Solving Problems Using TOP-TRIZ

Zinovy Royzen,
TRIZ Master
President, TRIZ Consulting, Inc.
Seattle, Washington
Tel: (206) 364-3116
zroyzen@trizconsulting.com
http://www.trizconsulting.com

Abstract

The author describes two cases he solved for his customers and techniques used in these TRIZ applications.

One of the described problems took a team six months until it decided to look for a help. Using TRIZ, the problem was solved in 15 minutes. Another problem delayed new product development for more than a year. It was solved at the first day of TRIZ facilitation.

The paper describes the methods used in the cases including the author's Tool-Object-Product (TOP) Function Modeling, some Standard Techniques and Conflict Solving Algorithm.

The paper also describes author's experience in teaching TOP-TRIZ.

What is TOP-TRIZ?

TOP-TRIZ is a further development of Classical TRIZ. It includes further development of problem formulation and problem modeling, Standard Solutions, ARIZ and Laws of Evolution of Technical Systems. It has integrated TRIZ methods into a user friendly system of analytical thinking.

Classical TRIZ

Genrich S. Altshuller, the creator of the Theory of Inventive Problem Solving, stopped development of TRIZ Methods to solve technical problems in 1985. His last version of TRIZ known as Classical TRIZ. It includes the following methods.

- Substance-Field Analysis
- 76 Standard Solutions
- Algorithm for Inventive Problem Solving (ARIZ)
- Laws of Evolution of Technical Systems

Some people include also 40 Inventive Principles and Contradiction Matrix, the earliest version of TRIZ, even though Altshuller did not mention them in his last technical book titled *To Find an Idea*.

Classical Substance-Field Models

Altshuller's Substance-Field model of the simplest system is composed of three elements — the two substances and a field.

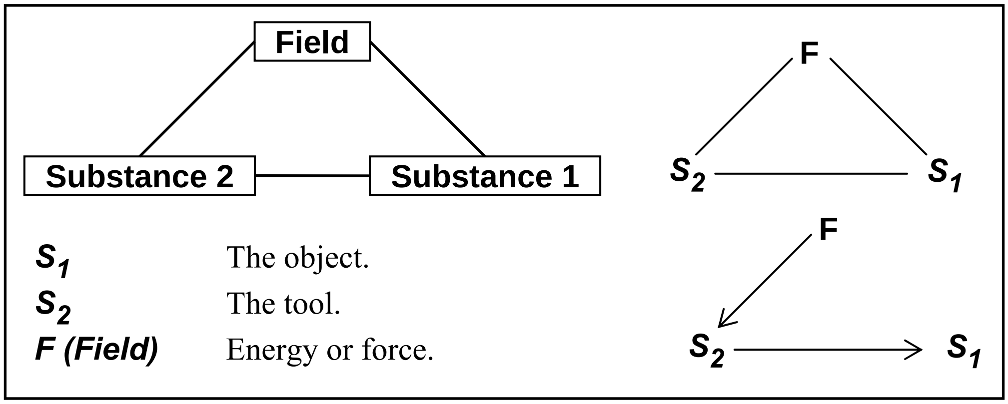


Figure 1: Models of the simplest useful system

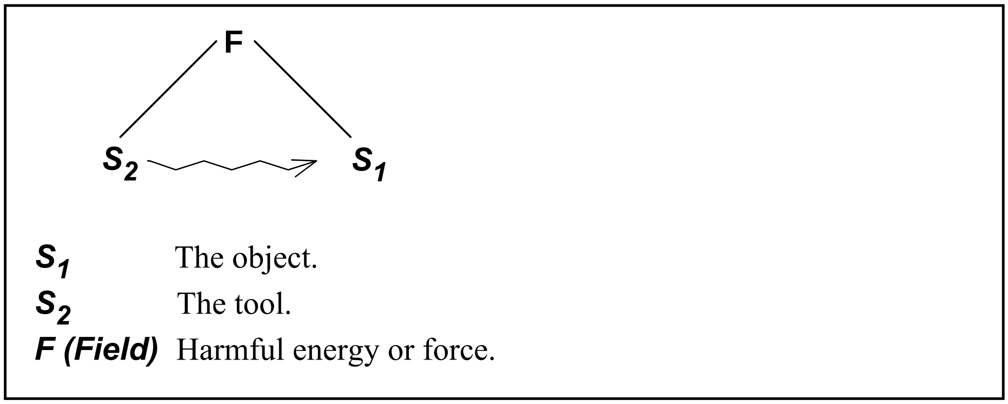


Figure 2: Model of the simplest system having a harmful action

Substance-Field Models describe models of the systems rather than functions.

Tool-Object-Product (TOP) Function Analysis

Tool-Object-Product (TOP) Analysis, the next generation of Substance-Field Analysis, was developed by Zinovy Royzen in 1989. The simplest useful function has four components. It has the tool of the function (or the function provider), the object of the function (or recipient of the action of the tool), the action of the tool at the object, and one more component — the product of the function. The useful function of the tool is to obtain the product of the function from the object. The action is described by one arrow, which simplifies the model.

$$T \xrightarrow{F} O \Rightarrow U.P.$$

O	The object of the useful action
T	The tool of the useful action
F (Field)	Energy or force, or description of the useful action
U.P.	A useful product.

