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Combination of ARIZ92 and NM (Nakayama, Masakazu) Method for the 5-th level problems

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Abstract

Altshuller categorized problems into 5 levels based on types of applied knowledge. The TRIZ Standard Solutions are considered to be most suitable for solving problems of 2-nd and 3-rd levels.

NM Method, developed by a Japanese inventor, Masakazu Nakayama, is a method that intensively uses analogy for solving problems. NM Method gives possibilities to solve all 5 levels of problems by using knowledge not only about man-made technical systems but also about natural phenomena, plants, and animals.

A combination of NM Method with ARIZ adds to the ARIZ's problem solving capabilities. This paper will discuss a new version of ARIZ, which I tentatively call YN/ARIZ02.

1. How does TRIZ deal with level 4 and 5 problems?

Altshuller categorized problems into 5 levels based on types of knowledge that is used to solve them.

Table 1 : Problem levels

Level	Description	%
1	Apparent solutions	32
2	Small improvement	45
3	Invention inside paradigm	18
4	Invention outside paradigm	4
5	Discovery	< 1

It is considered in TRIZ community that the 40 Principles and the Standard Solutions are most suitable for inventions of level 2 and 3. Inventions and discoveries of level 1 to 3 constitute more than 95% of all R & D works and above two tools are

powerful enough to coop with them. However, there are tougher problems that are categorized in levels 4 and 5. When we encounter those problems of level 4 or 5, we need to look for a help of additional tools. NM Method is one of the good tools to fill the gap.

TRIZ is a structured system of principles that have been formulated basically by studying patents from all fields of technology through ages. Patent claims show results of inventions, but they do not show steps of thinking that led the inventors to the results. Therefore, it is not clear how the inventors found the ideas. However, we can find the thinking processes that led to important inventions and/or key factors that made them happen in books and archives. There are some common features among those thinking processes and key factors. Thinking by analogy with phenomena of the around world is one of the most popular ways.

NM Method is a thinking method that intensively uses analogy for problem solving. NM Method learns from animals, plants, natural phenomena and man-made substances or systems. NM Method gives chances to tackle problems of level 4 and 5 because there are great varieties of wisdom in nature still to be found by man. Therefore, a combination of NM Method that learns from nature with TRIZ could make a powerful problem-solving tool.

2. What is NM Method?

NM Method is a thinking method that solves problems using analogy. It was named after initials of an inventor, Nakayama Masakazu. He has the title to more than a hundred patents. He worked in the central research laboratory of a telecom company and, afterwards, founded his own invention company.

NM Method searches for analogies not only in man-made systems but also in natural phenomena, animals and plants. Its process is made up from the following five steps;

Table 2 : Steps of NM Method and an example how to use it.

Steps and description	Example
Problem Select the problem to be solved	Mass production of flat glass sheets
①KW(Key Word) Define the function or the main feature of the required technical system in a short clause including a verb.	To make flat surface instantly.

②Q A(Question Analogy) Look for an event that meets with the KEY WORD defined in ① among natural phenomena or man-made systems.	Oil on water
③Q B(Question Background) Clarify the principle and/or the mechanism that work(s) in the background of the analogous phenomenon found in step ②	Relative density and surface tension
④Q C(Question Conception) Idea generation from the principle and the mechanism of QB.	Pour glass onto something that has larger density than glass. It could be molten tin.
⑤A B D(Abduction) Combine ideas and brush up the concept.	Put molten tin in a bath. Then pour glass onto it. (Float glass process)

Let's use the float glass process for making glass sheets as an example to explain how NM Method works.

Step 1 is called KW（Key Word）. It is the step of defining the function to be achieved or the major characteristics of the problem. It is required in NM Method to express the function in a verb clause. In this example, the issue is to make flat glass sheets in mass production. The issue can be defined “to make flat surface instantly”.

Step 2 is QA（Question　Analogy）. It is the step where you search for an analogy in heterogeneous situations.　The search for the analogy shall be done among natural creatures as well as artificial things.

It is done through asking following questions.

- Is there a thing that has the similar principle as KW?
- Is there a thing that has the similar function as KW?
- Is there a thing that has the similar features as KW?

When an analogy is found, it should be represented in the form of a simple picture that outlines its main features.　We have defined the issue to be "to make flat surface instantly".　We need, therefore, to find a phenomenon where a flat surface is formed in a short time.　As the result of the search we find "oil on water."　When oil is poured into water it comes up to the surface in a matter of seconds and forms a flat layer on top of the water.

The step 3 is called QB (Question Background). This step is to formulate the mechanism or the structure of the phenomenon that has been found as the analogy. Through what mechanism its function is achieved or its characteristics appear?　What structure the elements and parts that cause the function form?　Which principle works

in the background of the phenomenon? When you get the answers to these questions you need to draw a picture that shows the principle. The density of oil is smaller than water. Oil, with the smaller density, floats over water. The surface of water is extremely flat and smooth.

The step 4 is QC (Question Conception). It is the step to adopt the mechanism, the structure, elements and/or the principle of the QB to the situation where the initial problem was formulated. This is the stage when ideas are generated. The step 3 suggests that some liquid with larger density than melted glass should be introduced. Of course it should be molten metal. Molten tin might be a good choice.

