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## **Innovation In the Material Cost of the 8mm Camcorder Using Triz**

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**ABSTRACT:** A camcorder has come into wide use rapidly due to the increase of outdoor activities and the elevation of personal income. Therefore, camcorder manufacturers are trying to reduce material costs in order to expand the sale. In this project, TRIZ technology has been applied to achieve such a result.

This project suggests the improvement of a camcorder component named “ Pole Base” which is located in front of the Drum and guides the camcorder tape. It is consisted of 8 base components and is manufactured through 7 processes.

The suggested methods in this paper show how the number of components and processes are reduced. Three patents related to these technology changes have been submitted.

In this project, Function Analysis, Technical Contradiction and Su-Field Analysis are the main TRIZ tools that are used.



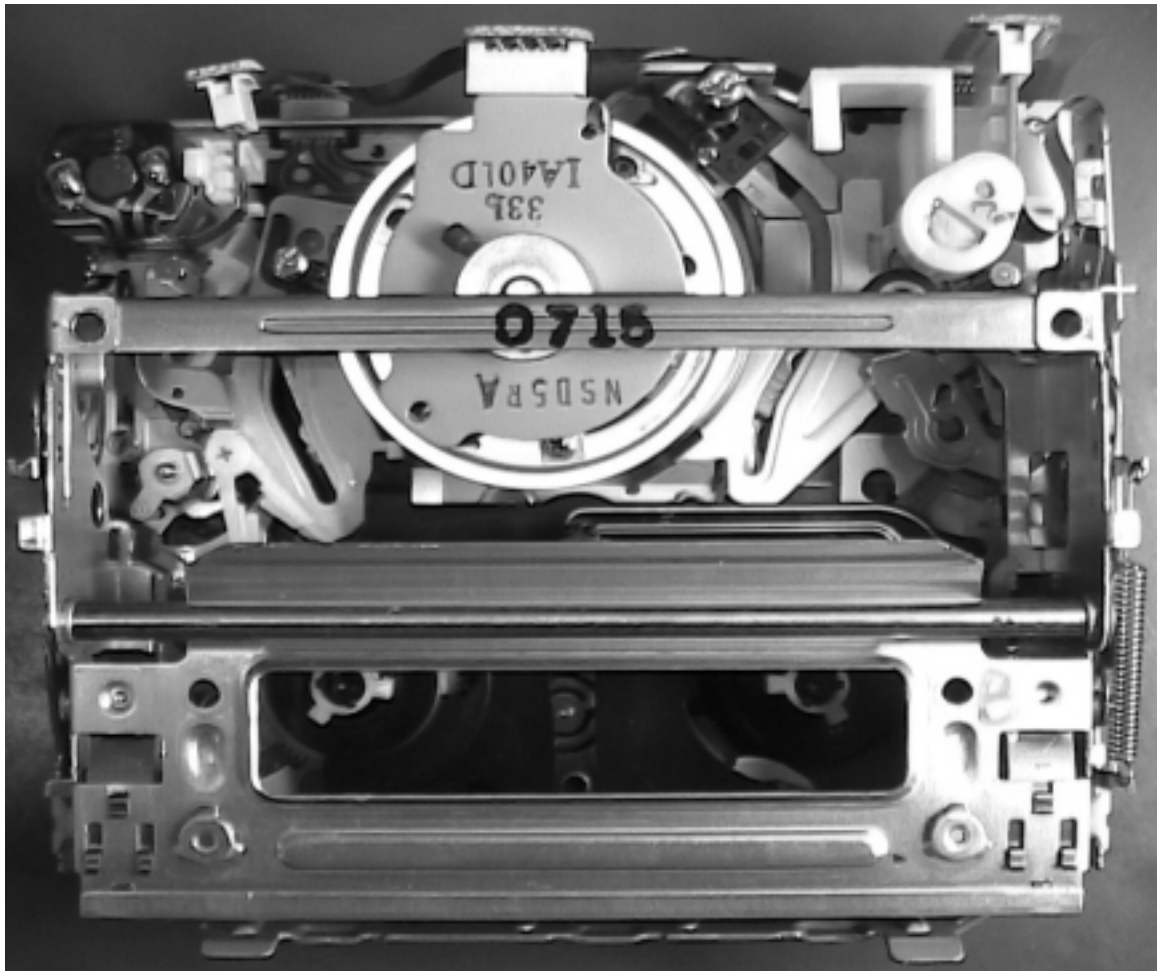
**Figure 1. Camcorder(video camera)**

### **BODY**

#### **INTRODUCTION**

In recent years, influenced by increase in gross income and leisure time, more people start to desire to record their valuable part of life. In order to fulfill their desire, the camcorder is good medium since it can both edit and keep images. Furthermore, the demand of the camcorder is over 10 million in the market worldwide. Due to this rapid market development and competition,, the price of camcorder keeps dropping more than 20 % annually. Therefore, manufacturers have tried to reduce the costs in order to survive in this competitive market.

This paper describes the cost reduction in video camcorder by using TRIZ.



**Figure 2. Camcorder deck assembly**

The camcorder (VIDEO CAMERA) is composed of Camera, Circuit, Appearance, and Deck. Among the rest, the Deck mechanism functions to record and play images by operating the tape and touching the tape into Drum. This project introduces POLE BASE S, one of parts of the deck mechanism, which helps to decrease the cost by reducing the number of assemble parts in half. As Pole Base S, which is located in the

entrance of Drum, guides the tape's location precisely, Drum can execute to record and play images. The possible malfunction problem caused by decrease of precision parts, can be solve by using TRIZ (Theory of Inventive Problem Solving), widely used problem solving method, which is most readily applicable to physical domains..

