# THE FUNCTION MODELING METHOD FOR NEW PRODUCT DEVELOPMENT

Kang, Young Ju*
Senior Research Engineer
TRIZ Specialist
Hyundai Motors
* kangyj@hyundai-motor.com

## ABSTRACT

Automotive industry is one of the most competitive areas and there are several technical issues like global warming and depletion of crude oil. Also the period for developing new car becomes shorter and shorter. This situation makes car industry desires more efficient innovation and it is why Hyundai-Motors introduced TRIZ into their R&D parts.

TRIZ covers several areas of R&D projects. Usually it is used for patent circumvention, system and process improvement, cost reduction, and new development of products. There are several steps for solving problem. All the categories of TRIZ need analytical stage.

The most popular tool for analysis is function analysis (FA). If the system is stable and existing, FA is very powerful method for understanding system. But if the project is for New Development of the System or technical forecasting, it is not suitable to use FA directly. In this paper, new modeling method will be discussed for new product development.

## 1. INTRODUCTION

TRIZ is evolving very fast and the development topic covers finding new area like business or patent, improvement of classical problem solving tools and also improvement of analyzing tools like VE-TRIZ. The analysis of problem is considered very important issue as much as concept generations.

One of the representative ways to model problem is function analysis derived from Value Engineering of Lawrence D. Miles. Through function analysis, it is possible to find contradiction and simplify the system and finally the more ideal system is achieved.

There are 5 main areas conventionally TRIZ used. Patent circumvention, cost reduction, system improvement, process improvement and technical forecasting. Function analysis proved its usefulness for 4 areas from beginning. But it is needed to study more suitable modeling of technical forecasting in the S-Curve, because it is unclear what components future system will have.

In this paper, it is discussed on new modeling method based on function modeling for developing new system or dramatically improved system. The method is basically based on the function hierarchical structure of Axiomatic Design. It will be discussed and the processes will be explained together with practical case studies.

## 2. What is called Innovation and New Product?

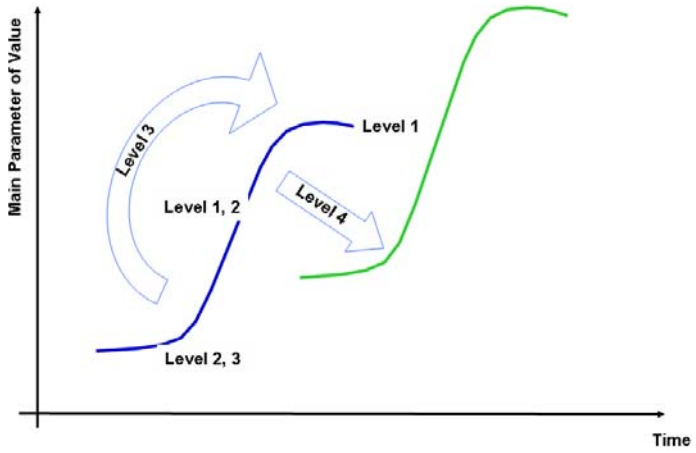
First of all, it is needed to define what is new product and innovation.

According to well known classification of the level of invention by G. Altshuller, Level 1 includes minor parameter change and most optimization. From level 2, the contradiction is resolved. Level 3 of invention starts to import technology from other industries. Level 4 keeps function but principle is changed. Level 5 is totally new start of S-Curve following new scientific development.

As shown in Figure 1, Inventions from level 1 to level 3 exist in same S-Curve and level 4 is based on new S-curve. Level 5 is totally new birth of S-Curve

So called innovation is moving upward on the S-curve. A new product in this paper corresponds to level 3 and level 4. It requires fundamental changes in the system and the conventional function analysis needs to be improved.

*Figure 1. S-Curve and Level of Invention*




## 3. Issue of Conventional Modeling

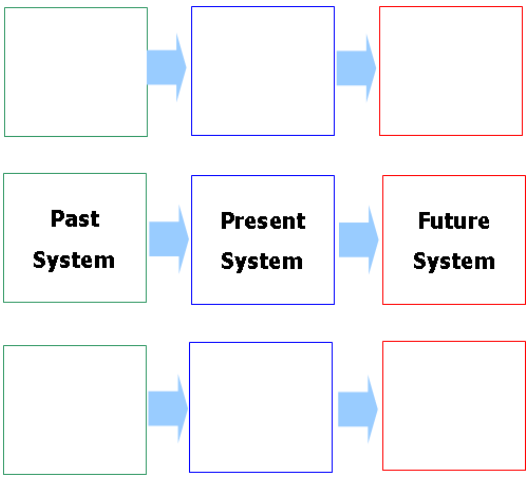
What will be the issue of conventional modeling method? There are mainly two ways of function analysis. One is for product and the other is for process. The topic is focused on function analysis for product.

There are 9 screens of technical system in figure 2. Function analysis usually describes system of present domain of the product. New product locates in right parts.

