Project Management Incorporating Dynamic Simulation & TRIZ

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Abstract: This paper proposes a method for refining a requirements definition in project management that incorporates dynamic simulation. Many studies have been reported on requirements definitions in project management, but there are few studies that use dynamic simulation and examine the refining of a requirements definition. A requirements definition for a manufacturing project is expected to be refined if bottlenecks in the production process are recognized and if solutions to them are fed back into the definition. This paper proposes a method for refining a requirements definition for a manufacturing project with dynamic simulation (DELMIA), theory of inventive problem solving (TRIZ), theory of constraints (TOC), and design to customer needs (DTCN).

Key words: Requirement definition; Project management; Dynamic simulation; Design to customer needs; TRIZ

1 Introduction

An imprecise requirements definition is one cause of project failure. In order to lead a project to success, it is important to examine a method for developing a requirements definition that is based on close communications with customers. This requires identifying customer needs accurately, investigating the feasibility of accommodating those needs in a project, and refining a requirements definition. Many studies have been reported on a requirements definition in project management[1]-[3]. However, there are few studies on requirements definition management into which dynamic simulation (DELMIA)[4], theory of constraints (TOC)[5], theory of inventive problem solving (TIPS in English, TRIZ in Russian)[6], and design to customer needs (DTCN)[7] are incorporated and integrated on the basis of the socialization, externalization, combination, and internalization (SECI) process, which is a method of knowledge creation. A requirements definition for a manufacturing project is expected to be refined if bottlenecks in the production process are accurately predicted and if such predictions are fed back into the definition.

This paper examines a framework for managing a requirements definition with dynamic simulation and TRIZ.

2 Framework for Requirements Definition Management

In developing a requirements definition for a project, it is important to share value judgments involving the project with customers. This requires identifying customer needs and investigating the feasibility of accommodating them in the project. The author and collaborators have reported on a method for refining a requirements definition with DTCN [1]. However, the main focus of DTCN is on accurately identifying customer needs, and little consideration is given to the feasibility of accommodating them.

This paper attempts to refine a requirements definition by introducing dynamic simulation into DTCN and taking into account the feasibility of accommodating customer needs in a project.

Figure 1 shows a framework for requirements definition management incorporating dynamic simulation. The requirements definition management is based on the SECI process, which is a method of knowledge creation [5]. In the socialization phase, according to the definition of the SECI process, tacit knowledge is created through the five senses; in this paper, bottlenecks in a production process are foreseen through simulation analysis on manufacturing time and task processes with DELMIA. In the externalization phase, designs are created through conversations and thinking; in this paper, proposed customer requests are thoroughly examined with TRIZ. In the combination phase, new knowledge is created through combination of formal knowledge; in this paper, requirements clarified through TRIZ are combined based on the concepts of "cloud" and "branch" in TOC and are captured as knowledge to be used for eliminating the bottlenecks in the manufacturing process. Consequently, in the internalization phase, DTCN makes it possible to obtain knowledge on the requirements definition that accommodates customer needs. Also, by running the SECI process, one can expect to "spiral up" knowledge for designing a requirements definition. In addition, the requirements definition management model can be evaluated quantitatively with a maturity model.

