Applied Modified TRIZ for New Product Development Project

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Abstract

TRIZ was developed in the former Soviet Union by G. Altshuller. TRIZ is a powerful and well used tool for generating new ideas for technical problem solving in new product development (NPD) project. This study attempts to extend and modify the TRIZ methodology to a broader application to resolve problems concerning the management issues of developing new products. The study is divided into three stages: 1. investigate and analyze the requirement of NPD; 2. use TRIZ tools to analyze and find NPD problem resolution; 3. build resolution action plan.

Keywords: New product development, TRIZ
1. Introduction

While facing intensive global competition, rapid technological change, and the shifting patterns of world markets, a firm is expected to maintain a competitive advantage. Thus, shortening the duration of new product development is a necessity (Song & Montoya-Weiss, 1998; Twigg, 1998). Many businesses employ techniques such as quality function deployment (QFD), concurrent engineering (CE), design for manufacturing (DFM), design for assembly (DFA), and modular design to improve NPD process (Schroeder, 2000; Stevenson, 2010).

Besides, developing systematic thinking process to analyze and solve the problem of NPD is another important issue for improving and accelerating the NPD process. There are several different ways to solve problems generally exist (Higgins 1996; Sheridan 1997; Applegate & Zawacki 1997): experience, consultant recommendations and expert suggestions, and computer assistance (expert system and simulation system). In the past research, many systematic approaches have been proposed such as: the Deming cycle (plan, do, check, and act PDCA), the seven management and planning tools (the affinity diagram, the interrelationship digraph, the tree diagram, the matrix diagram, matrix data analysis, the process decision program chart, and the arrow diagram), thinking process (TP) of theory of constraints (TOC), and system thinking of the fifth discipline to analyze and solve NPD problem (Yang 2002).

In this study, we attempt to extend and modify the TRIZ methodology to a broader application in a non-technological area. The purpose of this study is to propose ways of managing new product development. TRIZ provides people with a dialectic way of thinking, which guides us to understand the problem as a system, to get an image of the ideal solution first and to promote the performance of products by solving contradictions. The core of TRIZ consists of the 40 ‘inventive principles’ and the ‘contradiction matrix’ between 39‘engineering parameters’. In addition, a ‘prediction’ tool is available which helps designers to improve a performance or a function of a product by presenting some trends of system evolution. Furthermore, another tool is the ‘effects’ database which provides users with technical solutions for a given functionality. Utilizing these sub-tools, TRIZ supports designers with finding ways of solving problems in designing a product in general, not only in technologies.
2. New Product Development

New products fail for a variety of reason. Such as poor market research, product defects, poor timing of introduction, ineffective marketing campaigns, higher than expected costs, supply problems, and competition.

2.1 The process of NPD

The new product development process can be defined as a disciplined and definite set of tasks and steps that describe the normal means by which a company repetitively converts embryonic ideas into saleable products or services. Slack et al. (2010) proposed a five design stages from concept to specification. First, comes the concept generation stage that develops the overall concept for the product or service. The concepts are then screened to try to ensure that, in broad terms, they will be a sensible addition to its product/service portfolio and meet the concept as defined. The agreed concept has then to be turned into a preliminary design that then goes through a stage of evaluation and improvement to see if the concept can be served better, more cheaply or more easily. An agreed design may then be subjected to prototyping and final design. Owens & Cooper (2001) used five stages to describe the NPD process for tangible goods: 1. preliminary assessment, 2. business case preparation, 3. development, 4. testing and validation, 5. full production/market launch. Tsai et al. (2008) proposed a five stages new service development process: 1. discover new service, 2. define new service, 3. design new service, 4. delivery new service, 5. debug new service.

2.2 The tools of NPD

There are a number of tools and techniques to undertake new product development efforts effectively.

