engineering was very successful proving that cost of products can be reduced without sacrificing its

[2] Value Engineering (VE) was originated in late-1940's by an American engineer Lionel Miles from GE. First, it was recommended as a way to reduce cost of products through reducing excessive requirements and elimination of excessive quality. This method became popular in 1950's – 1960's; Value Engineering Association was established, the professional magazine was published. Pentagon introduced a requirement that all supplies for US Army, Navy, Air Forces, etc.have to undergo Value Analysis. VE is used in some industries up to the present, though it is not as fashionable. Today, there are about 400 professional Value Engineers in the USA (information from Conoco experts). In Japan VE is still very popular. Lionel Miles was one of six foreigners awarded with the "Purple Hart" for valuable contribution into Japanese economics.

functionality, i.e. quality. Simple, effective methods like Miles' functional analysis, FAST, Osborn's brainstorming, Zwikki's morphological analysis, etc., were developed and implemented.

At approximately the same time, Quality Engineering[3] became another significant and profitable achievement; proving that quality can be significantly improved at low cost through special means in organization of manufacturing. Simple, effective methods like fish bone diagram by Ishikawa, Taguchi method, QFD and others were developed and implemented.

Cost and Quality Relationship Today

During more than 40 years, the general culture of society, especially the technological culture, had changed drastically. These changes manifested themselves in the following facts:

- New generation of both managers and engineers are better educated and trained, and better understand problems of each other
- All industries have accumulated a substantial experience in both organizing of effective mass-production and design for mass-production. High-accuracy automated systems and machines, measurement and control have been developed
- High-effective methods of design, such as Design for Manufacturing and Assembly (DFMA), concurrent engineering, CAD/CAM, FMA and others, have been developed
- Methods of quality control are widely implemented
- Different ways of motivation and stimulation of team work on resources revealing and quality improvement are used

All this resulted in the fact that almost all apparent resources of cost reduction and quality improvement are "exhausted", and revealing of these resources becomes more and more difficult. The cost and quality relationship turned into a **Major Contradiction of Evolution.** From now on one had to make a choice: either quality reduction because of cost reduction attempts or cost increase because of attempts to improve quality.

Actually, this contradiction is the real cause of some disappointment in Value Engineering. Quality reduction and loss of competitive advantage cause bad reputation for VE among some engineers and managers. Similar disappointment in Quality Engineering has been caused by cost increasing resulting in the loss of competitive advantage, as well.

<u>Remark:</u> Classical Value Engineering and Quality Engineering are still successful in some areas. For example, VE is very popular in oil drilling. The reason is that this technology is very old, it has not being evolved for a long time because the oil companies did not have any reason for cost reduction. Only nowadays competition starts pressuring

[3] Quality Engineering (QE) was based on ideas of American specialist Deming; these ideas were successfully adopted in Japan. QE returned to the USA from Japan, and became very popular. Now, in the USA, there are many Quality Engineers and companies that provide training in QE; Quality Engineering Association is established, as well.

them. There are many of such "Lost Worlds", however, they are exceptions rather then the rule.

Conclusion:
Evolution of both design and management resulted in:

- Significant general improvement of technological systems, consumer products, services, etc.
- Exhaustiveness of apparent resources for improvement of products, services, etc.
- Reducing effectiveness of methods currently used for both cost reduction and quality improvement
- Aggravating contradiction between cost reduction and quality improvement of products, processes, services, etc.

Inventions as a Method for Resolving Contradictions

The history shows that contradiction between cost and quality usually occurs when trying to improve mature designs and processes that had stopped evolving long ago. New approaches, principles of functions performing, inventions shift equilibrium toward better satisfying customers through achieving higher quality of products and services at low cost. For example, when Ford Motor Company shifted to conveyor assembly of cars, it resulted in both drastic cost reduction and increased reliability. Shift from vacuum bulbs to semiconductors, then to microchips not only reduced cost of electronic systems, but repeatedly improved their quality, as well. Mass-production of "Big Macs" made them inexpensive and assured their high quality.