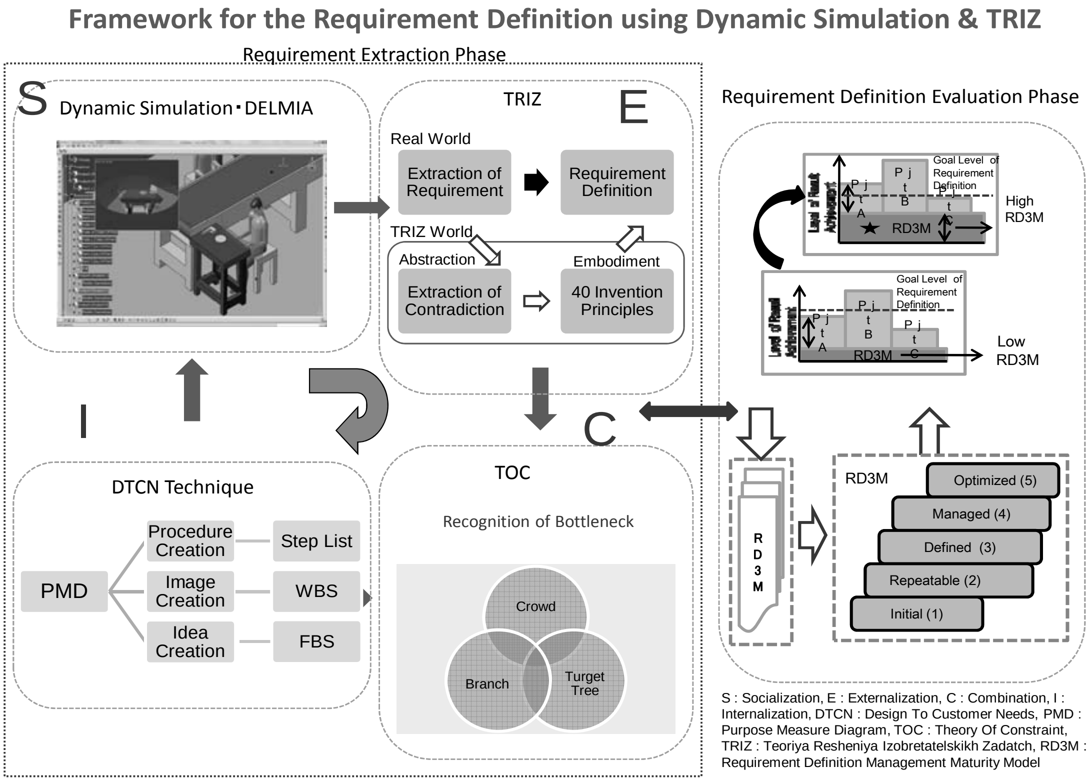


Figure 1　Framework For Requirements Definition Management Incorporating Dynamic Simulation

3 Process for Developing a Requirements Definition

3.1 Dynamic simulation

To ascertain the appropriateness of a production process, this paper uses simulation tools, DELMIA and QUEST [6]. The use of DELMIA makes it possible to discover process risks at an early stage, display performance relative to target values, plan a highly precise process by reusing an empirically proven process, and reduce the time for planning the process. With the use of QUEST it is possible to assess situations surrounding a manufacturing process, such as the level of worker fatigue, from an ergonomic perspective.

Figure 2 shows a production process for an automobile part, which is simulated with the use of DELMIA and QUEST. Using the dynamic simulation tools, one can understand the production process, compare it with an experience-based production plan, and evaluate the appropriateness of the process.

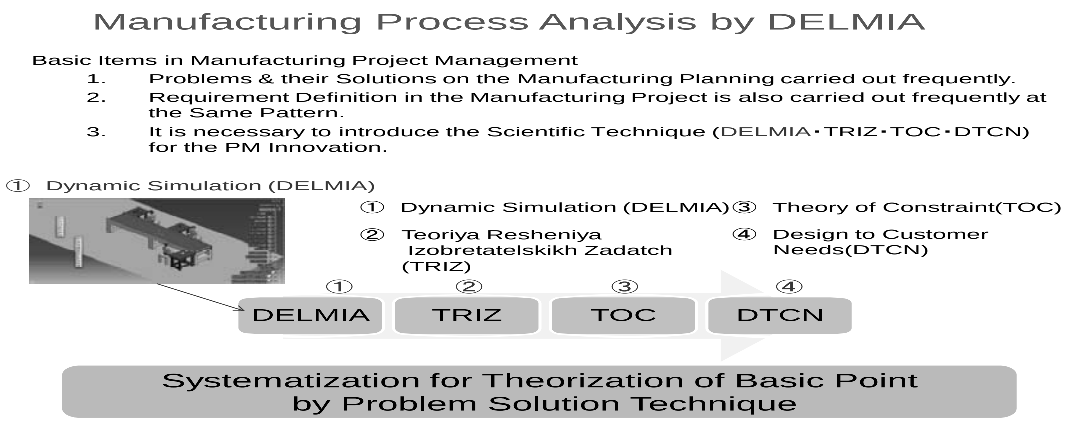


Figure 2　A Production Process for an Automobile Part which is Simulated with the Use of DELMIA