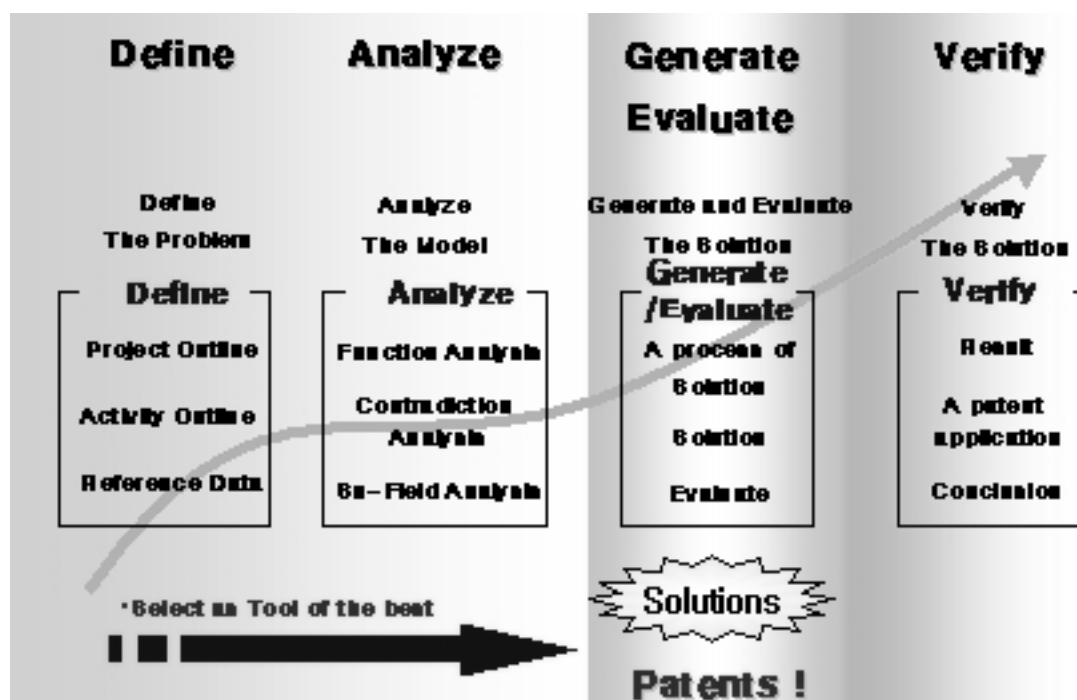


Figure 3. TRIZ solution step

Fig3 illustrates four generic steps to work out TRIZ solutions. The first step is to recognize and define the problem. And then it structures a problem into a “contradiction statement” and derives solutions that address the problem statement from both a technical and systematic perspective. After verifying and reviewing the proposal, the project is completed with achieving the patents.

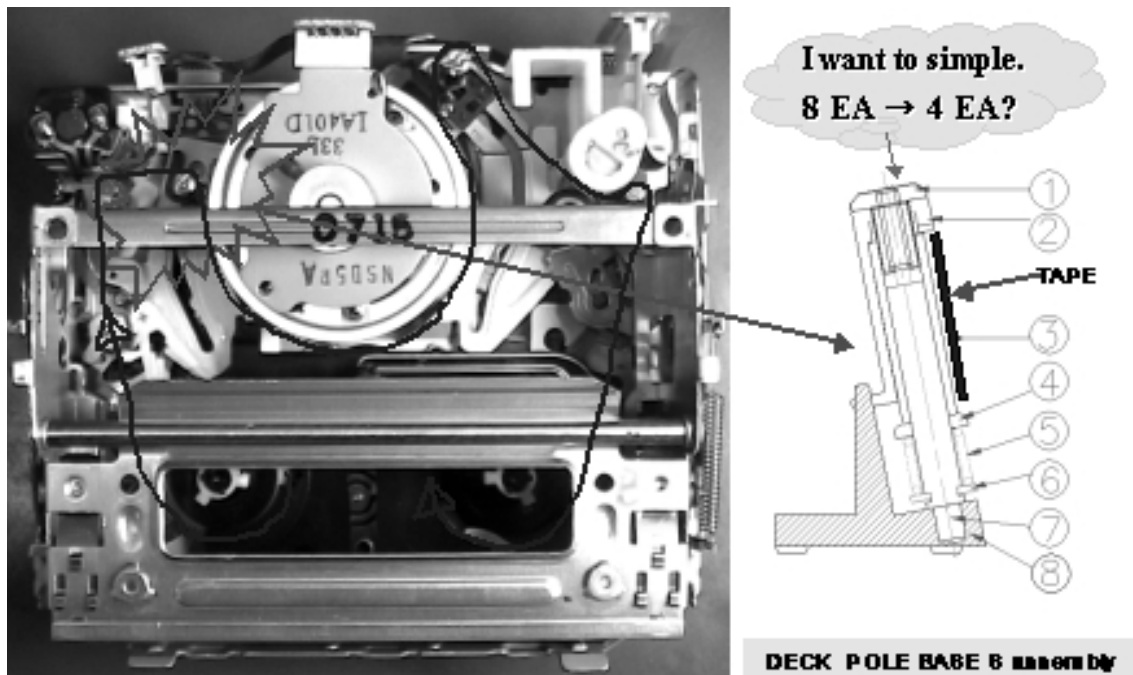


Figure 4. Camcorder deck assembly

NO	PART NAME	FUNCTION	COST
1	FLANGE TOP POST S	ADJUSTMENT	
2	POST GUIDE TOP	TAPE UPPER GUIDE	
3	SLEEVE POST S	TAPE FRONT GUIDE	
4	FLANGE LOWER POSTS	TAPE LOWER GUIDE	
5	SPRING POST S	TORQUE OCCURENCE	
6	E-RING	SPRING STOPPER	
7	SHAFT POST S	SLEEVE GUIDE SHAFT	
8	POLE BASE S	BASE PART	
PROFIT			
SUM OF PARTS			
ASS'Y COST : 7 PROCESS			
TEST COST : 2 PROCESS			
(HEIGHT PRE-SETTING, POLE LOCATION AXIS (X,Y)			
ASS'Y&PART COST			

Figure 5. Pole base s assembly analysis of price

## 1. Define step

The main purpose of reducing the cost of POLE BASE S is to win the cost competition of the camcorder in 2004. Any malfunction caused by the cost reduction of POLE

BASE S can be solved by using TRIZ. From this technology, the expected cost reduction is approximately \$100,000.00 a year with patents.

The required parts to be reduced are depicted in Figure 4 and the price of each part is shown in Figure 5. The left picture illustrated in Figure 4 is DECK assembly; whereas the right picture is Pole Base S. The Pole Base S is located in the top-left on the DECK assembly and functions to precisely guide the location of tape which is represented in circle in Figure 4. Moreover, it is currently composed of eight elements, and the goal of this project is to reduce four elements by using TRIZ method.

Figure 6 shows the assembled Pole Base S and its eight decomposed elements from the original object.