We can say with reasonable confidence that an invention (new manufacturing approach, new design, etc.), breaks the "vicious circle" of cost/quality quandary, and allows drastic improvement in both directions. However, inventions are not viewed as a reliable base: they are unpredictable, hard to plan, they totally depend on insight and luck, etc. It means that **the following contradiction is one of the most important ones for evolution of technology and the entire human civilization: the contradiction between need in timely, well-planned evolution of systems and inability to plan or at least to foresee the inventions.**

The Theory of Inventive Problems Solving

This contradiction can be resolved through utilization of the Theory of Inventive Problems Solving[4] (Russian acronym **TRIZ** (**ТРИЗ**) for **Теория Решения Изобретательских Задач**). TRIZ is a systematic approach to system evolution and resolving contradictions. For details, see Appendix 1. Up to the point, experience in applying TRIZ to cost reduction, quality and efficiency improvement, revealing causes of failures, forecasting and preventing undesired situations, development of new systems, etc., has been accumulated for more than 20 years. Value Quality Engineering (VQE)

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[4] Theory of Inventive Problems Solving (TRIZ) was originated by Russian engineer Genrich Altshuller in 1946 as an approach to help inventors. Since then, TRIZ was evolved by Altshuller and his colleagues. For information about TRIZ, see web site, www.ideationtriz.com.

approach developed in Ideation International Inc. is based on this experience. The software that supports VQE, **IWB for VQE™ (Innovation WorkBench for Value Quality Engineering™),** will appear soon. For detailed description of this software, see Appendix 2.

Besides TRIZ, VQE utilizes all useful and interesting approaches from Value Engineering, FAST diagrams, Quality Engineering, Fish Bone diagram, Taguchi method, QFD, DFMA, concurrent engineering, FMEA, etc.

VQE: Typical Objectives and Problems

The primary objective of VQE is general improvement of the system directed to simultaneous improvement of its quality, effectiveness, reliability, etc., and cost reduction. In terms of TRIZ, this direction is named "Increasing the Ideality of the System".

More specific objectives, like cost reduction without quality loss, or quality improvement without increasing cost, can be pursued, as well.

In this chapter, the typical ways to pursue these objectives are considered.

Creating a New Generation of a System

Creating a new generation of a system, i.e., a system with new principle of operation, is the most effective way of evolution. However, this way is the most expensive and labor consuming, because it usually requires long development and testing, replacement of the manufacturing equipment and approaches, drastic changes in the marketing, etc. Such a radical way should be chosen as seldom as possible. However, VQE has a special set of tools directed to synthesis of new systems. This set of tools is a complex one, and only partially computerized. It comprises the following major elements:

- Analysis of system functioning through computerized tool **Problem Formulator™** (computer-driven work)
- Applying the method of technological systems hybridization (cross-breeding) directed to creating a "monster-prototype" comprising the appropriate functional "bricks" (manual work)
- Applying the method for systems simplification (computer-driven + manual work)

Functional-Ideal Simplification

The Functional-Ideal Simplification[5] is a technique that allows reduction of parts or operations number, simplification of shape and manufacturing processes without any deterioration of the system performance. As a result:

- All elements that perform unnecessary or auxiliary functions are eliminated

[5] Vladimir Gerasimov and Simon Litvin. Functional-Ideal Simplification of an object. *Journal of TRIZ* 3, no. 2, 1992. (Russian).

- Sometimes, some elements that perform supporting and even major functions are eliminated as well
- Some functions become unnecessary
- Necessary functions are performed incidentally by either other elements from the system or by elements available in the system's environment, i.e., resources

Reduction and simplification of elements work in both directions, they reduce both cost and chances to deteriorate the quality.

The Functional-Ideal Simplification comprises the following steps:

- Justified choice of element to be removed or simplified
- Determination of its functions and their types: primary, supporting, auxiliary, necessary, unnecessary, harmful, etc.
- Formulation of Direction for Simplification:
  - For useful function:
    - This function could be skipped if…
    - This element could be eliminated if its function can be performed by…
  - For harmful function:
    - This function could be avoided if…
    - This element, together with its harmful function, could be eliminated, if its useful function can be performed by…
- Utilization of TRIZ tools for generating alternatives
- Utilization of Patterns of Evolution for improvement of invented alternatives

Elements' Idealization

Elements' Idealization is a Modification of the Functional-Ideal Simplification designed for improvement of simple parts and assemblies (up to 10 – 20 parts). This technique comprises the following steps:

- Determination of useful functions of the parts, both main and auxiliary
- Determination of harmful functions of the parts
- Determination of the main elements of the part, i.e., elements that provide primary functions
- Development of the Ideal Model, i.e., the schematic picture that comprises only the main elements
- Generating the simplest alternatives to complete the Ideal Model to the level of workable system
- Revealing and solving secondary problems

Both Functional-Ideal Simplification and Elements' Idealization can be provided in the manual mode; however, software support is available as well: the **IWB for VQE™** software contains the appropriate micro-algorithms and suggestions.

