Effectiveness of Engineering Solution Case Document Search Based on TRIZ Contradiction Matrix Theory

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Abstract. We propose a method to manage documents of engineering solution case based on TRIZ contradiction matrix theory. The document of engineering solution case involves know-how and techniques for solving mechanical issue. Usually the documents are written by engineers and practitioners, and managed by a company for sharing and inheriting among employees. However, an engineer who lacks literacy cannot find the previous case documents due to the inadequate keyword selections. To solve the query issue, we introduce TRIZ contradiction matrix theory for categorizing case documents. The engineers can retrieve adequate case documents by selecting improvement parameter and deterioration parameter on the matrix. Since the classification based on the matrix substantially categorize the case documents in terms of the problem solving methodology, it is effective and straightforward way of the specialized field and the key word. It is construction of the knowledge management support system that applies the idea of TRIZ. The problem solving that uses the reference information on this system is practiced and effectiveness is verified.

Keywords: TRIZ, Knowledge management support system, retrieval, contradiction matrix.

1 Introduction

Using the case collection made in the past case is important on knowledge and technological experience lore, and it has come to obtain a large amount of material easily by varied search engine in recent years. However, the literacy decrease's is due to decrease expert in specialized fields happening in enterprise etc. and obtaining a necessary case become difficult.

It is necessary to contain useful information on the success, the failure experience, and knowhow, etc., and to use the case collection for the power of people more. However, only the manufacturer understands the abounding knowledge, and it is likely not to transmit easily to the inexperience user of the case collection in the hoped real intention.

The conception knowledge of the word based on the expertise is necessary, and the case that the user requests is not necessarily obtained keywords by retrieval. Moreover, the number of case in each specialized field is limited, and similar solution of other fields cannot be used.

In a general search process, the case is examined putting narrowing and retrieval by keyword according to the specialized field. However, the user has the doubt in utility that sees the case, and there is possibility of will not use case if it is the one that the keyword does not show the intention that the case originally has, too.

Then, this thesis examined the knowledge management support system by an approach different from the case retrieval existing. The knowledge management support system in a new aspect that applied the TRIZ theory to the case retrieval and the document management of the case collection was constructed so that the user might obtain a necessary case, and effectiveness was evaluated. The improvement can be expected by applying the idea of technological contradiction matrix to use an existing combination in the TRIZ theory and to propose solving, and giving the user the reference information with utility in respect of the quality of the problem solving in this system.

2 Proposed Method

The effort on the input method of the case title and the keyword registration type, etc. is done to use potential data of the case better so far, and it can be used though even the inexperienced person can easily retrieve. Even if there are a lot of technical terms, the interpretation is not a little difference. Consequently, related keyword included in the document is not exactly useful information.

How the content of the case is handled for the knowledge management support system that constructs it in the present study becomes the key. It is important to drop the superfluous information of the content of the case very, and to catch essence, and it is a problem how to link an actual case with the tool that can be the handling it.

Then, the present study examined the knowledge management support system by an approach different from the case retrieval existing. It wanted to apply the TRIZ
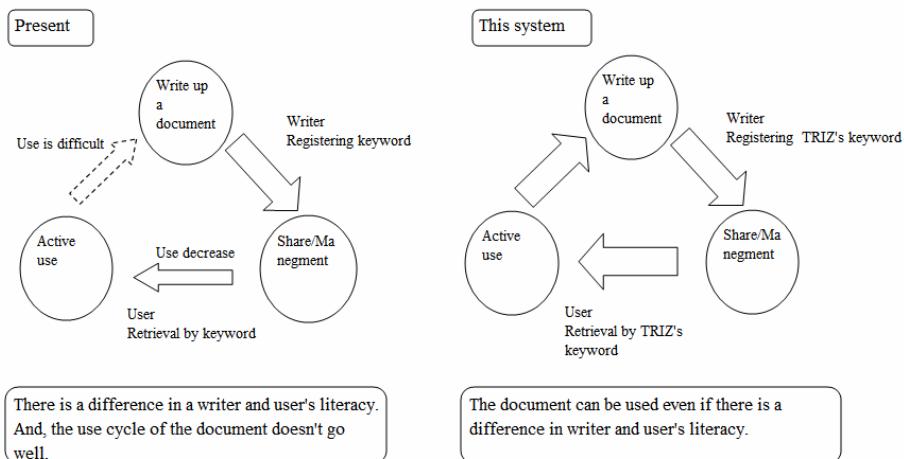

Fig. 1. Document use flow

theory to the case retrieval and the document management of the case collection so that the user may obtain a necessary case, to construct the knowledge management support system by a new viewpoint, and to evaluate effectiveness. Figure 1 is a conceptual diagram of the difference of the document use in current document use flow and the present study.