In Figure 6, the problem and goal of this project can be recognized. The aim of this project is to reduce the number of component parts from 8 to 4. Moreover, tape guide should be fully functional, even if the number of parts is reduced in half

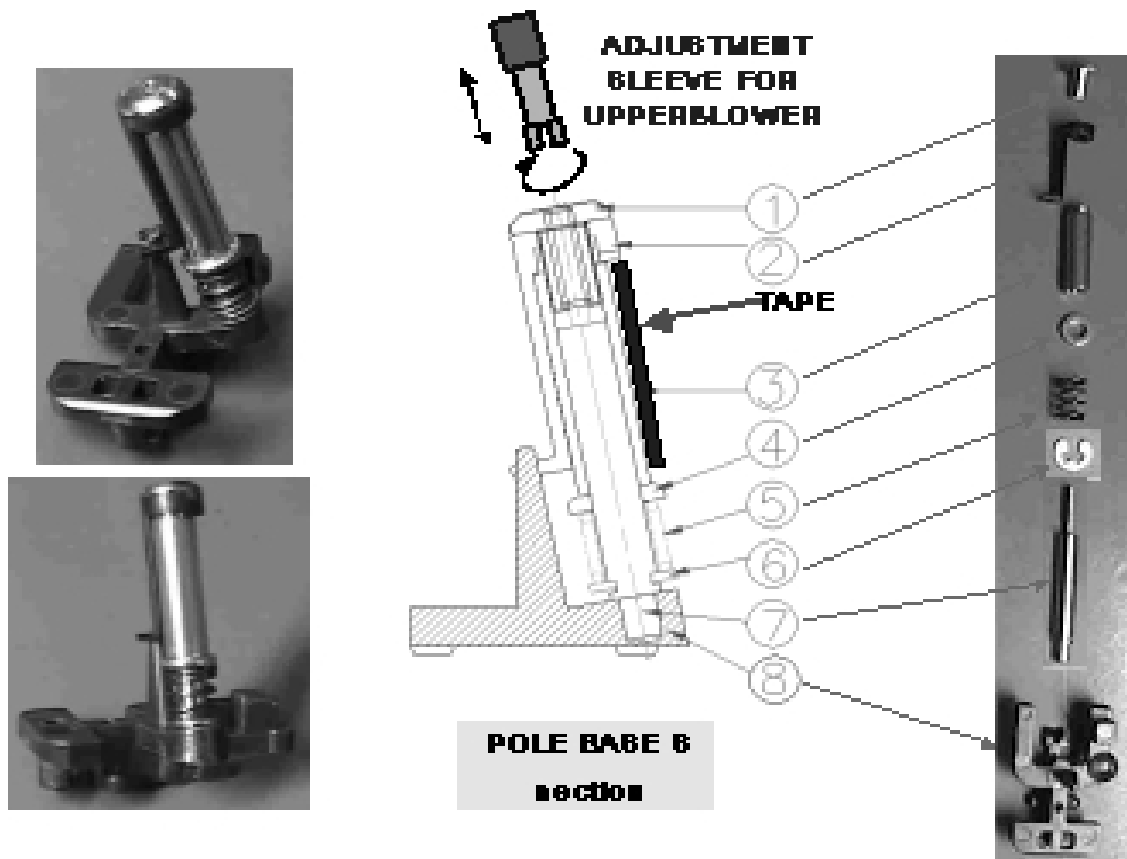


Figure 6. Pole base s assembly and disassembly

## 2. Analyze step

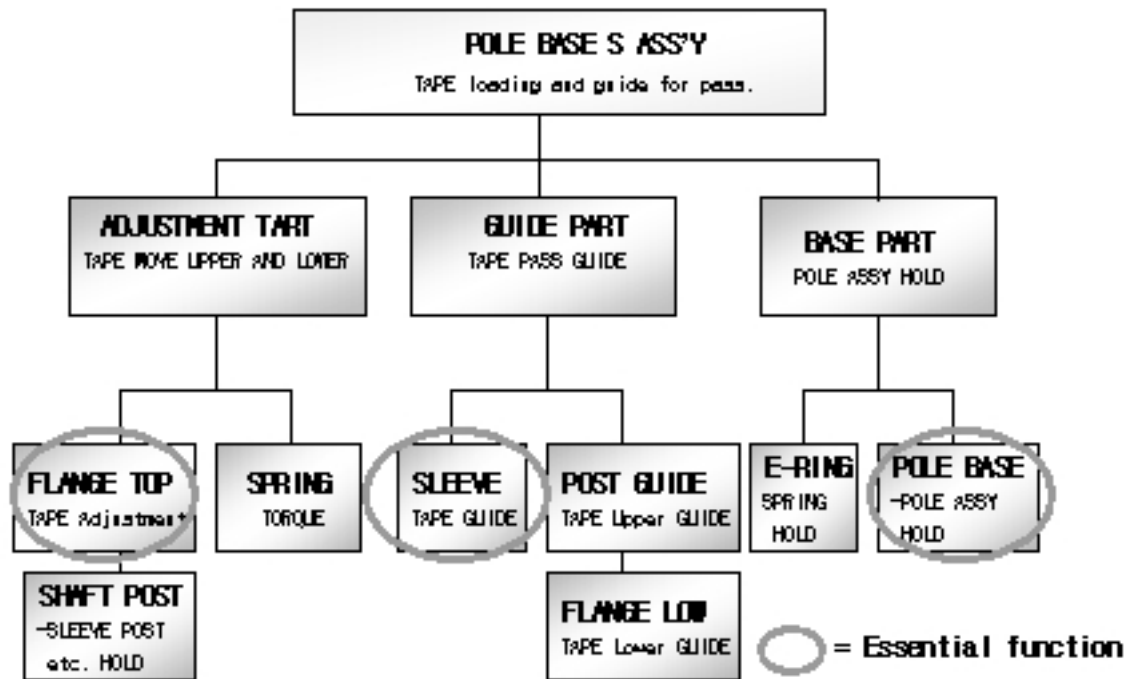
TRIZ models, based on the theory of inventive problem solving by Altshuller, are derived from the study of patents and observed trends in the evolution of technical systems. The application of this principle includes structuring a problem into a “contradiction statement”. Through analyzing the problem and finding contradiction, the various solutions can be presented. The most important thing is to find contradiction and to use the appropriate TRIZ tools for analyzing.

In this project, the most appropriate solution will be defined by simulating various tools. However, only the case study has been presented in this paper.

### **2-1-1 Function Analysis**

The First step is to find essential parts through analyzing the function of each element. As Figure 7, the function can be divided into three parts in terms of the Adjustment part, the Guide part, and the Base part. Both the Adjustment and Guide part are composed of three elements; whereas the Base part has two parts.

Through analyzing each function, the functionally essential parts were founded.



**Figure 7. funtion analysis-pole base s assembly**

The FLANGE TOP in the ADJUSTMENT PART, which performs the adjustment of the tape in the manufacture process, has a straight groove in the upper part and the lower part has a screw tap which makes rotation adjustment possible.

The Post GUIDE Top in the GUIDE PART, guiding the tape, keeps the tape location precisely through touching the upper part of the tape when the tape travels.