1. Quality Function deployment (QFD)

Quality Function deployment (QFD) has been recognized as an effective method for integrated product and process development. QFD is a structured approach for integrating the voice of the customer into the product design/development process. The purpose of QFD is to ensure that customer requirements are factored into every aspect of product development from planning to the production floor. QFD uses a series of matrices, called the House of Quality, to deploy customer input throughout the design, manufacturing, and delivery of the product. The premise is that
cooperation and communication among marketing, manufacturing, engineering, and R&D lead to greater new product success.

2. Concurrent engineering (CE)

Concurrent engineering means bringing design and manufacturing engineering people together early in the design phase to simultaneously develop the product and the processes for creating the product. This concept has been enlarged to include manufacturing personnel (e.g., materials specialists) and marketing and purchasing personnel in loosely integrated, cross-functional team. The purpose is to achieve product designs that reflect customer wants as well as manufacturing capabilities.

3. Collaborate product design (CPD)

CPD is the extension of CE, highlighting the importance for all personnel related to the process of product development to participate in R&D and discussion, including the designer, manufacturer, supplier, and salespeople. The R&D team may discuss all sorts of issues concerning design charts and documents via the Internet. If any revision is needed, both parties can conduct it immediately. Meanwhile, the team may also share files and save design resources by means of the collaborative design tool supplied by information technology companies so that information of product design may be spread rapidly, easily, and correctly (Chen et al., 2008; Kamrani & Abouel Nasr, 2008).

4. Taguchi methods

The basis of Taguchi method is that the product or service should still perform in extreme conditions. The Taguchi procedure is a statistical procedure for carrying out relatively few experiments while still being able to determine the best combination of design factors. Product and service designers therefore need to brainstorm to try to identify all the possible situations that might arise and check that the product or service is capable of dealing with those that are deemed to be necessary and cost-effective.
3. The Modified TRIZ

3.1 TRIZ

TRIZ (the Russian acronym for the ‘theory of inventive problem solving’) was developed in the former Soviet Union by G. Altshuller. TRIZ is a powerful tool for generating new ideas in a problem-solving process, which is integrated with knowledge and experiences of the world’s finest inventive minds. For a given problem, the way of TRIZ is always to identify and formulate a generic problem, then to use an appropriate tool to determine the generic solutions, and finally to interpret these generic solutions to choose a specific solution. TRIZ theory, based on technical system evolution, is comprised of various types of methods, calculations in aspects of solving technical problems, innovative exploration, as the problem comprehensive solving system. The basic constituents of TRIZ are the contradictions, 40 inventive principles, the matrix, and the laws of evolution, the substance-field analysis modeling, ideal final result, substance field resources, scientific effects and ARIZ (the Russian acronym for the ‘algorithm of inventive problem solving’). TRIZ is a scientific principle for solving problem and technical innovations but recent studies have shown that TRIZ principles are also applicable in product innovation, management (Mueller, 2005; Lau, 2004; Chang & Chen, 2004; Cong & Tong, 2008; Yang & Chen, 2011).

3.2 Modified contradiction matrix

In this study we collection the related literature of new product development performance to find out the performance indicators and divided into two aspects of the technology and management. By producing the expert questionnaire collect the executives, engaged in industry and education researchers of the proposed indicators applicability, and to determine the adoption of indicators.

1. Parameter

This study selected the top five important NPD indicates of technology and management dimensions from the expert questionnaire, and described as follows.

(1). Technology dimension.

- defective rate: shows how many errors in production occur on average.
• process ability: The process of manufacturing the product, including the ability of people, materials, instruments and methods presented.

• % of projects launched on schedule: the ratio of project completed on time.

• skill level of R&D personal: the advantages and effectiveness of R & D personnel in the technical.

• % of projects commercially successful: the success rate of new product development from planning to manufacturing.

(2). Management dimension

• customer acceptance: the customer acceptance is to make sure you understand and accept all of the things that can occur during an internet marketing campaign.

• product quality: the level of quality compared with other types of products.

• return on inventory: a performance measure used to evaluate the efficiency of an investment or to compare the efficiency of a number of different investments.