It is made easily to construct the one that the document use is promoted as being in the new flow of Figure 1 for the effectiveness of the problem solving to practice the document use in the present study and to verify it with the Web system of open source, to expand the user range, and to access information. It is applied to an actual case, and it is assumed that the quality of the problem solving is evaluated.

3   TRIZ Contradiction Matrix

It is time when actually occur a technical problem holds technical contradiction "Other one deteriorates by improving certain". At that time, the solution comes to do the trade-off (compromise), and to be going to grow dim, too. Because it persists in an immediate factor, it is thought that the directionality to the solution narrows and the flexibility of the idea is lost.

The TRIZ technology contradiction matrix is led to the solution by the parameter and catching, and replacing "Other one deteriorates by improving certain" with the item that abstracts the parameter respectively. Table 1 shows the outline of the TRIZ technology contradiction matrix.

Table 1. TRIZ Technology contradiction Matrix (Matrix2003)

Improvement parameter \ Deterioration parameter	1 Weight of moving object	2 Weight of stationary object	· · · ·	29 Noise	· · · ·	48 Measurement Precision
1 Weight of moving object		3.19, 35.40	· · · ·	35.2, 25.13	· · · ·	28.26, 35.10
2 Weight of stationary object	35.3, 40.2		· · · ·	14.35, 31.19	· · · ·	26.28, 18.37
· · ·						
18 Power	8.38.2, 25.31	19.2		24.23		2.37, 4.18
· · ·						
48 Measurement Precision	35.26, 32.1	26.25, 1.35.8	· · · ·	9.24.2, 37.25	· · · ·	

(Overlay note: When the parameter of a vertical and a horizontal axis is selected, the solution (number) is led.)

The TRIZ technology contradiction matrix is classified into 48 items to which the parameter described in a spindle and a horizontal axis is common, and the solution led there is classified into 40 pieces, and the priority level is presented in the solution. A feature thing is to catch the true nature of the problem when replacing it with the

Table 2. Improvement and Deterioration Parameter (Matrix2003)

1	Weight of moving object	21	Stability	40	Object affected harmful effects
2	Weight of stationary object	22	Temperature		
3	Length of moving object	23	Illumination Intensity	41	Manufacturability
4	Length of stationary object	24	Function Efficiency	42	Accuracy of manufacturing
5	Area of moving object	25	Loss of Substance	43	Automation — Manufacturing
6	Area of stationary object	26	Loss of Time	44	Productivity — and cost
7	Volume of moving object — Physical	27	Loss of Energy — Efficiency	45	System Complexity
8	Volume of stationary object	28	Loss of Information	46	Device Complexity
9	Shape	29	Noise	47	Ability to Detect/Measure
10	Amount of Substance	30	Harmful Emissions	48	Mesurement Precision — Measurement
11	Amount of Information	31	Object Generated Side Effects		
12	Duration of action - moving object				
13	Duration of action-stationary object	32	Adaptability / Versatility		
14	Speed	33	Compatibility / Connectability		
15	Force / Torque — Performance	34	Ease of Operation		
16	Use of Energy by moving object	35	Reliability		
17	Use of Energy by stationary object	36	Repairability		
18	Power	37	Security — Character		
19	Stress/Pressure	38	Safety / Vulnerability		
20	Strength	39	Aesthetics		

Table 3. List of Invention Principle of TRIZ 40

1	Segmentation			
2	Taking out	21	Skipping
3	Local quality	22	Blessing in disguise
4	Asymmetry	23	Feedback
5	Merging	24	Intermediary
6	Universality	25	Self-service
7	Nested doll	26	Copying
8	Anti-weight	27	Cheap short-living objects
9	Preliminary anti-action	28	Mechanics substitution
10	Preliminary action	29	Pneumatics and hydraulics
11	Beforehand cushioning	30	Flexibile shells and thin films
12	Equipotentiality	31	Porous materials
13	The other way around	32	Color changes
14	Curvature	33	Homogeneity
15	Dynamization	34	Discarding and recovering
16	Partial or excessive actions	35	Parameter changes
17	Another dimension	36	Phase transitions
18	Mechanical vibration	37	Thermal expansion
19	Periodic action	38	Strong oxidants
20	Continuity of useful action	39	Inert atmosphere
		40	Composite materials

parameter of 48 items to obtain the requested solution for the problem when the TRIZ technology contradiction matrix is used. Therefore, it never enters when extra information retrieves it, and it can approach the requested solution.