The POLE BASE in the BASE PART supports other 7 parts in the above.

## 2-1-2 Trimming

A software tool called TechOptimizer from Invention Machine Corporation has been integrated into a proprietary method for creative innovation. It is used as a model and provides assistance in understanding which aspects of a product need improvement and which of the inventive principles are most applicable. Therefore, when trimming by using TechOptimizer without the essential parts, we can conclude that the new component is needed as shown in Reformation #1.

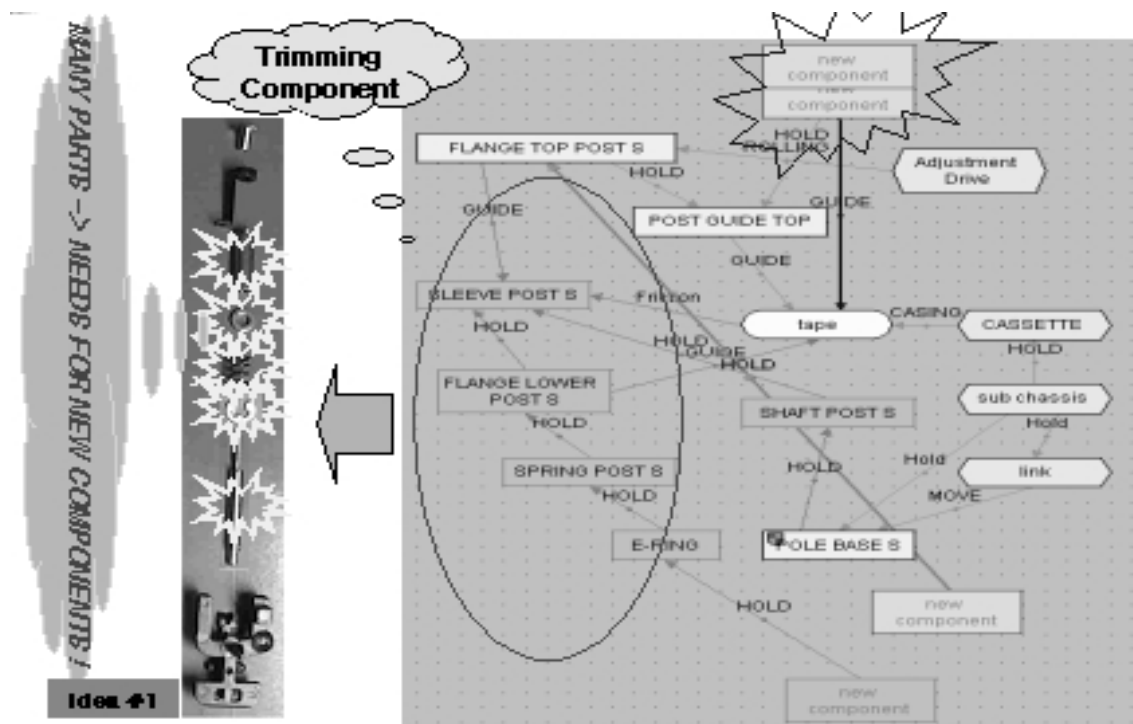


Figure 8. Trimming-pole base s assembly

## 2-2. The Analysis of the technical Contradiction.

Generic solutions at a technical level resulted in a collection of 40 inventive principles, a 39 x 39 “contradiction” matrix as well as physical resolution principles. At a system level, solutions may be derived by looking at 40 inventive principles that pertain to the overall development of engineering systems.

### 2-2-1. Define the Technical Contradiction

Through the reorganization of the problem, contradiction can be defined. In order to reduce the cost of pole base guiding tape, 4 parts of pole base need to be eliminated. However, it may cause the malfunction.

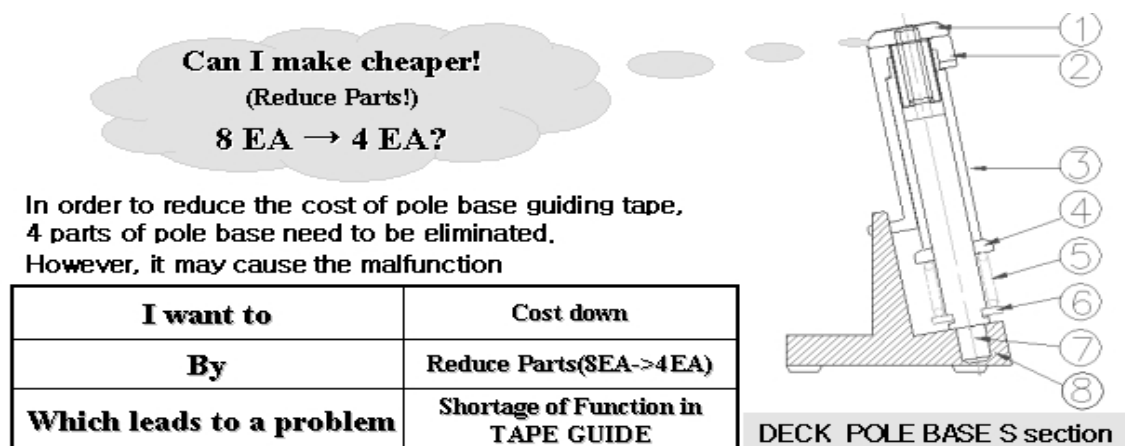


Figure 9. Technical Contradiction



### 2-2-2. A measure Reformation using the contradiction matrix.

As the definition mentioned above, 40 suitable invention principles have been found by using a chart of contradiction matrix, which fills in 39-reformation characteristics and deterioration characteristics.

A reformation characteristic is a reduction of parts, which will increase the quantity of mass.

A deterioration characteristic is a decrease in functionality, which can make persistence (lasting time of working) worse. This may cause the damage in either material or system.

