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HOW SK HYNIX APPLIES TRIZ TO INDUSTRY FIELD PROBLEMS

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Abstract: *Numerous companies in Korea are developing and introducing various processes and tools to solve the problems they face at the industrial field. Although these are useful in some aspects, the standardized problem-solving process cannot be flexibly adopted to deal with various problem situations in the field, which makes it not applicable to help solve the actual problem, and are used more as a reflection in the report preparation after the problem is solved.*
In the industrial field, it is necessary to present a flexible guidance that can be used immediately for prompt and accurate problem solving, and companies are trying to solve it by introducing various problem-solving processes. However, the industrial field needs an effective process that can be actually applied and used rather than the various processes introduced each time.
This paper introduces SK Hynix's 'S-Cube' Problem-Solving Process, which has proven to be flexible and has a rapid problem-solving effect in various problem situations in the industrial field. The 'S-Cube' Problem-Solving Process is an effective methodology that can utilize TRIZ in the industrial field, which provides a guide to quickly and easily analyze the cause of a problem, and makes it easy to find contradictions in a general approach without using complex terminology.
Key words: *QC Story, TRIZ, Flexible Field Problem Solving, S-cube, General action.*

1. INTRODUCTION

1.1 The Necessity of Problem-Solving Process to Solve Field Problems

The problem-solving processes used in industrial fields in Korea include QC Story, Six Sigma, and TRIZ. In particular, a process called 'QC Story' is used mainly to perform the problem in stages and because 'QC Story' is developed as a tool for explaining or presenting the plot after performing problem solving, it is different from the actual problem-solving process.

In the process of problem solving in the field, appropriate processes should be applied according to the situation of the problem. However, in practice, there are many cases in which an improvement is made in an arbitrary way, not through an appropriate process, and then the improved results are presented in reverse to the appropriate process. In other words, the problem-solving process is often used as a final report or thesis presentation in accordance with the improved results by other processes rather than being properly used to solve the actual problem.

The process of problem solving in the era of the 4th Industrial Revolution must be elaborate, accurate and prompt. There are always problems to be solved in the field, and in order to solve problems quickly and accurately, the existing problem-solving process is often difficult to apply. Therefore, the problem-solving process applied in industrial fields where timeliness is important should be simple and flexible.

1.2 Problems of the Field Problem-Solving Process

Many of Korea's prominent quality-related scholars believe it is unreasonable to apply the problem-solving process used for reports or presentations to the production field that changes every seconds. In addition, they believe that it is a realistic contradiction to quickly solve problems in accordance with a complex and formalized problem-solving process for industries with various characteristics.

Changnam Kim (Kim, 2012) argued that because QC Story is executed in 10 standardized steps from topic selection to reflection and future planning, there are difficulties in activities. In addition, he argued that 6 Sigma requires long-term education and training to acquire statistical problem-solving skills and the steps and analysis procedures of the problem-solving process are complicated for the field members to solve, which makes this process to cause the forcible use of unnecessary statistical techniques.

Kangin Lee (Lee, 2011) pointed out that QC Story, which is applied to the problem-solving process in the field division groups, is doing formal activities that do not fit the characteristics of various companies. He argued that this problem is the cause of a vicious circle of side effects that artificially compose the presentation manuscript.

Sangbok Lee (Lee, 2014) stated that the activities of the problem-solving process used in activities of Korea's division groups were naturally extinguished or could not lead the members to participate in voluntary improvement activities.

Dongseok Oh (Oh, 2020) and the SK Hynix National Quality Master's Council analyzed the problems in the use of QC Story, which are mainly used internally by the company. As a result, it was confirmed that there were six problems unsuitable for QC Story to be applied in the field. It was also confirmed that these problems directly led to field members avoiding the use of problem-solving process. The following is a summary of the six problems.