The last step 5 is ABD (Abduction). It is the step to form a concept from the ideas, and, then, to refine it into a concrete plan taking conditions and limitations of the problem into your consideration. Melted glass is poured into a long bath that is filled with molten tin.

This is the float glass process for making flat glass sheets which was invented by an Englishman, Sir. Alistair Pilkington. It is said that he got the idea when he saw oil on water and presumed that the same principle could be applied to the manufacturing process of glass sheets. I used the flow of Pilkinton's ideas, above, to explain the steps of NM Method.

3. Features of NM Method and the possibility of its combination with TRIZ

As mentioned in above 3, NM Method looks for analogy both in nature and in man-made systems. Here is a comparison between NM Method and TRIZ from the viewpoint of types of analogy incorporated in the method.

Table 3: NM Method and TRIZ

	NM Method	TRIZ
①Thinking structure	Analogy	Analogy、forced association
②The area to find an analogy	Nature and man-made systems	Patents and inventions
③Searcher of analogy	Problem solver	TRIZ scientist
④The viewpoint to find an analogy	Anything that is common, a structure, features and so on.	Type of the contradiction, structure of the events
⑤ Definition of the features that should be common.	Verb clause	A set of conflicting parameters, Substance field model
⑥ Discoverer of the common principle.	Problem solver	TRIZ scientist
⑦Creator of the solution	Problem solver	Problem solver

As shown in above Table 3, NM Method looks for an analogy from wider space than TRIZ does. The problem solver must do everything from finding an analogy to defining the common principle characterizing the analogy thus found. This means that the burden is much heavier for a problem solver when he uses NM Method. Although the process of NM Method makes thinking on the basis of analogy a little easier, a problem solver who uses NM Method needs to make great efforts to get a good result. Of course, it is unavoidable for a problem solver to make his own and a great deal of efforts to discover an idea that helps solve untypical problems, but the task can be extremely hard especially for a person who uses NM Method for the first time.

On the other hand, TRIZ beginners usually find it difficult to use its indirect approach to find the solution. (Actual situation → Model → Standard solution → Actual solution) Also indirect but simpler steps of searching analogy from the required function in NM Method is often easier for them. (Required function → Analogy → Solution)

In TRIZ an actual problem situation is transformed into different types of model. And the solution is searched on the basis of the model through a bottom up process, although the target is set to the Ideality. NM Method pays attention to the required function itself (or its features) and tries to use the structure or quality of some thing or phenomenon that realizes the required function (analogy) as the guide to the solution. It can be characterized as a top down process from the target.

By following ARIZ process from Mini-Problem, Ideal Ultimate Result to Physical Contradiction and so on, the space for searching analogy (and then solution) in NM Method becomes narrower and limited step by step, thus making the search for an analogy less complicated. By using NM Method, on the other hand, problem solvers get accustomed to the indirect way of finding solutions and, also, have bigger chance to find the solution from still wider space of the search. The TRIZ Technological Effects which are the library of natural effects and phenomena serve as the fund of knowledge for NM Method, too.

4 . A sample of the combination of ARIZ and NM Method

The sample has been made as follows:

- ARIZ92 as the basis

I used Ideation's ARIZ92 as the basis of the combination because it has a simple and straightforward structure. It incorporates all major tools of the classical TRIZ and is founded on the traditional ARIZ ideal.

・ The steps from Mini-problem to Maxi-problem

ARIZ starts to tackle the problem from artificially limited Mini-problem and then, afterwards, lifts the restrictions for the solution. From this viewpoint NM Method is a Maxi-problem approach. I, therefore, placed NM Method on the final stage of the idea generation process.

・ A 3 phases structure

The problem solving process is made up from three major phases; Understanding the problem situation, Idea generation and Refining the concept.

First, the problem is identified and analyzed in the Understanding the problem phase. Different tools and techniques are used for Idea generation and the ideas are refined and testified to a practical Concept that could be implemented in the form of an actual action plan.

The outline of the process is as follows.

Step 1. Understanding the problem situation

The system that has the problem is identified, its functions and Ideal Ultimate Result are defined and an initial understanding of the problem situation is gained.

Step 2. Identification of the of the Technical Contradiction

The feature to be improved and the undesired result are defined and the inventive principles are selected from the contradiction table and used to generate ideas.

Step 3. The Physical Contradiction

The Technical Contradiction is transformed into a Physical Contradiction, and the Separation Principles are applied for idea generation

Step４. The Su-Field Analysis

The object, the tool, the field and the relationship among them are identified and analyzed. The standard solutions are applied.

Step５. Simulation with ＳＬＰ model

The contradicting situation is transformed into a graphical model using Smart Little People. A simulation is made to change the model into one without the contradiction.

Step６. Application of the Effects

The required function is expressed in the form of Key Words (a verb clause "to do ~

to ～". An appropriate effect is selected from the Physical Effects.

Step 7 . Application of NM Method

Using the Key Words found in Step 6, an Analogy is searched (QA), the principle that works in the background is identified (QB) and, then, the principle is transformed into an idea for the solution (QC).