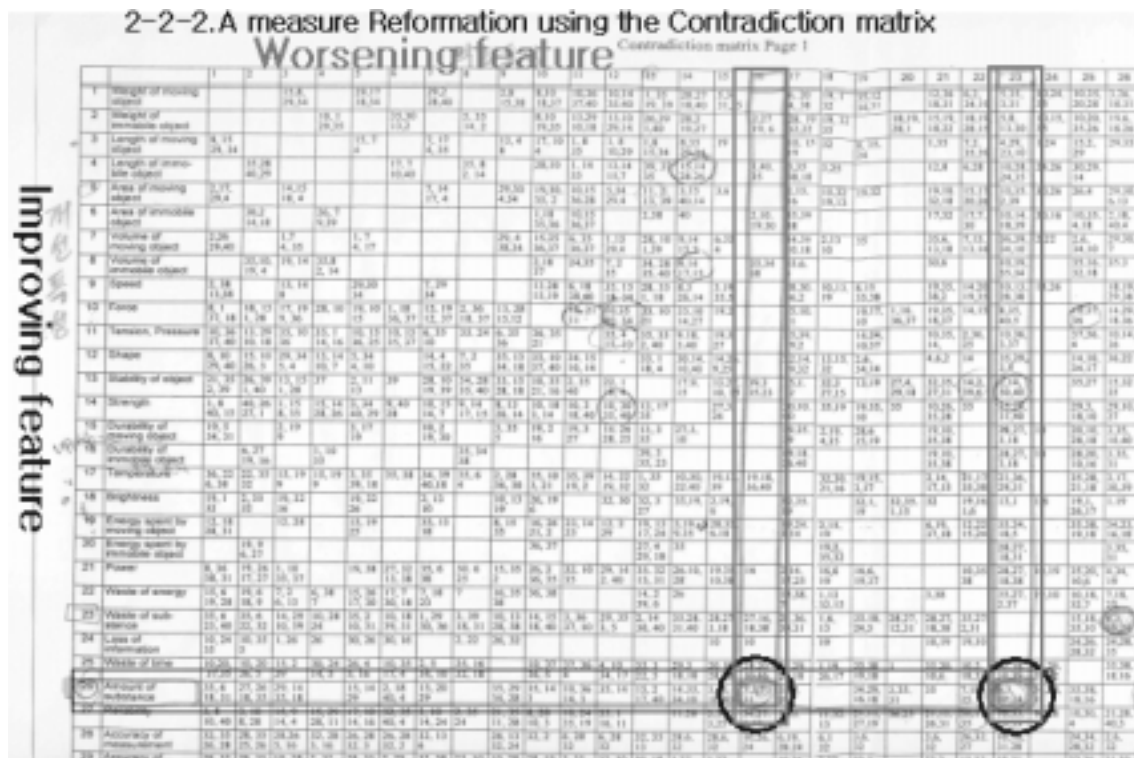


Figure 10. Contradiction matrix

The figure showed below, is a contradiction matrix chart

40 invention principles can be found at the crossing point of the reformation and deterioration characteristics in the chart.

Among 40 invention principles derived by contradiction matrix, a suitable invention principle of common theories are NO 1,2,3, for reducing the number of parts of ASS'Y from 8 to 4

In addition, the similar idea can be found by utilizing optimum solution database.

Figure 11 shows the invention principle of No 3,5,6, and Figure 12 shows an example of utilizing optimum solution in TechOptimizer data base.

- Show the invention principle of NO 3,5,6

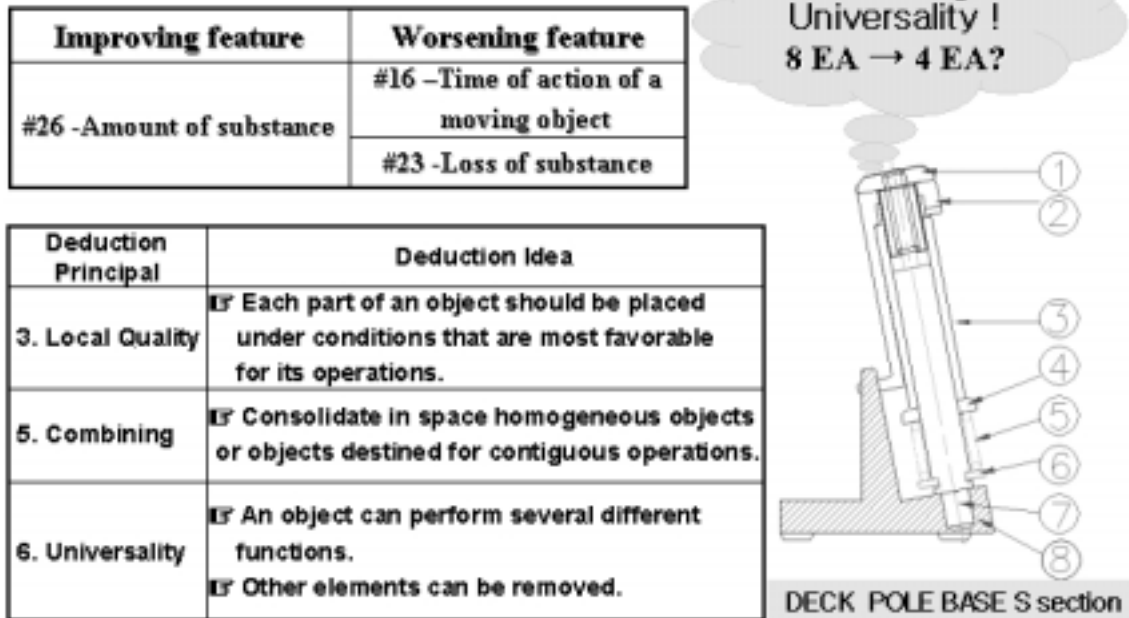


Figure 11. the invention principle

The example of combining idea found in TechOptimizer database

**Concept: Merging**

- bring closer together (or merge) identical or similar objects, assemble identical or similar parts to perform parallel operations,  
 - make operations contiguous or parallel, bring them together in time.

Previous    Next    Add concept

**Example: Drill-expansion anchor**

**Old design**

For an expansion anchor to be mounted in wood or plaster, it is first necessary to drill a hole in the material. This is inefficient because it increases the time needed for fastener mounting and requires special tooling.

**New design**

A proposed solution is to combine the expansion anchor and the drill. The expansion anchor consists of a coarse thread and a cutting tip in the form of a wood drill. The head contains a cross-shaped print for a screwdriver and a threaded hole. The expansion anchor is mounted with the help of a cross-head screwdriver. This design reduces the time needed for mounting. In addition, no special tooling is required.

France, Split BP Company, "Nauka i Technika", No.8, 1989

Figure 12. TechOptimizer-Combining idea

### 2-2-3. The improvement solution, using 40 Principles

Figure 13 shows the derivation of the solution #2 using No3, 5,6 in the Invention Principles.

#### 2-2-3. The improvement solution, using 40 Principles

1. Each part of an object should be placed under conditions that are most favorable for its operations  
=>① ② are improved,
2. Consolidate in space homogeneous objects, or objects destined for contiguous operations  
=>③ ⑦ are combined,
3. Other elements can be removed  
=>④ ⑤ ⑥ are removed,
4. An object can perform several different functions  
=>⑦ is instead of function ⑤⑥.  
=>⑧ is instead of function ④.