① Most of the projects in the field do not require a 10 step process.
② Solving problems at the manufacturing field is mostly an improvement-oriented activity that solves irrationalities.
③ Engineers carry out multiple tasks with one person working on duplicate tasks.
④ Most of the activity topics are selected or given to achieve KPI (Key Performance Indicator).
⑤ It is practically difficult to promote more than two projects per year, unless duplicate tasks are performed due to the schedule of ordering and manufacturing improved parts.
⑥ For quick task promotion, QC Story's steps are mostly executed in duplicate.

1.3 Problems in the Field Application of Statistical Problem-Solving

A number of companies in Korea have introduced Six Sigma as a methodology to accurately judge and solve field problems. Six Sigma's field problem-solving approach was based on statistical techniques and tools to assist in quantitative decision making. As a result, late-competitive companies that benchmarked companies that succeeded in Six Sigma aggressively adopted the Six Sigma methodology, but few companies have successfully settled it in the field. The main reason is that in order to obtain meaningful statistical results, it is necessary to perform numerous experiments with probability, and it is difficult to actively cope with many experiments in the field situation where production is the top priority. Eventually, field employees avoided difficult statistical techniques, and it was difficult to use them in the actual field even though they were difficult to learn. This resulted in the problem of it being only utilized by engineers in departments requiring statsticial experiments and rarely in front-line field.

1.4 Problems with the Introduction of Creative Problem-Solving (TRIZ) and Field Application

Many large corporations in Korea have introduced TRIZ, a creative approach to the problem in the sense of 'solve a problem with a creative idea', which is mainly used in development departments and research institutes.

As a creative problem-solving methodology, TRIZ is very useful, but in reality, it is difficult to understand properly compared to other methodologies. In order to acquire TRIZ to the extent that it can be used in the field, it requires a long training time and high cost, so it is mainly introduced and utilized by large companies.

TRIZ is considered to be a very suitable methodology for small and medium-sized enterprises, but it is difficult for small and medium-sized enterprises to have training opportunities.

Even for large companies that adopt and use TRIZ, for most engineers unfamiliar with creative thinking, TRIZ left a negative image such as 'TRIZ is a pun like logic that reverses problem-solving cases in reverse order', 'Difficult to utilize TRIZ', and 'TRIZ does not help in real problem solving'. In addition, applying TRIZ to the field with a completely different approach from the past problem-solving process has experienced considerable difficulties and threfore, it is no longer being expanded and only some innovative companies are utilizing it.

2. INTRODUCTION OF S-CUBE PROCESS

2.1 SK Hynix’s Unique S-Cube Problem-Solving Process

It is well known to Korean quality experts that the existing formal problem-solving processes, such as QC Story and Six Sigma are difficult to apply to various industrial fields. As mentioned in the previous papers and reports, many quality experts insisted that the company should apply their own problem-solving process, and some experts suggested their own problem-solving process. Based on this theoretical background, Dongseok Oh (Oh, 2020) and the SK Hynix National Quality Master Council developed a new problem-solving process suitable for SK Hynix's field improvement activities, taking into account the characteristics of the rapidly changing semiconductor industry in the era of the 4th Industrial Revolution.

This paper suggests two methods for successful field problem solving.

The first is the application of SK Hynix's unique 'S-Cube' Problem-Solving Process. There is the first problem that has never existed in the field. However, there are more problems that cannot be solved even if the problem situation is already known. Also, there are many problems with solutions that cannot be implemented due to issues with cost. SK Hynix's own process is suggested for a rapid problem-solving process that takes a different approach by securing flexibility in various problem situations.

S-Cube stands for Simple, Speed, Select, Special, Standard, and Synergy. In other words, the S-Cube Problem-Solving Process is simple (Simple), speedy (Speed), special process (Special) of SK Hynix that secures the flexibility of process selection (Select), and is a standard process (Standard) for field problem solving that can create total synergy (Synergy) that encompasses manufacturing, equipment, and processes.

The second method is to induce the contradiction to be easily revealed by providing a guide for quick and easy analysis of the core cause and expressing it in a general approach when presenting countermeasures against the final cause. This method provides help to easily find contradictory situations in a variety of small problems.

This paper proposes a specific and effective method to induce various approaches to TRIZ when solving problems in the field with the above two methods.