Table 2 is a list of the parameter that composes a spindle and a horizontal axis of the TRIZ technology contradiction matrix.

As for 48 parameters, some classifications are performed. No.1-11 in "Physical", No.12-23, in "Performance", No.24-31, in "Efficiency", No.32-40, in "Character", No.41-46 in "Manufacturing and Cost", and No.47-48 are "Measurement".

Table 3 is the one that is called the invention principle of 40 that hits the solution of the TRIZ technology contradiction matrix. It is shown by the figure in the matrix in order of the use recommendation.

4   Outline of Knowledge Management Support System

Figure 2 shows the conceptual diagram of this system. This system replaces with the parameter that catches the true nature of the problem in the user, and inputs it to this system of PC. The content of the TRIZ technology contradiction matrix takes into SQL data base, comes to be able to display the solution on the Web system that makes it, chooses the solution that the user suits, and can extract the case in addition along it. What used the current having read it from the table of paper like Table 1 by hand power has been achieved by the automatic operation by Web. It is a composition of the output part where the solution is presented from the input part where the parameter of a vertical and a horizontal axis is selected on the Web menu and the input item and the retrieval part where the relating case data base is called there.

The user should work to the TRIZ technology contradiction matrix when replacing it with the parameter of abstract. The solution presented there is qualitative, and some experience and training are necessary for the replacement with the event of the real world from there. This system makes the case related to the parameter a data base to support the part, and it is possible to call it. The most this system particularly additional point is reference actually case by data base Web site. (For example: JST Failure Knowledge Database) In addition, the user can deepen the idea by referring to the presented case.
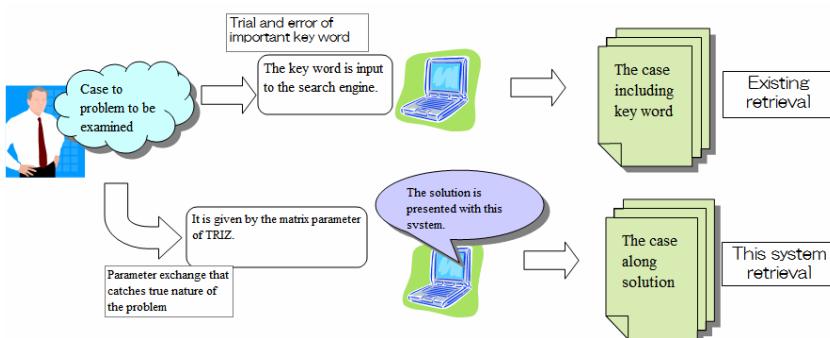

Fig. 2. Existing retrieval and comparison of concepts of this system

5   Usage Scenario of the System

The solution is easily presented by selecting inputting the vertical and the horizontal axis parameter of the TRIZ technology contradiction matrix. The solution is put the order of priority, and decides which solution has suited the settlement of the issue by the user according to it, and can retrieve the case corresponding to it. For instance, it is assumed that the noise problem occurs though I want to raise the output of the amplifier. When the parameter that relates when the user inputs it to the system is selected, "Power" and the deterioration parameter become "Noise" as for the improvement parameter. After selecting the parameters, the system presents some solutions. The user selects the appropriate one from among that. It is hit on that the meaning "Intermediary" indicates digital processing and the noise removal functions etc. when thinking that the solution "Intermediary" is the most appropriate here. When the user doesn't hit on, knowledge where the system calls the case collection that relates to "Intermediary" can be supported. The solution of priority ranking is cause by TRIZ. Figure 3 is an example of the screen of presenting the solution after inputting the parameters.
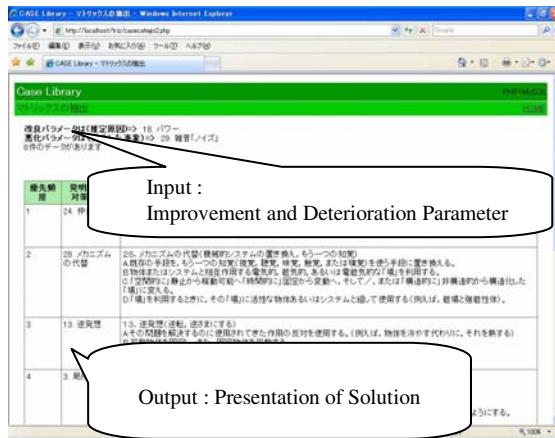
Fig. 3. Example of Displaying Solution of This System