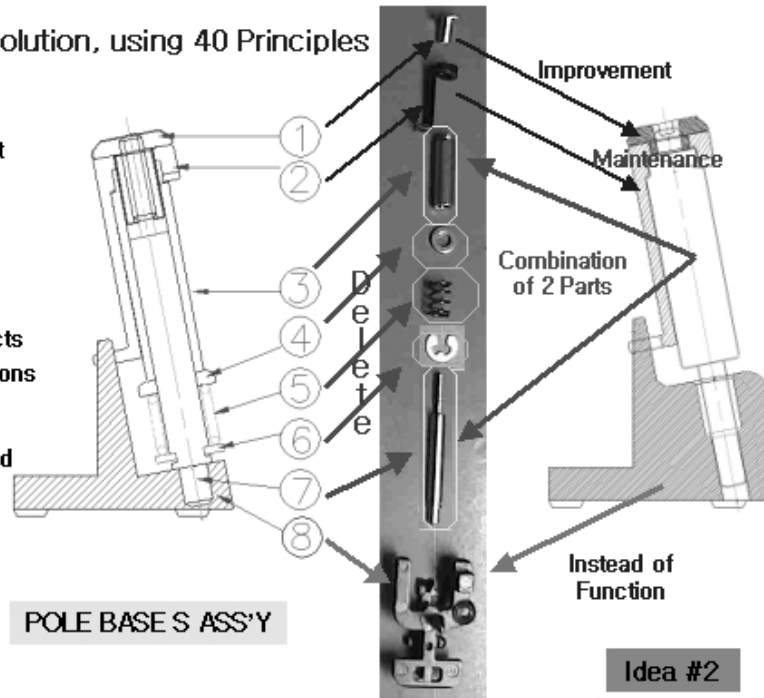


Figure 13. A measure reformation using the contradiction matrix

### 2-3. The improvement solution, using Analysis for Su-Field.

#### 1. Su-Field Analysis

Product: Magnetic Tape  
Tool: component  
(Simplified Pole Base Assy)

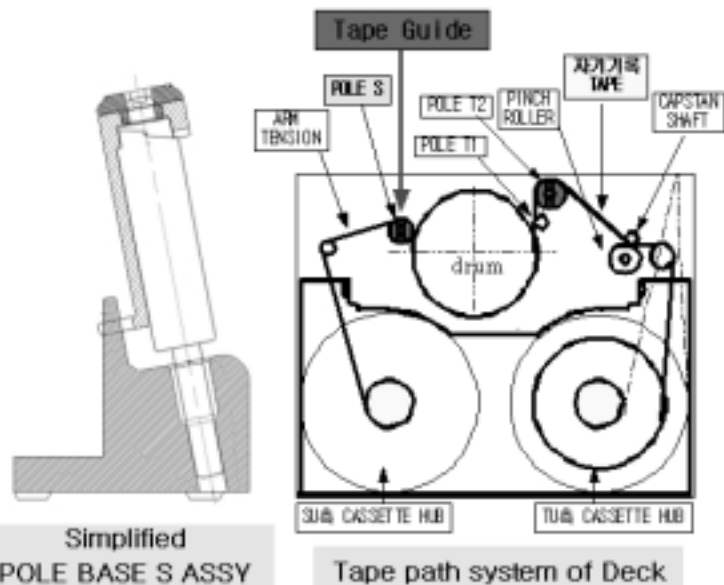


Figure 14. Su-Field Analysis

Su-Field (Substance-Field) is one of TRIZ tools to analyze problems related with existing technical systems by using Su-Field Model. In order to eliminate mental momentum from a sentence in Analysis for Su-Field, solution can be derived from depicting symbols for technical problems. Figure 14 shows how to make Su-Field model as defining product and tool.

Figure 15 is the process of deriving solution from Su-Field Model. Even though the cost of materials cut down, there is still malfunction problem guiding tape; therefore, the new system should be composed through adding the third element S3( X element).

- Tool: Components (Simplified Pole Base Assy)
- Product: Magnetic Tape

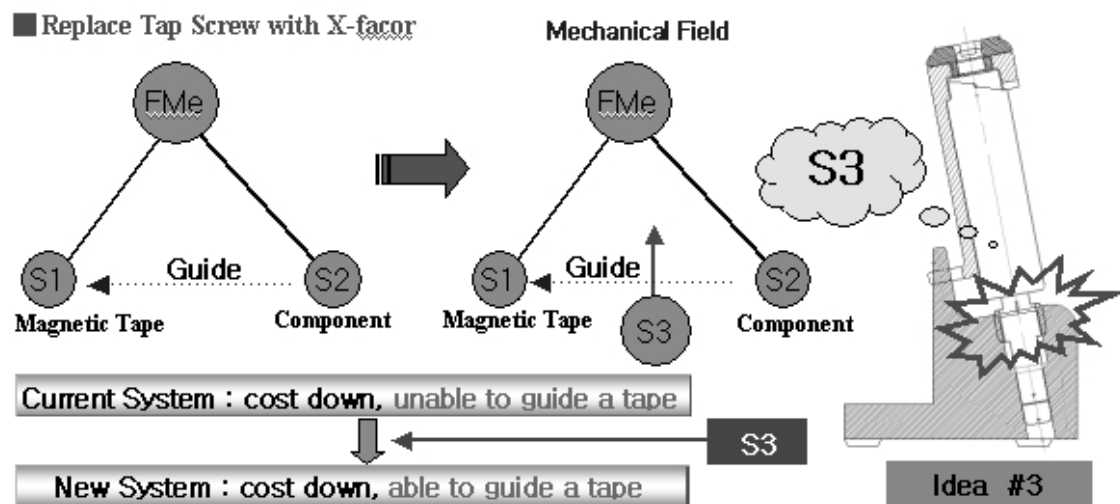


Figure 15. A measure reformation using the Su-Field Analysis

### 3. GENERATE/EVALUTE STEP

NO	Idea #	Problem	Method	Solution
1	Idea #1	Function Analysis	Trimming	Delete 5 components +Induction of new factors
2	Idea #2	Technical Contradiction	40 Inventive Principles	improvement+merging+removal: Delete 4 components
3	Idea #3	Field Model	Mechanical Field	Induce Idea#2 + S3

Figure 16. List of solution

Figure 16 is the list of solution through analyzing steps so far. From the Function Analysis (2-1. Trimming), the reformation is three existing essential parts plus new component. On the other hand, through analyzing technical contradiction (2-2), the reformation is to eliminate four parts. From the analysis for Su-field, the reformation #3 derives through adding the third element in reformation #2. The generate and evaluate step is to evaluate the reformations whether they are practical solutions for application. Figure 17 is the constructed solution. As shown in Figure, the solution is the combination of the reformation #2 and reformation #3; however, the reformation #1 resulted in the motive to derive the reformation #2.