• R&D costs: the costs that are incurred during the development and introduction of new products to the market, or during the improvement of existing products.

• new product sales profit ration: product sales profit ratio is the specified number of profit of = of rate product sales profit ratio that points to product sale and profit / product sale *100%

2. Contradiction matrix

A situation in problem solving where improving one parameter of a system causes deterioration of another parameter is called a contradiction. To ease the search for the most applicable principle, the Table 1 for contradiction matrix was developed. The Table 1 for contradiction is a matrix having these 10 parameters in two axes. You have to select parameters to improve on the vertical axis and the parameters that are deteriorated by the improvement on the horizontal axis. The intersections of the selected parameters contain reference to recommended principles.
Table 1: Contradiction matrix

<table>
<thead>
<tr>
<th>Deterioration</th>
<th>Improve</th>
<th>management</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>technology</td>
<td></td>
</tr>
<tr>
<td></td>
<td>defective rate</td>
<td>process ability</td>
</tr>
<tr>
<td>defective rate</td>
<td>1,6</td>
<td>1</td>
</tr>
<tr>
<td>process ability</td>
<td>10,3,1</td>
<td></td>
</tr>
<tr>
<td>% of projects launched on schedule</td>
<td>15,1, 10,5</td>
<td></td>
</tr>
<tr>
<td>skill level of R&amp;D personal</td>
<td>10,40</td>
<td>10,40, 4</td>
</tr>
<tr>
<td>% of projects commercially launched</td>
<td>1,10, 5</td>
<td>1, 10</td>
</tr>
<tr>
<td>customer acceptance</td>
<td>35,3</td>
<td>35</td>
</tr>
<tr>
<td>product quality</td>
<td>10,9,5, 1,10</td>
<td>3,35, 2</td>
</tr>
<tr>
<td>return on inventory</td>
<td>1,10</td>
<td>2,1</td>
</tr>
<tr>
<td>R&amp;D costs</td>
<td>10,5, 1</td>
<td>2,1</td>
</tr>
<tr>
<td>new product sales profit</td>
<td>23, 1,10</td>
<td>3,2</td>
</tr>
</tbody>
</table>

3. The principles

These are the 16 principles which can be able to meet this study to explore new product development management. I can use them via TRIZ contradiction analysis or standalone, as stimuli to prod your thinking forward.

Principle 1. Segmentation

- Five steps of Six Sigma improvement approach: Define, Measure, Analyze, Improve, and Control (DMAIC).
- Institute fast response team for handling urgent customer issue.
- Quality costs breakdown.
- Work breakdown structure (PERT/Gantt) for projects.
- Failure mode and effect analysis (FMEA)
- Fault tree analysis (FTA)
- Statistical Process Control (SPC)
- Design of experiment (DOE).
- Process for Lean Six Sigma.
- Cause and effects diagram
- Use Critical Chain Project Management (CCPM)
- Advanced Product Quality Planning (APQP).
- Design for Six Sigma
- Mass customerization: each customer is a market.

Principle 2. Taking out
- Lean manufacturing – elimination of non-value added activities.
- Removal of defective parts at screening inspection.
- Develop customized approach to customer satisfaction in order to differentiate the organization from competitor.
- Utilize cluster analysis: distill qualitative customer feedback into quantitative data.
- Technology transfer.
- Material Requirement Planning
- Enterprise Resource Planning
- Product data management.

Principle 3. Local quality
- Classification of product characteristics and defects.
- Use Pareto diagram for customer feedback analysis.
- Identify non-random patterns with trend analysis of customer satisfaction
survey.

- Strength, Weakness, Opportunity and Threat (SWOT) analysis.
- Weight importance of customer needs in Quality Functional Deployment (QFD).
- Selecting market segments on which organization will focus.
- Pareto principle (the 80/20 principle)

Principle 5. Merging

- Combine product quality with service quality to enhance customer satisfaction.
- Concurrent engineering (CE).