Intensification of Resources Utilization

Utilization of resources available in the system and its environment is an important issue for cost reduction and, to a lesser extent, for quality improvement. The following resources should be considered and utilized:

- Substances, objects
- Energy, actions, forces
- Space and space-related features
- Time and time-related features
- Systemic interactions, synergy
- Differences and deviations of features
- Changes in the system and its environment, etc.

IWB for VQE™ software supports effective revealing and utilization of resources through appropriate algorithms and detailed lists of typical resources, accompanied with examples of successful applying of resources for different purposes.

Controlling Functions Performance

To control a function means to influence this function through modification of conditions in the zone where function is performed. These conditions can be modified through influence on:

- Energy exchange:
  - Supply of energy into the zone
  - Release of energy in the zone
  - Transformation of energy in the zone
  - Accumulation of energy in the zone
  - Withdrawal of energy from the zone
- Material carrier of the function:
  - Introduced or being introduced into the zone
  - Available in the zone
  - Being modified in the zone
  - Rejected or being rejected from the zone
- Space where the function is being performed:
  - Modification of position
  - Modification of shape and dimensions
  - Separation and integration
  - Going beyond the boundaries of the zone
- Time periods related to the function performing:
  - Time before the function starts, for example, some preliminary actions or changes, etc.
  - Time during the function performance, for example, making some operations simultaneously or during pauses of the major action, etc.
  - Time after the function is finished, for example, to improve the results, to remove waste, etc.
- Function features and characteristics:
  - Initiation

    - Amplifying, weakening
    - Halting, etc.
- Systemic relations:
    - Introduction into the system
    - Excluding from the system
    - Providing synergetic interactions
- Critical conditions for function performing:
    - Bottle necks
    - "Triggering" conditions, etc.
- Resources available in the system:
    - Ones that are useful for the system
    - Ones useful or necessary for other systems

Resolving the Cost – Quality Contradiction

Revealing, formulation and resolving contradictions between cost and quality issues is an effective way to achieve both objectives. The following issues should be considered while applying this approach:

- Means directed to the cost reduction:
    - Reduction of number of parts, shape simplification
    - Reduction of cost and amount of raw materials
    - Labor reduction
    - Elimination of some auxiliary functions, etc.
- Requirements dictated by quality improvement:
    - Increasing the system complexity through introduction of additional subsystems and elements that improve quality
    - Using more expensive materials
    - Increasing the labor consumption, especially for finishing and testing operations, etc.

To formulate contradictions, the manual algorithm **ARIZ for VQE** can be applied; Separation Principles, i.e., separation in time, in space, upon conditions, systemic transformations, etc., can be used to resolve these contradictions. However, utilization of **Problem Formulator™** and **Operators**[6] **for Resolving Contradictions** from **IWB for VQE™** software for this purpose is more convenient and effective.

"Secondary" Problems: How to Resolve Them

[6] Operator is a generalized creative recommendation for resolving one or several typical inventive problems. These recommendations were revealed through analysis of massive patent fund and history of technology. Now, these recommendations are combined into the System of Operators in the IWB™ software and its derivatives. Each Operator is accompanied with a set of Illustrations that describe how this recommendation was successfully applied to resolve real problems. Utilization of Operators for problem solving assumes applying the analogical thinking for generating ideas: Operators do not give the direct instruction "What-to-Do", they give the analogy "What-to-Think-About". One should not expect that Illustrations give the direct solution to the particular problem; they only illustrate how to apply the Operator.

Any changes in the system are always accompanied with occurrence of so-called "secondary" problems. This name does not reflect their unimportance, it only indicates that they occur as a result, consequence of resolving the "primary", initial problem. In general, the "secondary" problems reflect the fact that any improvement of some characteristic usually results in side effects on other characteristics of the system; these side effects might be undesired, harmful; they are either apparent or non-obvious, hidden.

Usually, occurrence of this kind of "secondary" problem is a good reason to reject a "primary" solution, abandon not only its implementation, but also discussion or testing, despite of its apparent advantages. This attitude is a result of both psychological inertia of experts and absence of systematic methods for problem solving.

VQE approach, in contrary, considers a "drawback" of any idea as a new problem, and appropriate sets of Operators, i.e., suggestions, recommendations, are included in this method.

Operators Aimed at Quality Improvement

If ideas aimed at cost reduction cause quality deterioration, one should apply appropriate Operators that allow resolving the "secondary" problems related to the quality characteristics.