In developing this problem-solving process, the following three prerequisites were established to solve problems identified in the field and to respond to the problems in the field on a case-by-case basis.

① It should b a simple problem-solving process.
② Standardity and flexibility must be secured at the same time for field problem solving.
③ The problem must be solved in a speedy process, which is SK Hynix’s specialized DNA.

The S-Cube Problem-Solving Process was developed to create the basis for the above prerequisites and a three-dimensional problem-solving process optimized for field application. The meaning of 'S' in S-Cube refers to the initials of six words that give meaning to the problem-solving process. Cube means a cube, S-Cube means a three-dimensional problem-solving process, and it also means that six 'S's are included on each side. The meaning of the six 'S' is as follows.

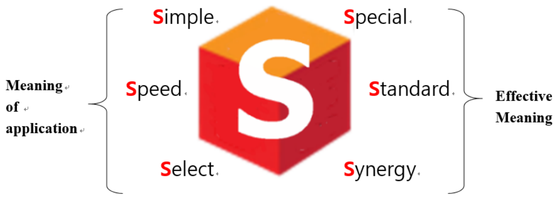

Fig. 1. S-Cube Process Symbol

Meaning of Application
- ① Simple: Simple Process
- ② Speed: Speedy Process
- ③ Select: Process with flexibility in process selection

Effective Meaning
- ④ Special: SK Hynix's unique and special process
- ⑤ Standard: Standard process of field problem solving
- ⑥ Synergy: Process that can create total synergy encompassing manufacturing, equipment, and processes

The S-Cube Process consists of a total of three stages of problem analysis-improvement-organization and the detailed process is shown in [Table 2-2]. In the problem analysis phase, the main focus was to identify unwanted phenomenon and to establish the root cause and solution, and the improvement was to focus on performing PDC (Plan-Do-Check) among PDCA (Plan-Do-Check-Action). Finally, the organization focused on conducting results analysis and standardization.

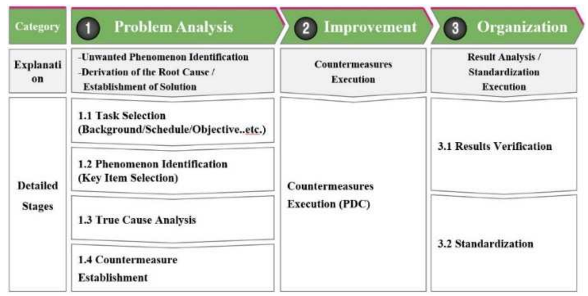

Fig. 2. S-Cube Process Detailed Process Map

2.2 Characteristics of S-Cube Problem-Solving Process

A. Selection stage by case according to the problem situation: Selective application is possible for selection of tasks, identification of phenomenon, establishment of true causes, establishment of measures, and standardization. There are newly arising problems, problems with known phenomenon but unknown cause, problems with which phenomenon and causes are known, but no countermeasures, and problems with countermeasure ideas, but difficult to apply in practice. In addition, there are cases where a task has already been selected by an organization, and in the case of standardization, it may not be selected if it is unnecessary by grasping whether a standard is necessary or not.