Principle 6. Universality

- Product, process and material specifications.
- Specifications for functional, mechanical and environmental reliability testing.
- Work instructions and workmanship standards.

Principle 9. Preliminary anti-action

- Mistake-proofing (Poka-Yoke) – design for foreseeable unintended to avoid undesirable situations.
- Prototype and pre-launch stages of Advanced Product Quality Planning (APQP) process.
- Key process employee certification.
- Quality system audit.

Principle 10. Preliminary action

- Concurrent engineering (CE).
- Training and qualification.
- Preliminary market research, before the product is designed.
- Project PERT/Gantt chart.
- Process flow chart.
- Just-In-Time (JIT) delivery concept

Principle 11. Beforehand cushioning
- On job training.
- Orientation program.

Principle 15. Dynamics
- Adjust calibration schedule on the basis of result.
- Optimum quality cost model.
- Continuous ranking change of jobs to be completed.
- Control chart, run chart and trend chart for displaying dynamic picture of process behavior.

Principle 16. Partial or excessive actions
- Acceptable quality level (AQL) – percent of defectives that is considered satisfactory as a process average.

Principle 18. Mechanical vibration
- Quality control circle.
- Frequently communicate in multiple modes.
- Co-design.

Principle 19. Periodic action
- Institute monthly and weekly customer communication in addition to annual survey.

Principle 23. Feedback
- Product returns and field failures analysis system.
Failure analysis – FMEA, FMECA, FTA.

Statistical process control (SPC).

Quality information system.

Principle 28. Mechanics substitution

- E-business.
- E-Commerce Solution Provider.

Principle 35. Parameter changes

- R&D team structure change.

Principle 40. Composite structures

- Do training with a combination of lecture, simulations, on-line learning, video, etc.
- Multi-disciplinary cross-functional team.

3.3 Case Study

Problem solving with TRIZ and its tools will now be demonstrated with an example. In today's conditions are becoming increasingly stringent quality control conditions, the product's requirements of domestic and foreign manufacturers are almost zero defects. Customers not be absorbed in product quality, but in the manufacturer's process stability, vendor's process capability, literacy of personnel, plant management. Manufacturers increase the stability of the process capability, in order to meet the needs of customer companies, or really find out the process to achieve process capability and reduce the need for the product defect rate.

Step 1: Establish Contradiction and select principles

To reduce product defect rate that can change the appearance, materials of the product, or manufacturing methods. This act caused by the stability of the process capability to drop, and resulted in conflicts. According to table 1 shows the variables - product defect rate that you want to improve and the variable- process capability want to avoid deterioration. Using contradiction matrix finds out the conflicting property grid.
The principles from Contradiction Matrix are:

1. Segmentation

3. Local quality

10. Preliminary action

Step 2: Apply principles to develop the solution

After brainstorming different principles, the following principles have driven the solution:

Principle: Segmentation

Statistical Process Control (SPC) is a problem solving program containing a group of techniques to determine whether a process is in statistical control. These techniques include control charts, histogram distribution, Pareto analysis and correlation methods. The most commonly used SPC tools are control charts. These control charts include X-bar and Range charts, and X-chart and Moving Range charts.

SPC refers to the application of statistical analysis techniques for real-time monitoring of the production process, the scientific distinction between random fluctuations and abnormal fluctuations of the product quality in the production process. That help manager solve the problems of instability of the process capability and reduce the defect rate.
4. Conclusion

In many industries, new product development is considered to be vital for a company’s long-term survival. At the same time, new product development is a risk and complex process. The main method of new product development that has been used by organizations for many years is team creation. At present, new product development teams are lack of effective ways to support creation. In this study, The TRIZ theory can allow the manager to quickly and accurately find the solution to a problem and the introduction of the theory into the new product development based on the TRIZ can realize conventionalization of the solution of the problem, and enable rules to be followed.
Reference


