ABSTRACT

HOW CAN TRIZ IMPROVE THE OUTCOME OF A VALUE ENGINEERING WORKSHOP

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As Design for Value Manager, I am responsible for facilitating Design for Assembly and Value Engineering workshops for Refrigeration and Cooking categories at Whirlpool Corporation. The Design for Value team is responsible for driving product cost leadership for Whirlpool by developing or redesigning products to deliver the best value for the customer.

I have fourteen years of global experience in the design and development of electromechanical products in the home appliance and automotive industries. I hold a bachelor's degree in Electronics Engineering from Shivaji University in Kolhapur, India and received Six Sigma Black Belt certification from Whirlpool through Six Sigma Associates, Inc. I am also an Associate Value Specialist (AVS) with SAVE International.
ABSTRACT

Value Engineering and TRIZ have been perceived as two powerful, independent tools to solve specific problems or issues. Traditionally the Value Engineering job plan is focused on delivering value five different ways: a) improving function while reducing cost, b) reducing cost while maintaining function, c) improving function while maintaining cost, d) improving function while increasing cost by a proportionally smaller amount, and e) reducing function while reducing cost by a proportionally greater amount.

TRIZ has always been understood to be an inventive problem solving tool for specific problems or issues. Teams are able to be more innovative with abstracted knowledge than with knowledge based upon your own limited experience. TRIZ utilizes basic concepts of ideality, resources, and inventive principles derived from millions of patents to resolve contradictions which might have required system comprises between useful results and harmful effects if TRIZ was not employed.

Each methodology has its own strengths and weaknesses. When employing Value Engineering, the creativity phase uses brainstorming as the primary method which generally yields a high quantity of ideas. One of the disadvantages of this methodology is that it may not come up with inventive solutions outside of the team’s specific area of expertise. However, when employing the TRIZ methodology with the same team, many different inventive principles are used to come up with out of box or innovative ideas which go beyond the team’s specific area of expertise. The FAST diagram principle employed during the VE function phase can be utilized as a starting point to generate a TRIZ functional model. However, the TRIZ function model also defines useful functions, harmful functions, and contradictions to improve the definition of the problem or scope of the project.

This paper will demonstrate how VE’s FAST diagram can be leveraged to build a TRIZ functional model in order to reduce cost and improve quality and thus give better value to our customers.

Introduction to TRIZ

In 1946, about the same time that Lawrence Miles was conceiving Value Analysis, Genrich Altshuller was developing TRIZ. TRIZ is the Russian acronym for the Theory of Inventive Problem Solving. At the time, Altshuller was a patent agent in the Soviet Navy and he saw a lot of patents, both foreign and domestic, come across his desk. He began to question whether invention was the result of creative genius alone or was there a structure or method by which inventions were made? Altshuller studied about 200,000 patents looking for structure in the inventions. Of the 200,000 patents he examined, he identified about 40,000 that embodied innovations. A further study of these 40,000 odd patents revealed 40 patterns of invention. These patterns are themes or abstractions that recur many times. Altshuller believed that these patterns could be the basis for an innovation algorithm.

In December 1948 Altshuller wrote a letter to Joseph Stalin addressed, “Personally to Comrade Stalin.” He told Stalin that there was chaos and ignorance in the USSR’s approach to innovation and that he had discovered a theory that could make the Soviet people the most innovative people in the world. Altshuller was, in fact, a patriot but his actions were treated as treason. Two years after he wrote to Stalin, he was arrested and sentenced to 25 years in prison. He was transferred to Siberia’s
Gulag where he worked as a logger and he also worked in the Varkuta coal mines. Throughout his incarceration, he continued to develop his TRIZ theories. A year and a half after Stalin’s death, amnesty was granted to many political prisoners and Altshuller was released. Over his lifetime, Altshuller developed a number of innovation algorithms including ARIZ-71, ARIZ-77 and ARIZ-85. Virtually all of this work went unnoticed in the West because of the cold war. With the advent of Perestroika and the fall of the Soviet Union, Altshuller’s work became recognized throughout the world. In 1992 the leading TRIZ scientists in the world relocated to the United States. Today TRIZ has experienced over 50 years of research and development and has been used to solve thousands of inventive problems in a wide variety of disciplines.

There are four fundamental concepts in TRIZ, which are essential to understanding and using TRIZ.