Because of mass production, production targets for automobile parts are set based on experience, and the problem has arisen that the feasibility of accommodating customer needs in a project is uncertain.

To dynamically simulate a manufacturing process, DELMIA and QUEST are used to simulate the number of operating days/hours, quantity produced, shifts, tact time, the number of direct workers, cycle time, the worker utilization rate, value produced, and the number of workstations. Simulation analyses on production plans are conducted, and the current production plan and the simulation results are compared. This reveals that initial plans lead to a significantly increased number of processes and greater costs, which makes it possible to calculate appropriate conditions for daily production operation that are consistent with production targets. Table 1 shows an example of the result of a simulation using DELMIA and QUEST for the production process.

Table 1 An Example of The Result of A Simulation

Purpose : Evaluation of Production Plan Based on Production Planning
using DELMIA & QUEST of Simulation Tool

Result : It is Difficult to Achieve the Production Plan.
It will be Greatly Increased the Operation Hours.

Number of Production/Day＝Number of Production/／Operation Day
Tact Time ＝Operation Hour/Day／Production Quantity

Items	Plan	シミュレーション			Unit
		Ver. 1	Ver. 2	Ver. 4	
Operation Day	20	20	20	20	Day/Month
Operation Hour	7.5	7.5	7.5	7.5	Hour
Shift	2	2	2	2	−
Number of Production	1250	1019	1000	1011	Piece/Day
Tact Time	43.20	53.00	54.00	53.40	sec
Number of Direct Operator	5	5	5	5	Person
Number of Indirect Operator					Person
Cycle Time	217	238	249	249	sec
Operation Ratio of Operator (Average)		89.5	95.5	95	%
Earned Value	83	68	67	67	Piece/Hour
Number of Operation Desk	10	10	10	10	

3.2 Inventive problem solving

Elimination of bottlenecks in a production process requires understanding the characteristics of the process, such as the costs and time required for production, and examining measures for improvement based on them. In this paper, after the simulation analysis with DELMIA and QUEST, factors in bottlenecks in a production process are analyzed by TRIZ [7]. Figure 3 illustrates a TRIZ-based factor analysis of production process bottlenecks. TRIZ is applicable to Levels 2 and 3 where complicated inconsistencies can be overcome and corrections can be made. In a manufacturing project, it is often the case that process bottlenecks are found on the basis of experience, that ways to reduce or eliminate the bottlenecks are examined, and that measures are implemented in the actual manufacturing process (Figure 4, top). In contrast, in TRIZ, production-related inconsistencies are identified after manufacturing process bottlenecks are found. Focus is then shifted from reality to the world of TRIZ, where 40 invention principles are converted to keywords for refining a requirements definition, and factors in the bottlenecks are analyzed. The bottom table in Figure 4 shows some examples of the keywords for analyzing factors of bottlenecks, which are converted from the 40 invention principles.