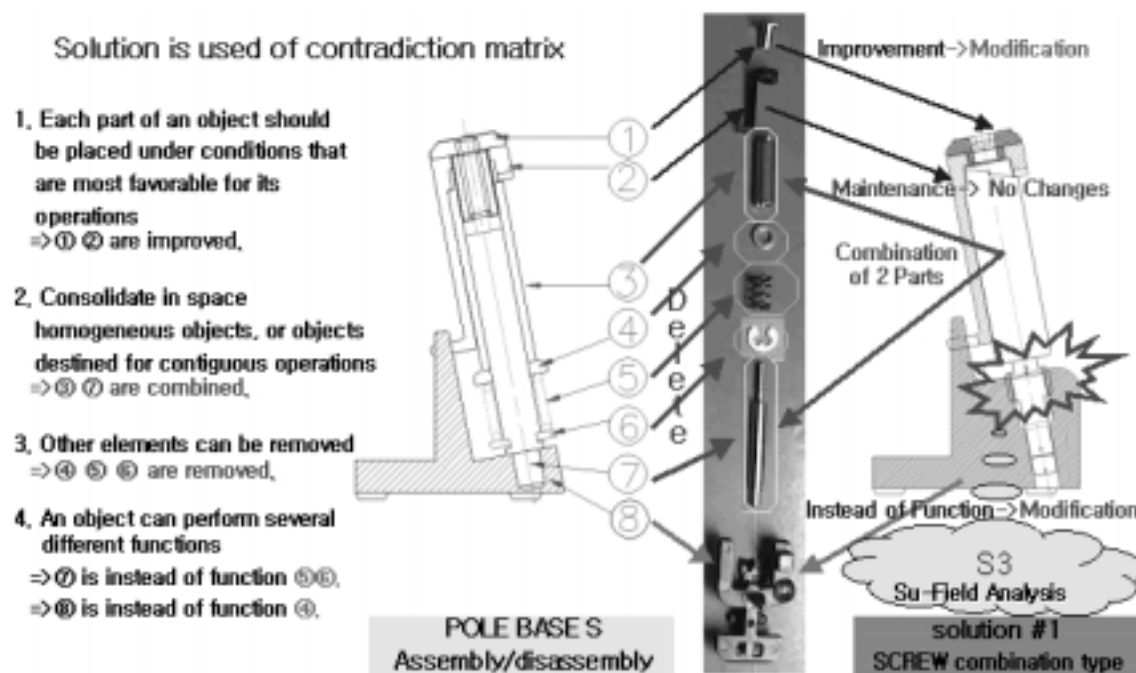


Figure 17. solution

Figure 18 is the result of reformation. Firstly, the result was screw combination type; however, in this paper it was omitted to mention..

No.	Solution	Necessary Time	Necessary Sum	Possibility	Patent	Remark
1	SCREW combination type	3 Months	Nothing	Application in Future	Patent pending	Difficult to manufacture (SUS=>Brass + Nickel Plating)

Figure 18. List of solution

## 4. VERIFY STEP

The last stage of TRIZ solution is to check the reformation is satisfactory and how many patents are. Finally, the project ends with summing up the final conclusion. Unless the final settlement has been reached without friction, the extra solution can be added more.

### 4-1. Results for verifying

As figure 19, the result of examining production is ok if both examination of parts and the status of SET test are ok.

No.	Solution	Results
1	SCREW combination type	1. (SUS→ Brass + Nickel Plating) Verification : OK. 2. Quality Assurance Test Verification Completed (2003.9.30) 3. Productivity Verification : LINE Adjustment Test Completed (n=200) . 4. Pole Location Test Result : No Changes when rotates 90 Degree. 5. 6 Sigma Application Completed

Figure 19. Results for verifying

### 4-2. Results for applying patents

As Figure 20, three patents are applied for POLE BASE.

Three Patents Were applied!	1. Pole Base Equipment for Camcorder (Structure Simplification) 2. Pole Base Equipment for Camcorder (one body type SLEEVE) 3. Pole Base Equipment for Camcorder (Elimination of lower guide)
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Figure 20. Results for applying patents

## SUMMARY

This project figured out reducing the cost of parts in DECK Mechanism related with operating Tape in widely used camcorder by using TRIZ method. As reducing 4 parts from 8 parts in POLE BASE S Assembly, one of parts in DECK Mechanism, the malfunction solved out by using TRIZ method, the cost of materials are 38 % down from \$0.32 to \$0.20 and the production increased 50 % more. Moreover, three patents related to POLE BASE S already have been submitted. Through Function Analysis (Trimming), Technical Contradiction, and Analysis for Su-Field in TRIZ Tool, the

settlement is reformatted; furthermore, through inspecting and verifying the production and progressing mass-production with one part, the cost of materials cut down \$150,000 a year.

1) The project result (Figure 21)