To make system improved dramatically, it is needed to formulate proper problem. Function analysis is strong to find problems from existing system. But it is hard to find novel problems because it is bound to existing system.

New system evolves according to the development of subsystem and supersystem. Therefore it is needed to overview evolution of supersystem and subsystem together.

*Figure 2.FA is focused on center of 9 screen.*




New product has characteristics as follows

1. The principle function is remained
- Even though the new system is developed, the principle function remains same but the components are changed.
For example, the data storage devices evolved from tape recording to optical or magnetic drive system. The components are totally changed but functions remained. For example, Walkman evolves to the MP3 player.

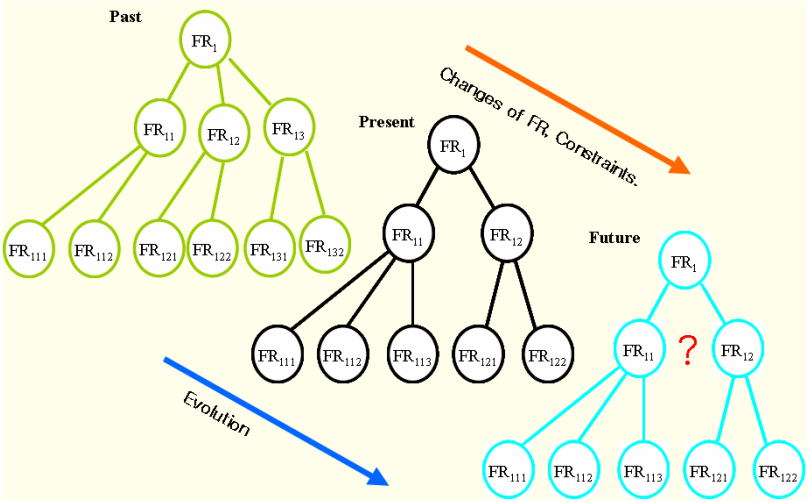
2. It is influenced by supersystem or subsystem evolution.
- For example, the electric vehicle had poor performance due to limit of battery capacity. Because the capacity of battery is increased by lithium battery, it is begin to use in the car industry. To develop new product, it is needed to see subsystem and also supersystem.

CECA(Cause Effect Chain Analysis) helps to change the viewpoint of system, but it is usually focused on target disadvantages and unclear for modeling full technical system.

## 4. Axiomatic Design and Its Modification

Axiomatic Design is developed by Nam P. Suh of MIT. It suggests several rules for good design called axiom. In Axiomatic Design, usually hierarchical structure is used for modeling design. As discussed in chapter 3, the new product keeps its principle function. To developing new product, modeling should be modeled based on function. Therefore hierarchical structure of Axiomatic Design can be useful modeling method for developing new product. In Axiomatic Design, there are several axioms and theorems but they will not be discussed in this paper, because only Axiomatic modeling method is thought to be helpful for the topic.

*Figure 3.Evolution of Functional Requirement*




At the top of hierarchical structure, principle functional requirement is located as shown figure 3. In the lower level, detail functional requirements are mentioned. Upper functional requirement has supersystem function.

Function analysis describes the functions in the lower level. But hierarchical structure shows full structure of functional requirements of the technical system.

Hierarchical Structure has the advantages which can overview technical system and analyze deeply as Cause Effect Chain Analysis.

The higher function can have several lower functional requirements, which are not included in the function analysis. It gives more chance to formulate problems for developing new product.

Even though the new functional requirements have strong constraints, they can be overcome by supersystem evolution.

From this modeling, it is found additional advantages compared conventional Function Analysis as follows

1. It has advantage to reformulate from surface problem to fundamental problem.

2. It is easy to consider additional functional variants for existing system.

There are steps for applying function hierarchical modeling for new product developments.

Step 1. Extract all the function from conventional technical system.

Step 2. Build Hierarchical Structure

Step 3. Step back from target functional requirements

Step 4. Consider other functional requirements

Step 5. Finding new Design Parameter (Component) which can meet the Functional Requirement

Step 6. Evaluate new design.

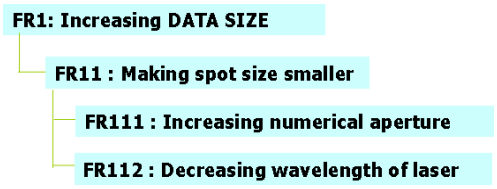
Step 7. Development of new concept

## 5. Case Study 1 : Developing New Data Storage Device

Optical storage system like DVD-ROM is very popular system nowadays. Development of the system starts from CD-ROM to DVD-ROM and the system reached Blue-Ray Disc now. If seeing S-Curve of optical storage devices, it is found easily original system was LP record and the principle is changed to the optical field from mechanical needle. And the optical disc is developed.