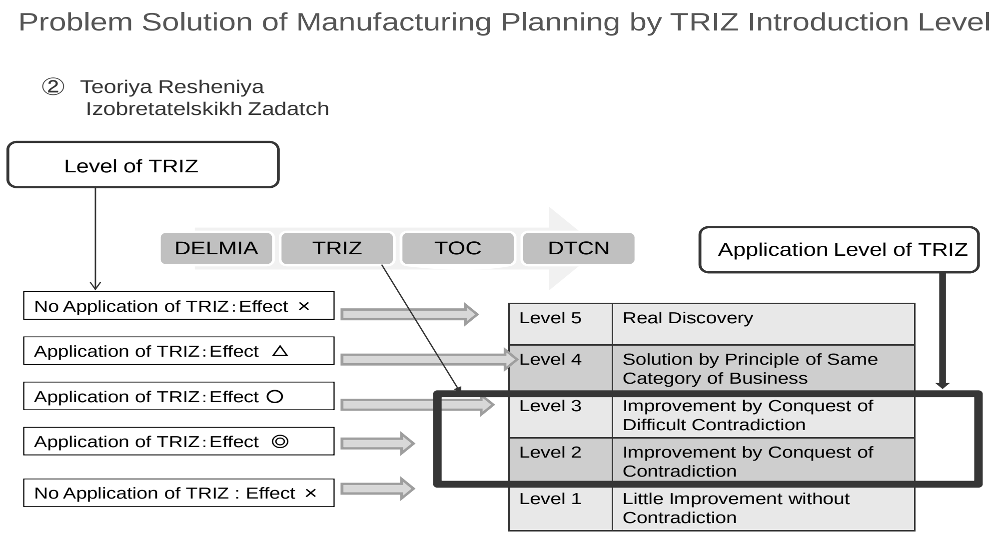
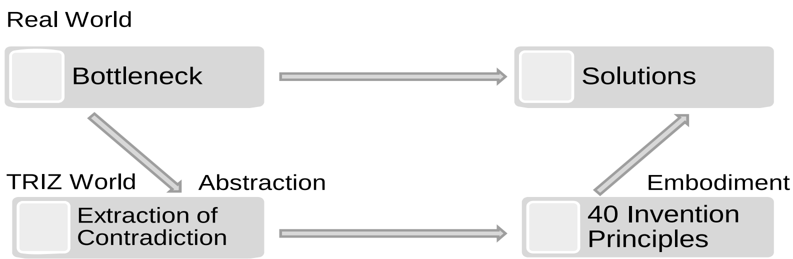


Figure 3　A TRIZ-based Factor Analysis of Production Process Bottlenecks

3.3 Theory of constraints and a method for designing a mechanism to accommodate customer Needs

To examine the appropriateness of a manufacturing process, it is important to clarify necessary conditions for achieving manufacturing objectives, using TOC[8]. The use of TOC makes it possible to understand core problems in a manufacturing process, foresee remedies and post-remedy conditions, and see obstacles clearly. Also, using the concept of "cloud" in TOC, one can not only clarify goals in common between customers and the project team and whether such goals should be fulfilled, but also shift emphasis away from a problem in the form of customers versus a project team to a problem for both customers and a project. Furthermore, using the concept of "branch" in TOC, one can analyze causal relations among phenomena with if-then logical statements. It then becomes possible to understand why actions of both customers and a project must be changed and to implement necessary measures responsibly. In addition, this paper uses the work breakdown structure phasing theme technique in DTCN and proposes a method for developing a requirements definition that satisfies both customer needs and feasibility conditions for accommodating them (Figure 5).



Example of Transformation from Invention Principles to Solution of Bottleneck

Division	Classification of Customer Needs	Combination	Combination of Customer Needs	Reaction	Recognition of Actual Problem
Separation	Move to Other	Generality	Concurrent Operation	Operation	Prediction the Difficulty
Limited Part Feature	Change Each Other of One Point	Nesting	WBS & Work Package	Protection	Backup of the Important Information
Asymmetry	Not Adjust of Unnecessary Points	Balance	Take the Balance for the Customer Needs	Equal Potential	Loosen for Customer Needs