The first concept is “contradiction”. When Altshuller studied his initial group of patents, he was looking for inventive solutions to problems. Altshuller observed that most technical problems contain at least one contradiction. An engineering solution to any problem seeks to compromise or optimize by finding an acceptable balance of useful and harmful effects. An inventive solution, by contrast, resolves the contradiction. Due to the fact that inventive solutions resolve contradictions, they have a greater economic potential than engineering solutions and will often result in paradigm shifts in a product or industry. Not all contradictions can be resolved, however. In this case we have a paradox. Since resolution of contradictions is at the heart of the TRIZ approach to problem solving, it offers the best method for identifying inventive problem solutions.

The second concept in TRIZ is “ideality”. Research of the worldwide patent fund and other sources of inventive achievements have revealed the following general pattern; technological systems tend to evolve in the direction of increasing ideality. In other words, systems become smaller, less costly, more energy efficient, pollutes less, and so on. TRIZ defines ideality as the ratio of a system’s useful functions to its harmful functions. Functions are activities, actions, processes or operations related to your system. A system’s useful functions include the following three types:

1. Primary Useful Function – the purpose for which the system was designed
2. Secondary Functions – other useful outputs that the system provides in addition to the primary useful function
3. Auxiliary Functions – functions that support or contribute to the execution of the system’s primary useful function, such as corrective functions, control functions, housing functions, transport functions, etc.

A system’s harmful functions include all harmful factors associated with the system such as the cost to design it, the space it occupies, the noise it emits, the energy it consumes, the resources needed to maintain it, manufacturing costs and so on. The best solution to a problem is one that advances a system on its evolutionary path toward ideality. Therefore, ideality should always be kept in mind during problem solving process per Figure 1 below.
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The third concept in TRIZ is “resources”. Resources are properties or attributes that provide us with the ability to increase system ideality. There are six classifications of resources.

- Functional – the capability of a system or its surroundings to perform additional functions including super-effects.
- Fields – any kind of energy, action or force available in the system or its environment. This includes mechanical, thermal, electrical, chemical, magnetic or electromagnetic fields.
- Information – additional information about the system that can be obtained with the help of dissipation fields, matter or fields passing through the system.
- Substances – materials from which the system or its surroundings are composed.
- Space – free, unoccupied space existing in the system or its surroundings.
- Time – time intervals before the start, after the finish, and between cycles of a technological process, which are partially or completely unused.

The fourth concept is inventive principles. In Altshuller’s original work he identified 40,000 patents that embodied inventive solutions, solutions that resolved one or more technical contradictions. This heroic work was done in a time when computers and databases were a thing of the future. Altshuller looked at the resources employed to solve these inventive problems and examined the trends toward ideality. From this study he developed 40 inventive principles. The inventive principles are themes or abstractions found in inventions that are repeated over and over.

Altshuller determined that the inventive principles could be applied to solve a broad spectrum of inventive problems and he developed an innovation algorithm which is a step-by-step procedure to generate inventive problem solutions. Today, the TRIZ community has identified several hundred patterns of invention and many TRIZ consultants have developed software to implement new and advanced innovation algorithms.

**The Value Engineering Job Plan**

A Value Engineering provides a consistent systematic approach that is efficient and less susceptible to oversight than simple and traditional cost cutting measures. Work is organized from conception through implementation. Good value options are clearly identified with the preferred option to increase function while decreasing cost, however, reducing cost while holding function constant is often selected as a second option. One of the greatest strengths of Value Engineering is
FAST diagramming. FAST diagrams are an outstanding analytical technique, which can be used to analyze and manage the most complex processes as part of the function analysis phase in the Value Methology. Just to elaborate, the framework of that approach is termed the Value Engineering Job Plan. The generic Value Engineering Job plan has different phases including project selection and information gathering as part of the pre-workshop activities, information sharing, functional analysis, creativity (idea generation), evaluation and development as part of the actual hands-on workshop and implementation and follow-up as post workshop activities per Figure 2 below.

**Iterative Value Engineering Job Plan**

Why Use TRIZ as a Value Engineering Creativity Tool?