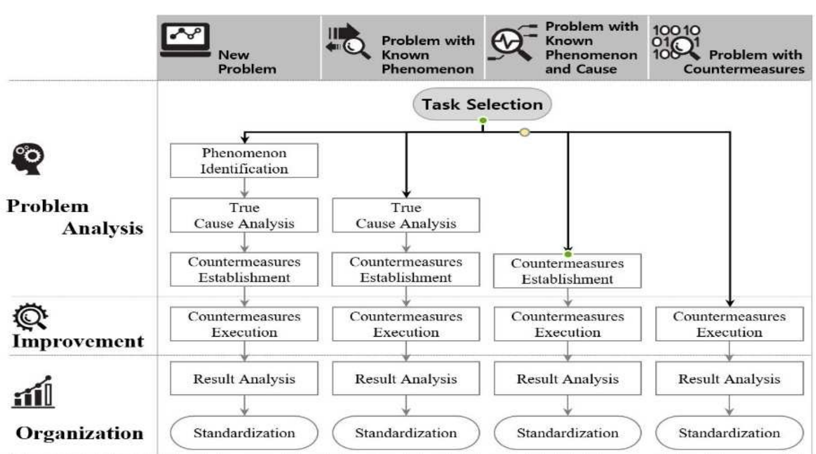

Fig. 3. Process Roadmap According to the Problem Situation

B. Problem analysis stage: If there is a creative idea during the process of identifying the phenomenon or analyzing the true cause, improvement is possible immediately. That is, all stages of the problem analysis stage are complementary to each other, and it is characterized by leading to improvement almost simultaneously without before and after stages. The background was identified through the problem-solving method applied in the field.

At the time of grasping the phenomenon, many field members expressed experiences that identified the cause and even improved immediately and reflected the opinions of these field members.

C. Analysis of true causes and establishment of countermeasures integration stage: It is characterized by deriving countermeasures simultaneously with analysis of true causes. Usually, when the true cause is analyzed, members of the field often come up with a countermeasure.

This also reflected the opinions of the field members and generalized the problem-solving process applied in the field. Nevertheless, the idea in this process is a general measure, so contradictions can be revealed at this stage.

In this stage, if the problem caused by contradiction is modeled, creative ideas can be presented by actively utilizing the TRIZ technique.

D. Improvement stage: P (Plan), D (Do), C (Check) are executed, and A (Action) is performed in the organization stage. In fact, few companies will perform the Check phase of the improvement stage and the Action phase immediately, which will standardize.

If SK Hynix has also improved, it will produce for a period of time and standardize when it is stable. To actually reflect this process, the Action (standardization) phase was inserted at the end of the organization stage. When the proposed countermeasures suggested by the field members are applied in the actual field, secondary problems or side effects sometimes occur. At this time, if you utilize TRIZ well, you can re-analyze the problem and present creative ideas that will help in solving problems.

3. TRIZ APPLICATION TO S-CUBE PROBLEM-SOLVING PROCESS

3.1 Application of TRIZ to SK Hynix's Unique Field Problem-Solving Process

TRIZ can be applied from the problem analysis stage. The *guide* based on why-why analysis is provided so that phenomenon can be analyzed based on functions and the key causes are quickly and easily identified. The countermeasure against the found cause is a method to induce the countermeasure to be found in the course of the cause, and to express the contradiction by expressing it in a general approach when suggesting the countermeasure against the cause. This method provides help to easily find contradictory situations in a variety of small problems.

3.2 Application of TRIZ from the Problem Analysis Stage

Problem analysis consists of identifying the phenomenon, analyzing the true cause, and establishing a countermeasure. First, key items or parts are selected through step-by-step analysis of the phenomenon.

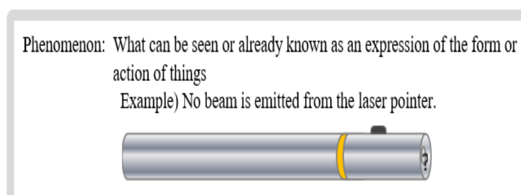

Fig. 4. Phenomenon Identification Stage 1-Phenomenon

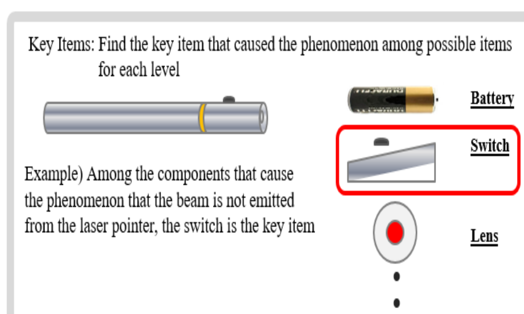

Fig. 5 Phenomenon Identification Stage 2-Selection of Key Items by Levels

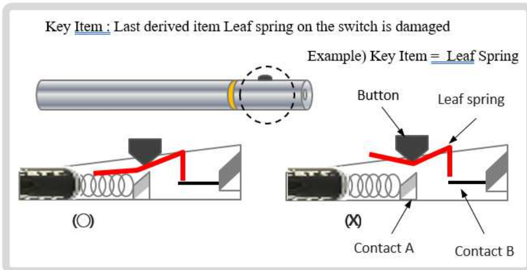

Fig. 6. Phenomenon Identification Stage 3-Selection of Key Items

Next, model the core problem by analyzing the functional relationship between the parts through functional interaction analysis with the surrounding parts based on the identified key items or parts through the stages of Figures 2-4 to 2-6.