Figure 4　Problems Solution by TRIZ

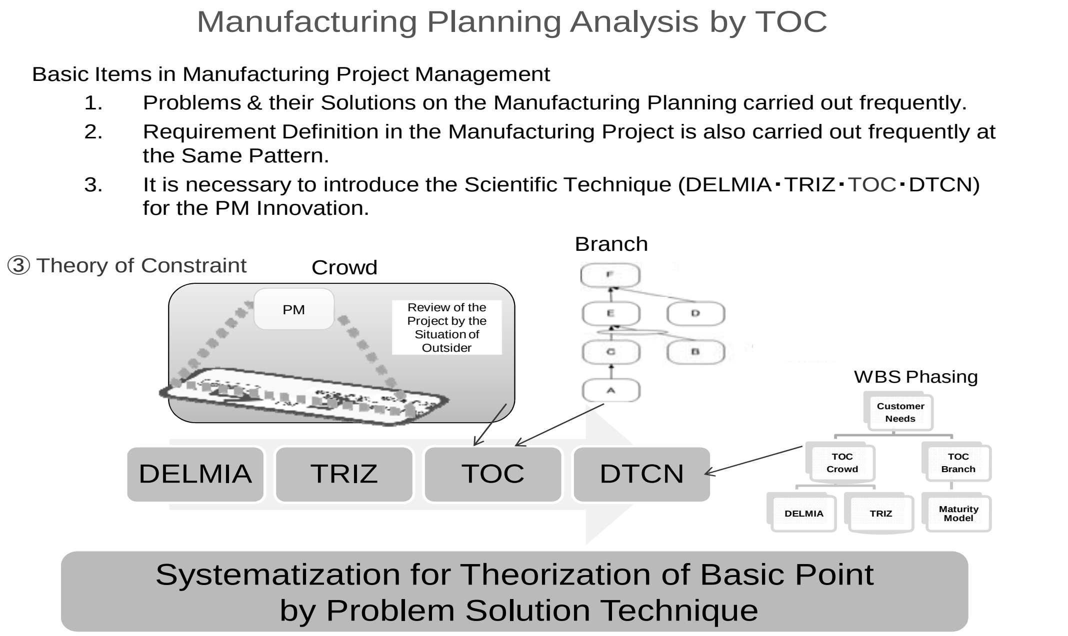


Figure 5 Problems Solution by TOC & DTCN Technique

3.4 Examination of requirements definition management

This paper proposes a method to find and eliminate bottlenecks in a manufacturing project, using dynamic simulation, TRIZ, and TOC. The application of the aforementioned analytical results to DTCN makes it possible to develop a requirements definition for a manufacturing project that can fulfill customer needs and achieve the accommodation of them in the project. Figure 6 shows the result of examining requirements definition management for an automobile part manufacturing project. Through the use of TRIZ, TOC, and DTCN, it is possible to understand the difference between the manufacturing process built on experiences and the result of DELMIA simulation.