Some creativity tools used in Value Engineering include:

1) Brainstorming and Brainwriting

2) Nominal Group Technique

3) Gordon Technique

Today, however, the most commonly used creativity tool with the Value Engineering Methodology is brainstorming developed by Alex Osborn. However, a common drawback to brainstorming and other creativity tools, is that the idea quantity and quality depends on participant knowledge and their collective imagination based upon their limited experience, even though with excellent facilitating. Another major weakness of brainstorming is the...
value achieved from a project will depend directly on the degree of innovation embodied in the solution. Brainstorming techniques are limited by psychological inertia and the collective experience of the people in the brainstorming session. More participants will broaden the base but the group quickly becomes unmanageable as size increases. Another weakness is that many practitioners are drawn to simple cost reduction projects. In fact, the most common problem definition proposed by managers is, “Our costs are too high.” Some people accuse Value Engineers of sacrificing ‘function’ in favor of ‘cost reduction’. One attractive opportunity to improve the Value Engineering process is to strengthen the ‘identify alternatives’ step. Taking a Value Engineering approach to this problem tells us that in order to increase ‘value’, we must increase ‘function’ (strengthen the identify alternatives step) without adding any additional cost or at least, by assuring that customers are willing to pay the additional cost in order to obtain the improved dentify alternatives step per Figure 3 below.

**VALUE is Improved by:**

- **Improving** function while **reducing** cost,
- **Reducing** cost while **maintaining** function,
- **Improving** function while **maintaining** cost,
- **Improving** function while **increasing** cost by a proportionally **smaller** amount (will only work if customer will pay increase), or
- **Reducing** function while **reducing** cost by a proportionally **greater** amount

![Figure 3](image)

After reviewing these above issues with traditional creativity tools, a decision was made to utilize TRIZ as the creativity tool of choice for a Value Engineering Workshop held in November, 2010 with a cross-functional team of 14 people in Evansville, IN on a water delivery system which is part of the ice and water module set in a Refrigerator. This module set was not just looking for traditional cost saving ideas but quality improvement ideas as well. The workshop team was more interested in generating innovative ideas which would be able to deliver the best value to customer than just generating a large quantity of ideas.

The Value Engineering process began in the usual manner with a Pre-workshop meeting to define the module set, establish the measure(s) of success, gather the information
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needed for workshop and obtained management sponsorship and commitment. While conducting the workshop, the Value Engineering Job Plan was followed including information sharing and functional analysis where the FAST diagram was developed for the water delivery system per Figure 4 below.

After the FAST diagram is completed, the next step in the TRIZ process is to build a functional model using the major critical path in the FAST diagram. This model is built much like a Classical FAST diagram except that functions can be either useful or harmful, corresponding to the definition of ideality. The functional model deconstructs a problem by creating a functional diagram that relates the useful and harmful factors in the system. Unlike a FAST diagram, the modified functional model can include objects, system, actions, parameters and conditions as well as functions. As harmful functions are added to the model, they can include consequences of the functions in the ‘when’ direction per the TRIZ functional model in Figure 5 below. This functional model can also include costs, because costs are by definition, harmful functions. The functional model of the system including physical components of the system, harmful functions and cost elements can now be analyzed for opportunities. At this point there are three types of opportunities to consider:

1) we can improve a useful function

2) we can reduce a harmful function

3) we can resolve a contradiction (which is a function that can generate a harmful function or both a useful function and a harmful function) per the yellow boxes in Figure 5 below.
This analysis leads to opportunities both for product improvements and cost reductions by utilizing the TRIZ inventive principles. The goal of the TRIZ methodology is to generate ideas to improve the usefulness of functions and components in the functional model and at the same time, also investigate ideas to reduce or eliminate harmful functions thus resolving any contradictions in the system.

SUMMARY

The economic value of the project, of course, depends upon identifying an innovative, high value solution. Most brainstorming techniques used in Value Engineering are psychological in nature and plagued by psychological inertia which tends to limit the number and quality of ideas. TRIZ on the other hand, is a scientifically based problem solving methodology driven by an extensive knowledge base. TRIZ can generate a large set of potential solutions that are highly innovative. The combination of Value Engineering with TRIZ offers an opportunity to identify higher value solutions more quickly. To summarize in numbers, this TRIZ functional model approach referred to in this paper, generated 120 ideas where the group thought that 25-30% of the ideas would not have been generated if this TRIZ methodology had not been used. Out of 120 ideas, at least 22 were considered easy to implement and would provide quality improvements as well as deliver cost saving and added value to the customer. Nine business cases were developed by the team requiring $500K in investment with an annual risk weighted estimated savings potential of $2.5M.