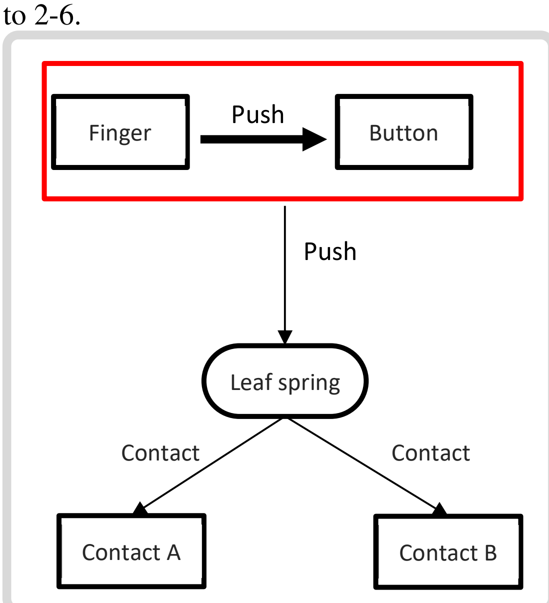

Fig. 7. Functional Interaction Analysis and Problem Modeling

In order to find out the causes of the identified core problems and the following results, a true cause analysis is conducted. The analysis of the true cause mainly uses characteristic factors and association methods, but it has a disadvantage that it is easy to see after reorganizing. There are many other tools, including cause-effect analysis. However, all the cause analysis is based on the why-why analysis, so that employees in the field can sufficiently analyze the cause by knowing the concept of why-why analysis. Here, many employees believe that the only countermeasure to the final cause is the correct countermeasure. However, since the ultimate goal is to eliminate the phenomenon of the problem, the problem can be solved in the middle stage even if it is not necessarily the final cause.

The reason can be seen in the case of Estonia Ferry, which is representatively introduced in TRIZ theory [Figure 2-8].

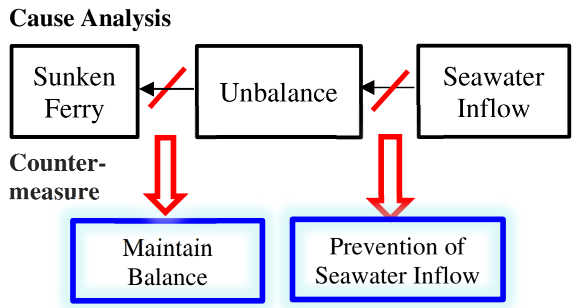

Fig. 8. Estonia Ferry Case

The following method is a method of presenting a guide so that the cause analysis and countermeasures can be done simultaneously.