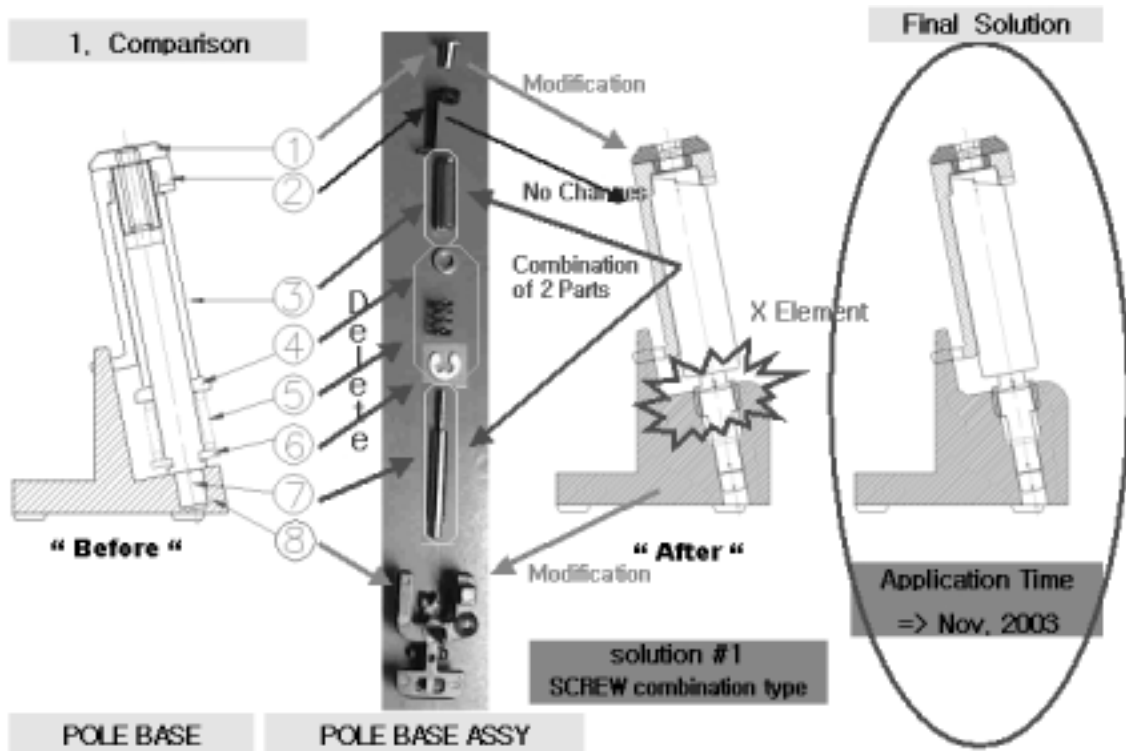


Figure 21. Porject Results

2) Comparing POLE BASE S before and after improvement( Figure 22)

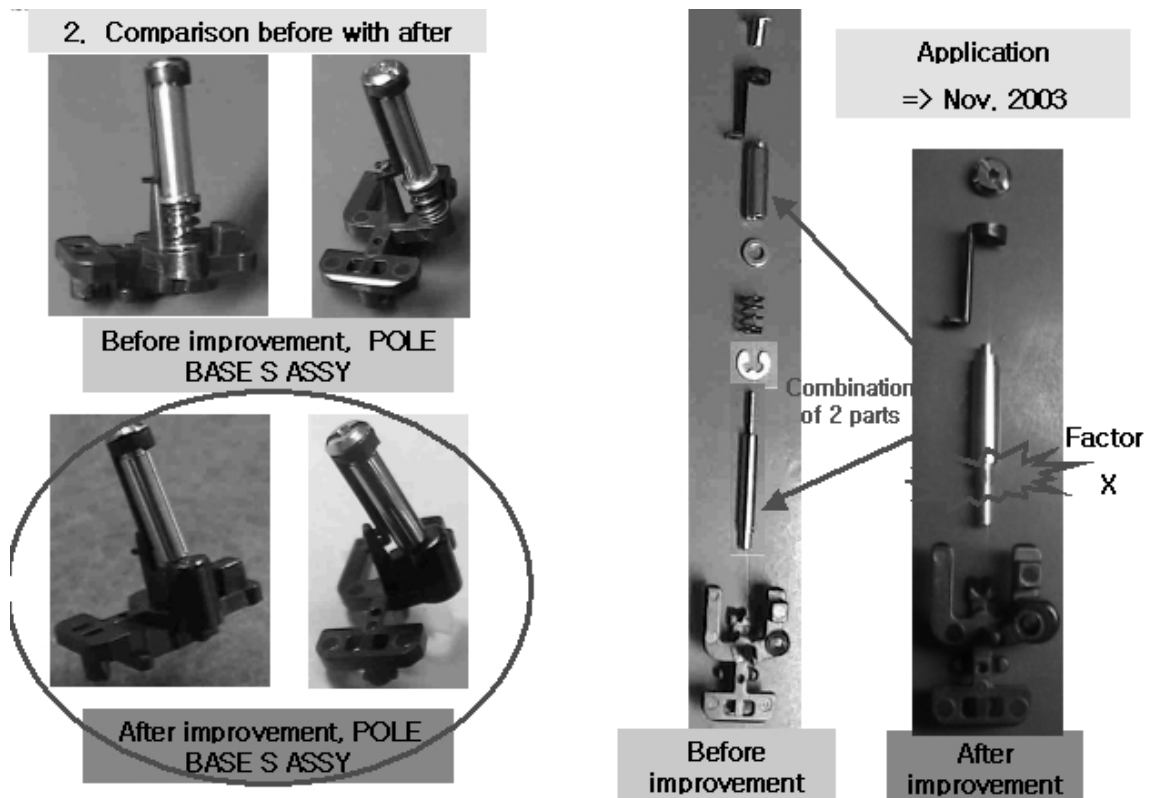


Figure 22. Comparing POLE BASE S before and after improvement

3) The effect of reducing the cost of materials (\$150,000 / year)(Figure 23)

NO	Components	FUNCTION	Previous Costs	Improved Costs	Differences	Remarks
1	FLANGE TOP POST S	ADJUSTMENT			W20	Improvement
2	POST GUIDE TOP	TAPE UPPER GUIDE			-	Common Parts
3	SLEEVE POST S	TAPE FRONT GUIDE			-	Merging
4	FLANGE LOWER POST S	TAPE LOWER GUIDE			W20	Elimination
5	SPRING POST S	TORQUE OCCURENCE			W10	Elimination
6	E-RING	SPRING STOPPER			W5	Elimination
7	SHAFT POST S	SLEEVE GUIDE SHAFT			W85	Elimination
8	POLE BASE S	BASE PART			-	Modification
9	Assembly Costs	7 Process→3 Process			W15	Reducing
10	Inspection Costs	2 Process			-	The Same
11	Profits	-			-	The Same
Sum of Parts					¥12.9	\$150,000

■ Financial Effect : \$ 200,000

1) Reduction of Material Cost: \$150,000 ( ¥12.9 X 1,200,000 SET)

2) Improvement of Productivity 50%: \$15,000 (Manufacturing Process Time:50 sec→25 sec)

3) Improvement of Inferiority Rate 70%: \$35,000 (90 Degree Rotation Inferiority:15%→5%)

Figure 23.The effect of reducing the cost of materials



## CONCLUSION

### 1. Project Results

- Application: solution#1(By testing idea #2,3)
- Schedule: Nov. 2003
- Patent : 3 patents in Oct 2003

### 2. Project Effects

- Initial goal: \$100,000
- Financial Effect: \$200,000

1) Decreasing Material Cost: \$150,000 (  $\phi ? - \phi ? = \phi 12.9 \times 1,200,000 \text{ SET}$  )

2) Improving 50% of Productivity: \$15,000

(Manufacturing Process Time: 50second → reduced to 25 second)

3) Inferiorty rates 70%: \$35,000 (90 Degree Rotation Inferiorty: 15% → 5%)

### 3. Impression and Plan

- Impression : TRIZ gave me the logical thought for invention and several solutions from tool and database.
- Plan : I want to make marvelous and financially successful inventions by using TRIZ.