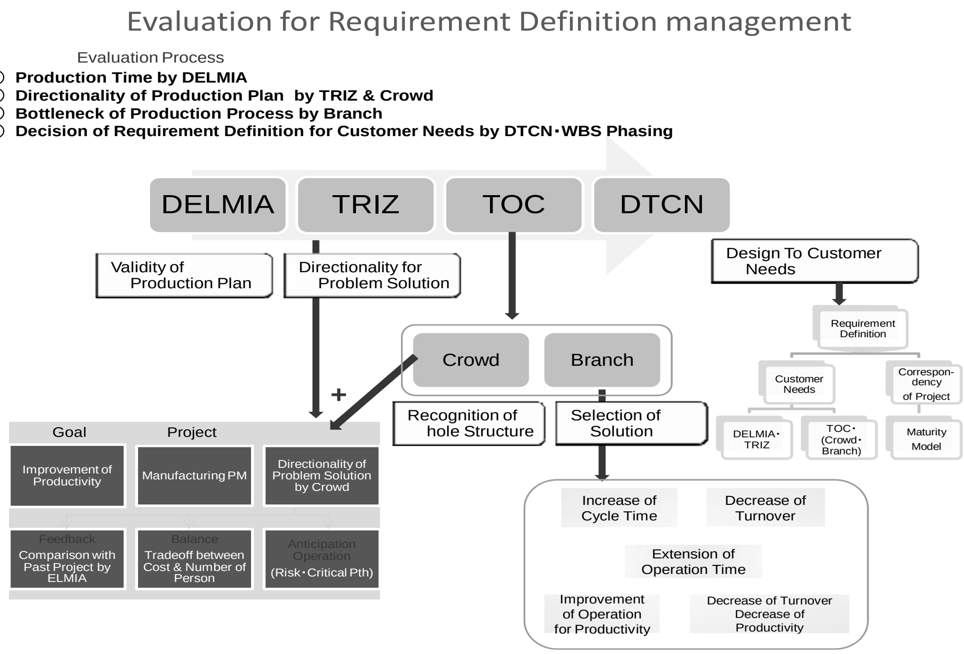


Figure 6 Verification for Requirements Definition Management

This paper proposes a requirements definition management maturity model (RD3M) to evaluate requirements definition management. The levels and the management process in the RD3M are shown in Figure 7. In a project, a requirements definition has traditionally been refined through increased and improved communications with customers, but the definition has not been thoroughly evaluated with a maturity model. Requirements definition management has been nothing more than written or repeated processes. However, this paper finds that the proposed method makes a managed process feasible and increases the maturity of requirements definition management from Level 1 to Level 3.

4 Conclusions

Examining project management based on dynamic simulation, this paper

(1) proposes a requirements definition management model incorporating DELMIA, TOC, TRIZ, and DTCN;

(2) finds production conditions in which customer needs and feasibility conditions for accommodating them in a project are both considered, as a result of investigating the effectiveness of a requirements definition management model with dynamic simulation in the context of a mass-production project for an automobile part; and

(3) reveals that the maturity of requirements definition management can be increased, as a result of proposing a RD3M to assess requirements definition management and examining it in the context of a project for manufacturing an automobile part.

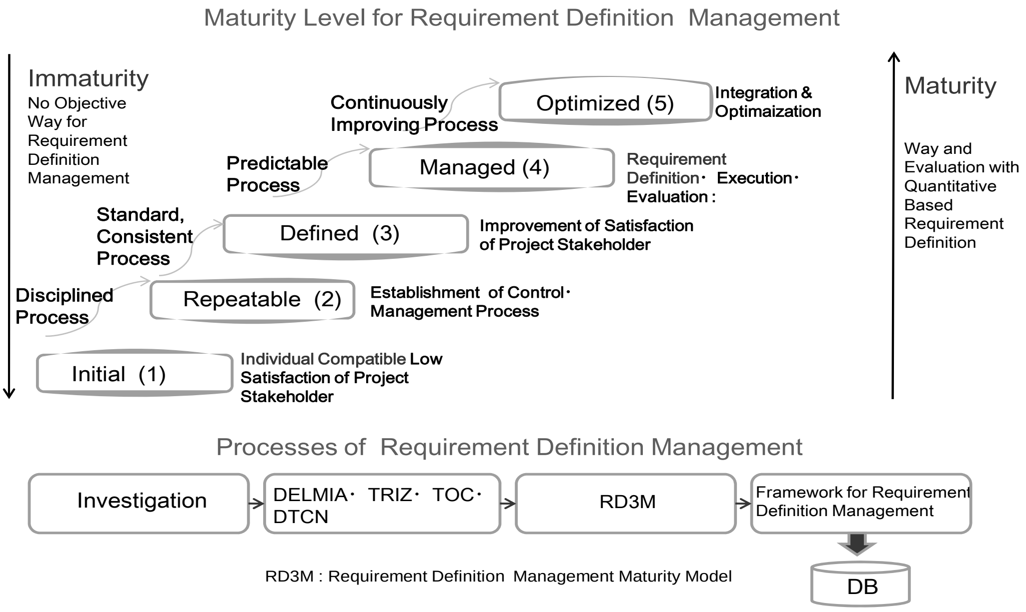


Figure 7　Requirement Definition Management Maturity Model

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