Step 8 . The application of the Patterns of Evolution of Technological Systems

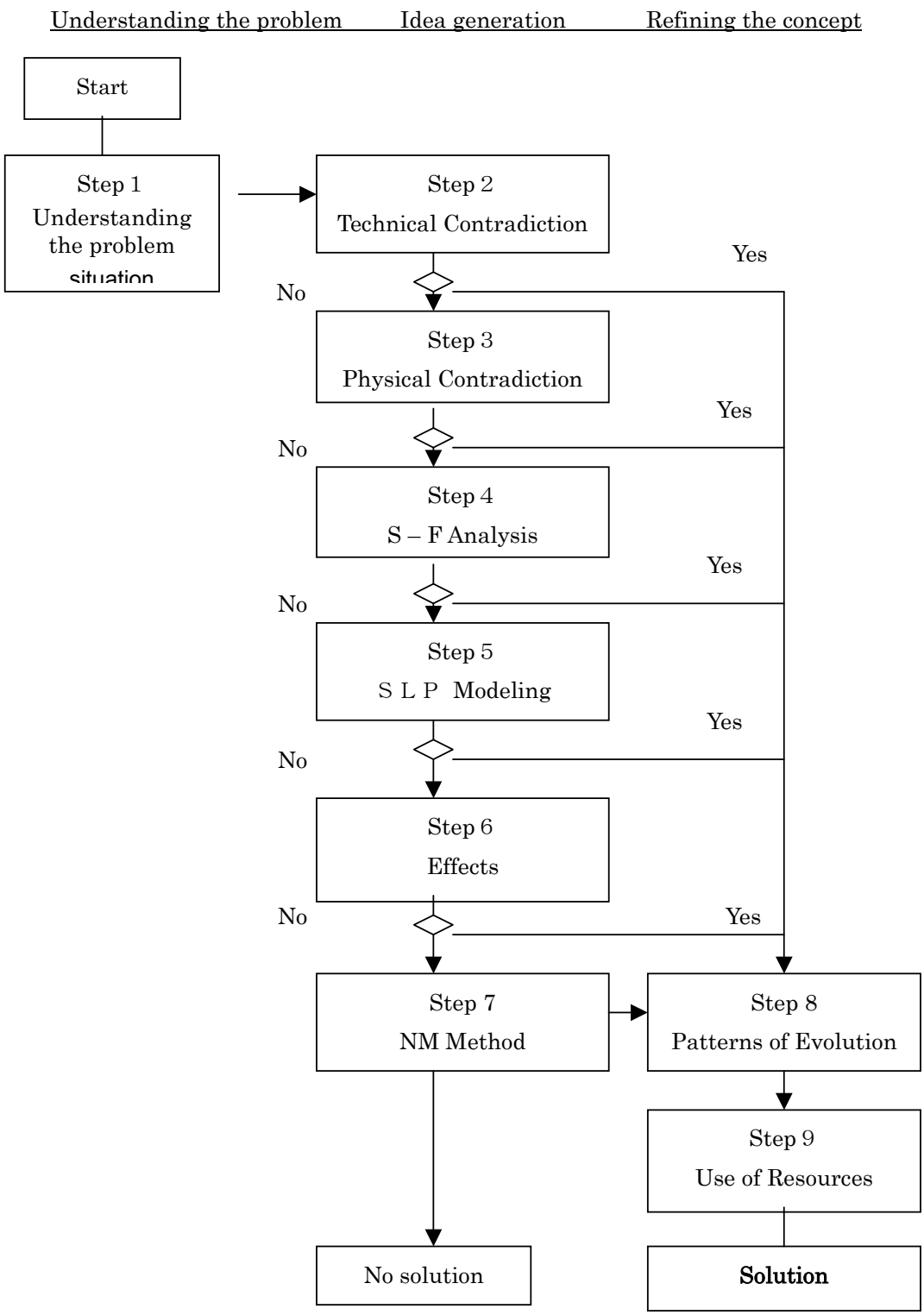
The Patterns of Evolution is used to categorize and refine the ideas obtained so far.

Remarks: Steps 8 and 9 correspond to the Abduction step of NM Method.

Sep 9 . Search for resources

A search for the Substance and Field Resources in and around the system for its optimization

Chart 4: Flow of YN/ARIZ02



５．Notes to YN/ARIZ02

The Idea generation phase can be used in two ways.

① Improvement of an existing system

If the target is improvement of an existing system - overcoming some drawbacks of the existing system or its modification to meet some new requirements and so on - it is recommended to follow the steps from 2 to 7. The problems of the existent system must be is examined first and, if the solution is not found, you need to start the process from step 1 onward.

② Development of a new system

When you need to develop a new system on the basis of the market requirements, it is more suitable to use the process in the reverse order starting from 7 and proceeding backward to 2. First, you need to find the principle that satisfies the requirements then study the system mechanism, the structure and materials.

For this reason, the Effects and NM Method are used first. In the process of realizing the principle you encounter different secondary problems. These problems are solved through the use of the Technical Contradiction, the Physical Contradiction and other tools and techniques of TRIZ.

References

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