6   Experiment and Evaluation

Five graduate students and seven company technical engineers participated in the experiment. Graduate students were inexperience persons, and technical engineers were experienced. The experience persons have knowledge of rotating machine techniques (drawing and calculate experience: fan, blower and compressor etc,). The technological trouble case that was actually was quoted from Nakao's failure best 100 and the experiment was prepared by two titles. Their title are "Failure of Return to the
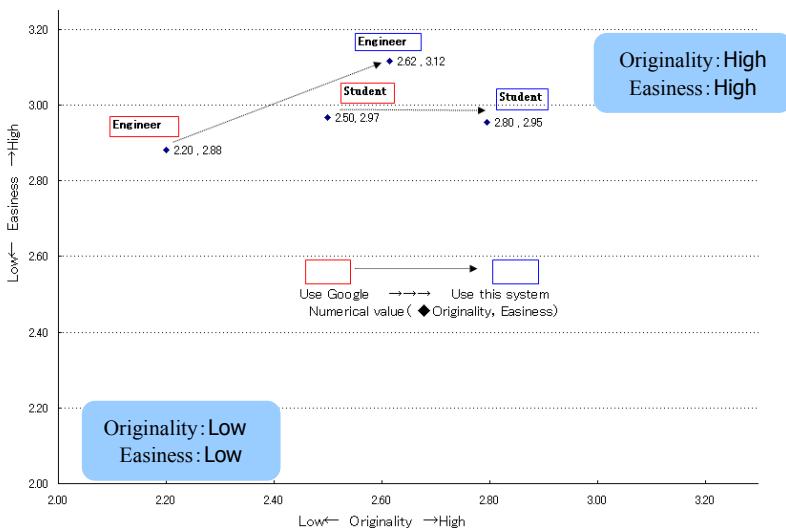
Fig. 4. Solution key word Evaluation of Originality - Easiness

Earth of Space Shuttle 'COLUMBIA'" and "The rust proof painting is defective in the coil spring". It searched for the solution by the index site by the first problem, and the solution was requested in the following problem according to the procedure of the conception of the system and TRIZ made in the present study. To prevent it with the rose of data by the difficulty of the problem, order was changed and alternately (1st - 2nd title or 2nd -1st title) executed by participants. And 1st system is used search engine, 2nd system is used this system. The evaluation score (five stages) was applied to each solution key word by originality and easiness as an evaluation of the utility of the solution key word, each mean value was compared.

Originality of solution key word as for easiness, the student was a level-off and a tendency that the evaluation raises in originality in an easy evaluation. It became a tendency that this system of both originality and easily rises in the Engineer. (Fig.4)

7   Conclusion

In this paper, a method to manage engineering documents by categorizing TRIZ contradiction matrix is presented. The engineers who cannot find proper query keywords can retrieve a set of document by selecting the parameters regarding the problem. We developed a system which implements the proposed method as Web service. We also confirmed the effectiveness of the proposed method through an experiment with both experts and non-experts of mechanics.

The merit of our method is to free the engineers from considering advanced technical terms while retrieving case documents. Thus this approach is suitable for non-expert engineers. Also referring the similar case documents in the same matrix cell

inspires the non-expert engineers to find better solution and related terms. We continue to confirm the effectiveness of this approach by increasing case documents, and including documents of other areas.

References

1. Mann, D., Nakagawa, T.: Knowledge Creation Study Group: TRIZ Practices and Benefits. Systematic Technological Innovation, vol. 1 (2004) (in Japanese)
2. Mann, D., Nakagawa, T.: TRIZ Practices and Benefits. Vol.2. New Contradiction Matrix (Matrix 2003) (for Technologies in General) (2005) (in Japanese)
3. Nakao, M.: 100 Scenarios of Failure (2005) (in Japanese)
4. JST Failure Knowledge Database, `http://shippai.jst.go.jp/fkd/Search`