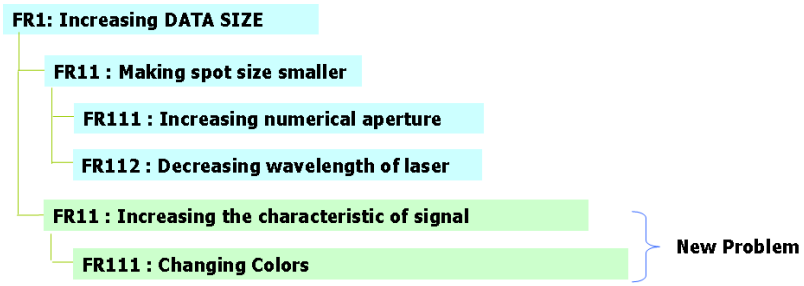
The optical disc's main parameter is size of storage. It is increased by finding new laser diode which can generate shorter wavelength of laser.

Following the steps it is possible to make hierarchical structure.



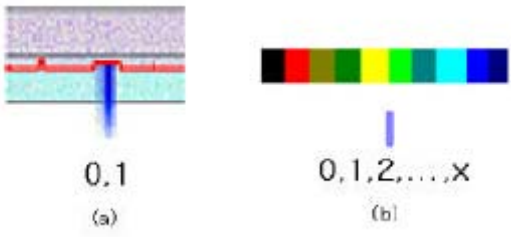

Usually it is focused on to reduce wavelength of laser. If only seen the function analysis of DVD-ROM, the engineer will focus on the method to improve the useful function in the system or eliminate harmful effect. But it has limit to develop totally new system.

If the higher function is considered to be developed new system, it is possible to find new variants for increasing data size.



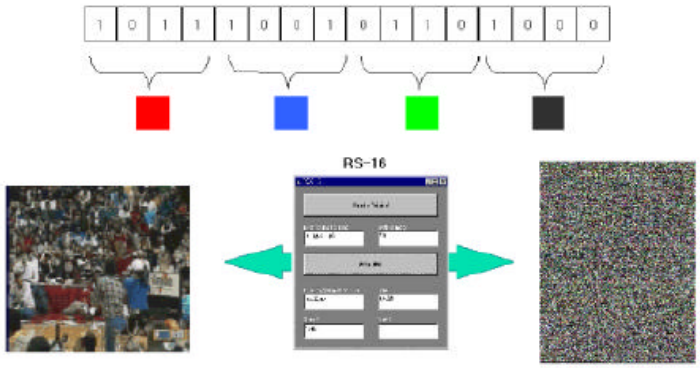

From this problem, it can be found to satisfy the new functional requirement. Usually conventional optical storage system uses mono signal of 0 and 1. Is it possible to change the characteristic of signal? One of methods is derived from Inventive Principle #17 and #32. If multiple wavelength of signal is used, the storage size will be increased as shown in figure 4.

*Figure 4. Using color signal for increasing storage.*




The prototype of color code storage is developed by using conventional photo as storage device. Special software converts the data into bitmap file. After that it is printed in the photo sheet. In figure 5, it is shown that movie file is converted into bitmap image file.

*Figure 5. Color code system: Michael Jordan movie file is change to bitmap file*




The concept for increasing data size by using multiple wavelengths is kind of new for data storage but it is already used in optical communication system. Modern optical fiber

transmit signal not only 0 and 1 but also multiple wavelength. It increases the speed of data transfer rates about 3 times.

Nowadays there are more promising way to increasing data storage size of the optical disc. Holography disc is other variants of increasing storage size by increasing characteristic of the signal. There can be found proper methods for increasing characteristics of signal.

The modeling of conventional CD-ROM or DVD-ROM can not give the problem like this. Function based hierarchical modeling is more promising for new product development.

## 7. Conclusion

The formulation of problem is one of the most important for engineering system improvement. TRIZ provides lots of tools for generating concepts but it is needed good analysis method.

In this paper, it is found that hierarchical structure of Axiomatic Design is strong for developing new product. By applying modeling from Axiomatic Design to TRIZ, the forecasting part of TRIZ can be effectively enhanced.

Function base modeling has several advantages as below.

- It helps engineers overcome psychological inertia of existing system and overview full system.
- Reasons of each function can be revealed.
- This modeling can be applied for the areas as

    1) Extreme Patent Circumvention
    2) Forecasting in the same S-Curve
    3) Forecasting for jumped S-Curve

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## 9. Biography

Young-Ju Kang, TRIZ Manager of Hyundai Motors
TRIZ Specialist Level 4. No. 82

Received M.S. in Mechanical Engineering from Yonsei University with the study on TRIZ and Axiomatic Design. Joined LS-Cable (former LG-Cable) in 2001 and was in charge of TRIZ. Organized LS-TRIZ Association and worked as the secretary of the association.

Working at Hyundai Motors as TRIZ Manager from 2007. Published 7 papers about real application of TRIZ and new theory in international TRIZ conferences and also patented more than 50 inventions about several areas of industries like machine, electronics, and processes in Korea and international.