Operators Aimed at Cost Reduction

If ideas aimed at quality improvement cause cost increase, one should apply appropriate Operators that allow resolving the "secondary" problems of deterioration of cost-related characteristics.

The following iterative process of applying these groups of Operators is recommended:

- Generating the idea aimed at quality improvement
- Solving the "secondary" problem of cost increasing
- Checking the potential side effects of this solution on the quality characteristics
- Solving the "secondary" problem of quality improvement, etc.

The similar chain of solutions and problems might be applied if one starts with an idea aimed at cost reduction.

Obtaining Additional Benefits

Sometimes, cost might be slightly increased if some additional benefits in quality can be obtained; some quality deterioration, for example, loss of some abilities of the system, might be tolerated if cost is drastically reduced.

These approaches are supported in the **IWB for VQE™** software by an appropriate set of Operators named "Obtaining Benefits".

VQE Methodology: Step-by-Step Procedure

Step 1. Choice of Mode

At this step, the mode of further work is chosen from the following list:

- General improvement of the product / process directed to simultaneous cost reduction and quality improvement
- General reduction of the product / process / service cost, with keeping or some improvement of its quality
- General improvement of the product / process / service quality, with keeping or slight cost reduction
- Forecasting of potential quality improvement and / or deterioration, and resolving potential problems of quality loss
- Determination of causes of quality deterioration, failures, undesired events, etc., and their elimination and prevention

The further work is planned depending on the chosen mode, estimated volume, desired results, number of team members, etc.

Step 2. Informational-and-Creative

Work at this step comprises collection, categorization and re-structuring of information related to the VQE-analyzed object. This work is supported by list of selected questions in the Innovation Situation Questionnaire (ISQ) module of **IWB for VQE™** software.

Then, the team collects and categorizes all previously suggested ideas and concepts related to the analyzed system especially the ones that have been rejected or not implemented. The team reveals the reasons for abandoning (usually because of some "secondary" problems). Often, addressing these problems utilizing standard Operators allows skipping complex and labor consuming further steps of the VQE process, and proceeding directly to the **Concept Evaluation and Improvement** stage.

If direct causes of a problem in the system are not clear, the **Failure Analysis** module of **IWB for VQE™** software is highly recommended for use.

If the team's objective is to predict and prevent potential quality deterioration, the **Failure Prediction** module of **IWB for VQE™** software is recommended.

Sub-step	Software support available
Collection, categorization and re-structuring of information related to the VQE-analyzed object. This work is supported by list of selected questions in the of software.	**IWB for VQE™** Innovation Situation Questionnaire (ISQ) module
Collection and categorization of all previously suggested ideas and concepts related to the analyzed system, formulation and solving secondary problems.	**IWB for VQE™** System of Operators module (Express mode)

Revealing direct causes of a problem (if necessary).in the system are not clear, the of software is highly recommended for use.	**IWB for VQE™** **Failure Analysis** module
Prediction and preventing potential quality deterioration (optional).	**IWB for VQE™** **Failure Prediction** module

Step 3. Analytical-and-Creative

The teamwork at this stage comprises development of cause-and-effect (functional) description of the system / problem, transformation of this description into the Directions for Innovation, then analysis and exploration of these Directions. Formulation of Directions for Innovation allows "slicing" the large problem into small, easy to analyze pieces. The following step-by-step procedure is recommended for this stage of work:

Sub-step	Software support available
"Mapping" the knowledge about the system and the problem in the set of Problem Description Diagrams	**IWB for VQE™** **Problem Formulator™**[7]
Formulation of General Directions for Innovation aimed at both cost reduction and quality improvement (automated)	**IWB for VQE™** **Problem Formulator™**
Analysis and categorization of each General Direction for Innovation according to the special rules	
Consideration of applying the known ways for each General Direction	
Selection of Directions and/or functions (key knowledge nodes on the Diagram) for further analysis	
Correction, clarification and adding information to Knowledge Maps, formulation and analysis of new Directions (if necessary)	**IWB for VQE™** **Problem Formulator™**

An extensive experience of Ideation specialists shows that at this stage the team usually finds many simple, easy-to-implement ideas aimed at cost reduction, improvement of quality and system's effectiveness. The reason is that the Problem Formulator generates Directions that are not apparent for experts, but are easy to resolve through known means as soon as they are revealed.

