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Using the design for Six Sigma approach with TRIZ for new product development

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ABSTRACT

Design for Six Sigma (DFSS) is a proactive process that entails incorporating the voices of customers into the design of products and processes. DFSS is used to establish a quality design by implementing preventive thinking and tools in the product development process. Recently, an innovative theory of inventive problem-solving (TRIZ) approach has been successfully incorporated into product development processes. In this paper, we present a case study conducted based on the DFSS with TRIZ method for developing a new product called very-high-bit-rate digital subscriber line 2 comprising multiple-dwelling units. The results indicate that the DFSS with TRIZ method can be effectively applied in new product development. The profit of this 4-year study is projected at US$6,555,262. Seven patents are invented during this product development.

1. Introduction

Over the past three decades, numerous companies have embraced Six Sigma projects for improving their competitiveness. Six Sigma is a structured approach to problem solving that entails placing emphasis on improving or optimizing existing products or processes (Chowdhury, 2003; He & Goh, 2015; Montgomery & Woodall, 2008). New product development is essential to the growth of most organizations. During the past two decades, people working in product development have experienced major changes in the expectations of their design processes. Design for Six Sigma (DFSS) was implemented with the aim of creating new products or processes driven by the requirements of customers. DFSS is used to translate customer expectations into design requirements, select and implement the most effective design alternatives, and verify that new products meet the standards of the environment for which they are designed (De Feo & Bar-El, 2002; El-Sharkawy, Salahuddin, & Komarisky, 2014; Hasenkamp, 2010; Shahin, 2008). DFSS frameworks such as identify, define, develop, optimize, and verify (IDDOV); identify, develop, optimize, and verify (IDOV); and define, measure, analyze, design, and verify (DMADV) are widely used in numerous industries. Baril, Yacout, and Clement (2011) developed a methodology based on the DFSS for designing product.

The theory of inventive problem solving (TRIZ) is a tool used for revealing and solving creative problems in any field as well as developing creative thinking skills and personalities (Altshuller, 2000). TRIZ has been shown to be an effective problem-solving methodology since its development more than approximately 70 years ago. TRIZ enables people to adopt a dialectical thinking style, which guides them to understand problems as systems, to first obtain a concept of the ideal solution, and to promote the performance of products by solving contradictions. Previous studies have integrated TRIZ with problem-solving tools in the manufacturing industry (Domb & Dettmer, 1999; Sheu & Hou, 2013). During application, defining conflicts and developing innovative solutions based on those conflict is critical. The effectiveness of DFSS can be enhanced by incorporating structural tools such as axiomatic design and TRIZ into the design (Gao, Guo, Gao, & Yang, 2015; Li, Ming, He, Zheng, & Xu, 2015; Wang, 2015; Zhang, Yang, & Liu, 2014).

We present a case study to demonstrate how the DMADV framework with TRIZ is used to develop a new network device called very-high-bit-rate digital subscriber line 2 comprising multiple-dwelling units. The tools for DFSS are discussed in Section 2. Such tools can be used to enhance the productivity of DFSS projects with less effort. Section 3 describes a case study that involves combining DFSS with TRIZ to demonstrate the

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applicability of this combination. The final section presents the conclusions and directions for future research regarding DFSS.

2. Design for Six Sigma with TRIZ and case company

A clear, documented, and useful new product and process development framework is fundamental to a successful DFSS project. DFSS involves a systematic integration of tools, methods, processes, and team members throughout product and process design. DFSS comprises five phases: define, measure, analyze, design, and verify. In each of these phases, tools are used to ensure that the product and process design are conducted appropriately (Table 1).

In the analyze phase, TRIZ enables people to adopt a dialectical thinking style, which guides them to understand problems as systems, to first obtain a concept of the ideal solution, and to promote the performance of products by solving contradictions. Three basic tools are used in TRIZ: (1) 39 general engineering parameters are used to describe the technical conflicts and 40 invention principles are used to solve the conflicts or contradictions; (2) a knowledge database system comprising physical, chemical, and geometrical effects and rules is used for problem solving; and (3) the substance-field model is used for modeling technological problems and deriving answers (Yamashina, Ito, & Kawada, 2002). In this study, we develop a process flow based on TRIZ tools including Initial Ideal Result (IFR), Resources, Conflicts, Identify Function Modeling (IFM), and Pugh method for developing design concept selection in the analyze phase (see Fig 1). This TRIZ process has been successfully applied to other new products development in case company.