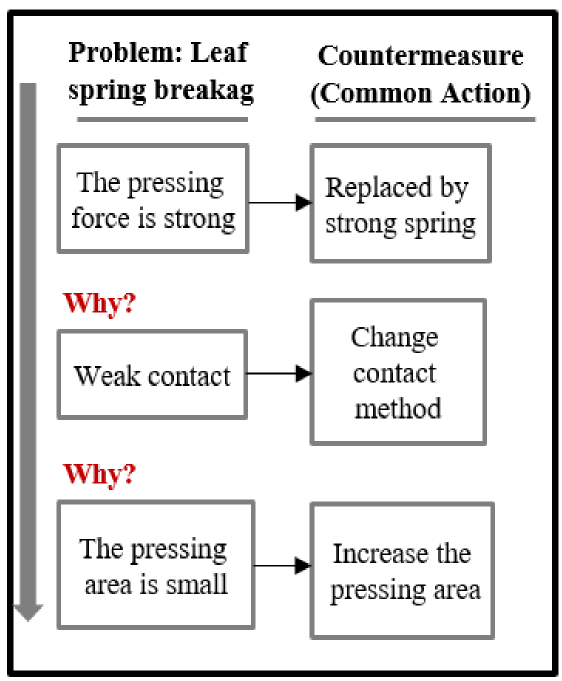

Fig. 9. True Cause Analysis and Countermeasures

Since the proposed countermeasures are general measures, easy problems can be solved immediately, but contradictions appear at this time for countermeasures with side effects. In the same way, the contradiction in the improvement stage appears in the stage of executing the improvement, and therefore, the field employees can simply analyze the core of TRIZ as shown in [Figure 2-10] with the contradictions appearing at this time and quickly present a solution idea.

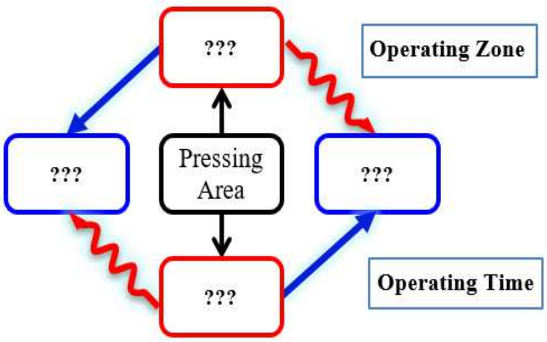

Fig. 10. Contradictory Modeling Analysis

4. CONCLUSION

SK Hynix presented two unique methodologies to the field and applied them to real-world problem solving, which resulted in finding a fast and creative idea in the industrial fied of the 4th Industrial Revolution era.

SK Hynix's unique methodology, which provides a flexible approach in a variety of problems in the manufacturing industry field, and an effective tool to approach field problems with TRIZ, made it possible to settle the TRIZ methodology in actual industrial field.

This methodology is designed to make the process eaiser for engineers who have difficulty applying TRIZ to industrial field problems. Once this methodology is settled in the field, the company can increase performance by driving autonomous innovation with creative ideas.

Unlike other large companies, SK Hynix's employees from various field of production and maintenance at the production site solves many problems by utilizing TRIZ methodology.

This paper will be utilized in all industrial fields dealing with real technology, which will help TRIZ develop and settle in the field.

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Cum SK Hynix aplică TRIZ pentru probleme din domeniul industrial

Rezumat: Numeroase companii din Coreea dezvoltă și introduc diverse procese și instrumente pentru a rezolva problemele cu care se confruntă în domeniul industrial. Deși acestea sunt utile în unele aspecte, procesul standardizat de soluționare a problemelor nu poate fi adoptat în mod flexibil pentru a face față diverselor situații problematice în domeniu, ceea ce face ca acesta să nu fie aplicabil pentru ajutorarea

rezolvării problemei reale și este utilizat mai mult ca reflecție în pregătirea raportului după rezolvarea problemei.
În domeniul industrial, este necesară prezentarea unei îndrumări flexibile care poate fi folosită imediat în rezolvarea rapidă și precisă a problemelor, iar companiile încearcă să o rezolve introducând diverse procese de rezolvare a problemelor. Cu toate acestea, domeniul industrial are nevoie de un proces eficient care să poată fi într-adevăr aplicat și utilizat în locul diferitelor procese utilizate de fiecare data.
Această lucrare prezintă procesul de rezolvare a problemelor "S-Cube| de la SK Hynix, care s-a dovedit a fi flexibil și cu un efect de rezolvare rapidă a problemelor în diferite situații problemă din domeniul industrial. Procesul de rezolvare a problemelor "S-Cube" este o metodologie eficientă care poate utiliza TRIZ în domeniul industrial, care oferă un ghid pentru a analiza rapid și ușor cauza unei probleme și face ușoară găsirea contradicțiilor într-o abordare general fără a folosi o terminologie complexă.

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