In addition, separation of the complex problem into small pieces and collecting of known ways for different Directions often result in new, effective combinations of known ideas that were not considered before.

[7] Problem Formulator™ is an intelligent piece of software transforming experts' knowledge about the system/problem into the "Knowledge-map" Diagrams and then into a set of Directions for Innovation providing with creative approach to system modification and problem elimination or prevention.

Step 4. Operational-and-Creative

At this stage, the team applies the Operators from the **IWB for VQE** software for exploring the Directions selected at the previous stage. As a result, new ideas are generated. The following procedure is recommended for this work:

Sub-step	Software support available
Direct applying the Operators to the General Directions	**IWB for VQE™**
Refining the selected Directions	**IWB for VQE™** **Problem Formulator™** System of Operators
Applying the Operators to the Refined Directions	**IWB for VQE™** **Problem Formulator™** System of Operators
Revealing the resources that can be utilized for ideas found during the work	**IWB for VQE™** **Problem Formulator™** System of Operators

Step 5. Algorithmic-and-Creative

At this stage, team applies the set of micro-algorithms to resolve some specific typical problems, such as:

- Synthesis of new systems, if the concept of new generation of product / process is necessary
- Modification of conditions for function performing, if some functions, usually the primary ones, should be improved
- Functional-ideal simplification, if the system should be simplified
- Elements' idealization, if the part or simple assembly should be simplified
- Utilization of available resources, for improvement of effectiveness of the system and reduction of its cost

Step 6. Concepts Evaluation and Improvement

At this stage of work, all ideas are collected together, categorized, prioritized and evaluated from implementation point of view. For ideas selected for further implementation the following operations are highly recommended:

- Consideration of opportunities to improve them through utilization of available resources and applying of Lines of Evolution
- Failure prediction to preliminary reveal the potential "secondary" problems
- Resolving of the potential "secondary" problems
- Evaluation of improved ideas
- Planning the works that should be done for implementation: engineering and economical calculations, testing of feasibility, design, etc.
- Preparing the Project Report and recommendations on implementation

Step 7. Implementation

Usually, at this stage the project team is on a stand as new (secondary) problems always occur required immediate resolution, and nobody but project team can do it effectively. The following works are recommended at this stage:

Sub-step	Software support available
Failure prediction for concept selected for implementation revealing and resolving potential problems that might occur during implementation; the ways to prevent these problems should be introduced in the implementation plan	**IWB for VQE™** **Failure Prediction** module
Knowledge-Mapping of the implementation process, which allows for effective monitoring and correction of the implementation process	**IWB for VQE™** **Problem Formulator™**
Solving secondary problems	**IWB for VQE**

General Recommendations on VQE Method Utilization

1. Teamwork is the best for VQE (see Ideation Brainstorming[8]), although it can be used for individual work as well.
2. The best results can be achieved with the utilization of **IWB for VQE** software. For that, a facilitator must have at least 3 days (24 hours) of appropriate education.

   For "manual" use of the VQE methodology, the facilitator must have at least 6 days (48 hours) of appropriate education by Ideation International Inc., and use the Ideation proprietary materials.
3. All steps of VQE process involve creative work aimed at generation of new ideas and concepts; the difference is in creativity methods used at different stages, and growing from step to step extent of required creativity. Always be prepared to the challenge!
4. VQE methodology comprises tools for resolving different kinds of problems: from minimum changes in the system up to drastic changes associated with development of the system of new generation. This is the major difference between VQE method and both Value and Quality Engineering approaches that are not equipped with tools for generating high-level creative solutions capable to drastically change the system; these approaches are aimed at small changes in the system. Don't reject "too crazy" ideas; try to utilize all range of opportunities the method and software offers!
5. VQE methodology is equipped with special tools that provide you with opportunity to foresee and prevent potential problems that might occur while modifying the system. Always apply them for evaluation of your own ideas!
6. VQE's variety of tools allow you:
   - Effectively plan any particular work during the VQE project according to the specific requirements of this work

[8] Ideation Brainstorming is a derivative from the conventional Brainstorming procedure that involves utilization of IWB™ software to effectively manage idea generation. For more information, see Appendix 2.

IDEATION

- Start applying this method after minimum education, through utilization of limited set of simplest tools and step-by-step mastering in more complex and effective tools
- Customize method according to your personal preferences and abilities, i.e., select and mainly the tools that match your knowledge, habits, type of thinking, other psychological specifics.