A digital subscriber line access multiplexer (DSLAM) is a network device, often located in telephone exchanges, that is used to connect multiple customer DSL interfaces to a high-speed digital communications channel by using multiplexing techniques. Asynchronous transfer mode (ATM) technology is used in traditional 20th century DSLAMs to connect them to upstream ATM routers and switches. These devices then extract the Internet protocol (IP) traffic and transmit it to an IP router in an IP network. By contrast, an IP-DSLAM extracts the IP traffic in the DSLAM itself and passes it to an IP router. The advantages of an IP-DSLAM over a traditional ATM-DSLAM are that the merged equipment is less expensive to create and operate and can offer a richer set of features.

The case company, called Company A, is located in Taiwan; it was established in 1989. Company A specializes in manufacturing and developing state-of-the-art electronic and network communications products and tools. Company A had a success in original equipment manufacturing (OEM) and original design manufacturing (ODM) for ATM-DSLAM devices. Recently, IP-DSLAM became the mainstream product in the market. The top three suppliers of IP-DSLAM devices in the global market are Huawei, Alcatel, and UTStarcom. Company A decided to enter the IP-DSLAM market. In the past five years, the case company initiated 38 projects for developing IP-DSLAM devices. However, only five projects

Table 1
DMADV approach for product development.

Phase	Tools	Activities
Define	Project charter	1. Team
	Market research, voices of customers, Kano analysis, etc.	2. Customer requirements
	Breakeven analysis, internal rate of return, net present value, sensitivity analysis, etc.	3. Financial analysis
	Brainstorming the risks, Rating the risks, etc.	4. Risk analysis
Measure	Design for excellence, QFD, DFMEA, etc.	1. CTQs
		2. Design requirements for system and subsystems
Analyze	TRIZ, brainstorming, benchmarking, etc.	Concept design for product and process
Design	Taguchi method, robust design, design of experiment, tolerance analysis, simulation, etc.	Parts and processes scorecards
Verify	Accelerated life test, documentary, etc.	1. Reliability test
		2. Maintainability plan
		3. Error proofing by design
		4. Process quality control plan

Note: QFD = quality function deployment; CTQ = critical to quality; DFMEA = design for failure mode and effect analysis.

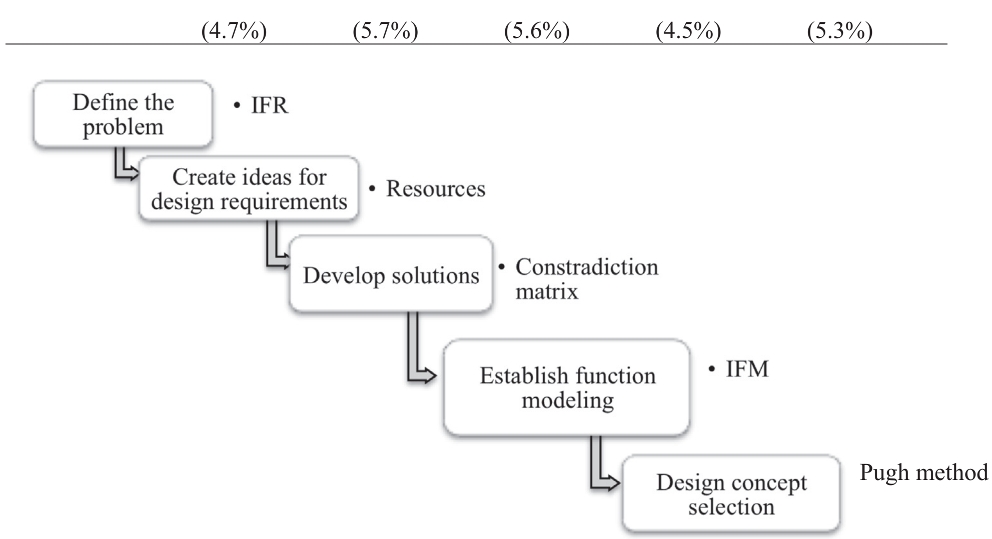

Fig. 1. TRIZ process in the analyze phase.