TRIZ, Value Engineering and Quality Engineering. Brief History

In 1977, the USSR Ministry of the electrical industry decided to conduct an experiment with implementation of Value Engineering into its enterprises. At that time, one of the co-authors of this paper, Boris Zlotin was appointed to be a chief of the VE department of the USSR largest electrical machine enterprise "Electrosila". By that time, he already had three years of experience in intensive application of TRIZ to real problems solving.

From the very beginning, Mr. Zlotin's responsibilities were not limited to cost reduction. Because of existing problems with quality of the products, he was supposed to help with revealing the root causes and preventing quality deterioration and quality improvement as well. This assignment gave a start to a wide scale experiments of utilization of TRIZ for both cost reduction and quality improvement. During the next 20 years, thousands of people from different enterprises participated in this work.

In addition to Mr. Zlotin, the following TRIZ specialists participated and contributed: Voluslav Mitrophanov, Vladimir Gerasimov, Simon Litvin, Vladimir Petrov, Esther Zlotin, Igor Vikentyev, Alla Zusman, Len Kaplan, Zinovy Royzen, Vladimir Proseanic, Svetlana Vishnepolschi, Vladimir Shapiro, Sergey Malkin, Gafur Zainiev, Valeriy Prushinskiy, Kirill Sklobovskiy, Peter Ulan, Alexander Selutsky, Michael Rubin, Alexander Chistov, Igor Kholkin, Izaac. Bukhman, Vladimir Kaner, Michael Shusterman, Vladimir Podkatilin, Lev Shulyak, Gennadiy Ivanov, Vissarion Sibiryakov, Victor Ladoshkin, Lev Pevzner, Alexander Lubomirskiy, Alexey Pinyaev, Sergey Iakovenko, Alexey Zacharov, Nikolai Kolchev, Nikolai Khomenko, Vyacheslav Saurin, Alexander Gasanov, Victor Sichev, Gregory Yezersky, Dmitriy Smirnov, Vladimir Kovalev, and others.

From the Value Engineering side, the following VE professionals participated: Vladimir Glezer, Valery Vasilyonok, Nina Moiseeva, Michael Karpunin, Vladimir Dostal and others.

Also, numerous students attending VE and TRIZ seminars, thousand of working team members participated. We would like mention in particular the members of the first VE+TRIZ projects: Boris Lyarskiy, Konstantin Volgin, Gennadiy Topchan, Yuriy Bratanchuk, Svetlana Gismieva, Irina Knorring, Sergey Nikishen, Vladimir Kalish and others.

Since 1992 when Ideation International Inc. was established, this work continued in the United States. Numerous projects including the ones for Ford, General Motors, Johnson & Johnson, Amoco, Rockwell Automotive, Mercury Marine and others have been completed. We would like to acknowledge the contribution of our American colleagues: Dana Clarke and Mark Barkan.

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Appendix 2

Ideation Brainstorming

Ideation Brainstorming is a modification of traditional brainstorming based on utilization of TRIZSoft™ to support team facilitation process. It includes the following steps:

Preparation to team work session, including:

- Knowledge mapping the problem
- Automatic formulation of problem statements and selection the ones for the team work session
- Selection of Operators for team work session

Team work session, including two stages:

- Idea generation stage
- Evaluation stage

Idea generation stage includes generating ideas for selected problem statements based on selected Operators. The following rules should apply:

- Everybody should be able to see the computer screen
- Facilitator is guiding team through problem statements and Operators
- Facilitator's assistant documents all suggestions, questions in the way visible to all team members
- Working on one problem statement should take in average from 5 to 15 min.
- Working with one Operators should take no more than 3-5 min.
- Work with a specific problem statement or Operators stops if no more new ideas are generated in 1-2 min.
- All critique is forbidden during this session

Evaluation stage follows the idea generation stage to provide preliminary evaluation of ideas, unveiling and document secondary problems. During this stage, the following rules should apply:

- Utilization of specific questions developed (embedded in the IWB software)
- Limit 5 to 10 min for the session
- Working with the next problem
- If an idea is very valuable, it is possible to move to solving secondary problem(s)

When teamwork session is finished, facilitator and his/her assistant organize the results of the session, build if necessary new knowledge maps and formulate secondary problems (if any). All suggestions and problems are presented to the next teamwork session.

Note.
Unlike the traditional brainstorming session when the fantasy of the team members is quickly exhausted and therefore the productive time is not more than 1-1.5 hour, Ideation

brainstorming may last for 3-5 hours with 10 min. break every hour. Ten – fifteen serious problems may be considered during this time.