Figure 3. TOP model of a useful function

$$T \overset{F}{\rightsquigarrow} O \Rightarrow H.P.$$

O	The object the harmful action
T	The tool of the harmful action
F (Field)	Energy or force, or description of the harmful action
H.P.	A harmful (unwanted) product or products

Figure 4: TOP model of a harmful function

Very often a useful action also causes an unwanted effect, or an attempt to improve a function leads to deterioration in another function of the system. Conflicts are the most difficult type of problem in innovation. TRIZ offers models to describe any type of conflict.

$$\begin{tikzcd} T \arrow[r, shift left, "F_u"] \arrow[r, squiggly, shift right, "F_h"'] & O \end{tikzcd} \begin{array}{l} \Rightarrow U.P. \\ \Rightarrow H.P. \end{array}$$

O_1	The object of the useful and the harmful function
T	The tool of the useful function
F_u	Energy or force, or description of the useful function
F_h	Energy or force, or description of the harmful function
U.P.	A useful product.
H.P.	A harmful (unwanted) product or products

Figure 5: TOP model of a conflict

Modeling a function by describing all four components — the tool, the object, the action, and the product — improves understanding of both the function and the best ways for its improvement.

Advantages of TOP Function Modeling:

- **Universal Model of a Function**
  Neither the tool of the function nor the object of the function has to be a substance. TOP Function Modeling allows you to model any function in any system. It is a more generic way to model a function than Substance-Field Modeling.

- **Complete Description of a Function**
  Desired and unwanted products of the functions of a modeled system improve understanding of the system and simplify analysis of the system resources.

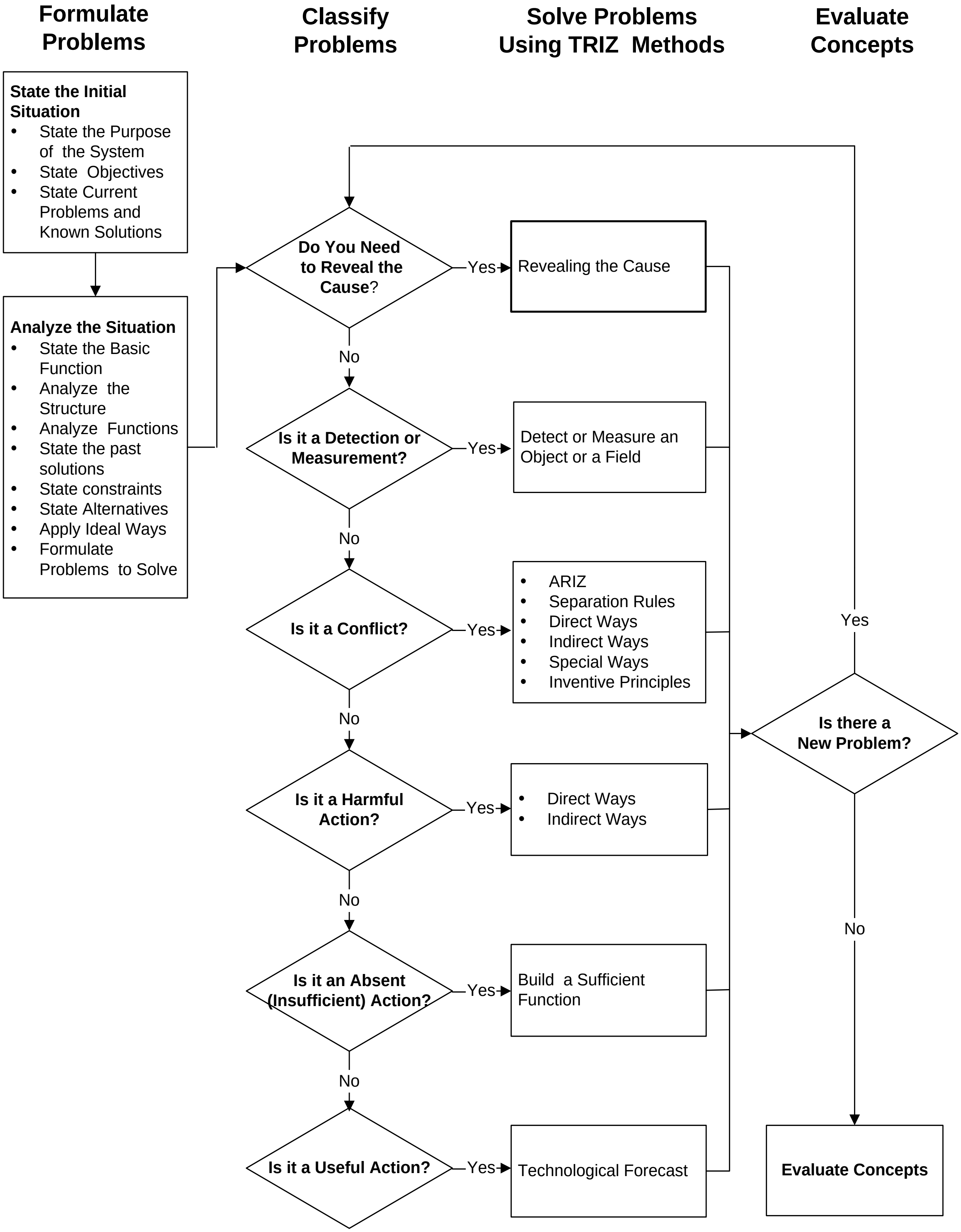
- **Link Between Functions**
  Introducing the product of a function into its model provides a very convenient and understandable link between functions. For example, a product of the first function can be a tool or an object of a subsequent function.

  The link between functions is important in understanding not only a desired performance of a product, but also the chain of unwanted functions. Links between functions simplify cause-effect analysis and improve the process of revealing the cause of a current or potential failure of a product.

- **Increasing Effectiveness of Function Analysis**
  Function analysis guides you in decomposing the performance of your product into single functions — both useful and unwanted. The system approach guides you in describing the function of the supersystem of your product and interactions between the product and its supersystem. It also guides you in analyzing and describing interactions between the product and its surroundings that are not part of the supersystem. Then a single function can be considered separately if it needs improvement.

Function modeling helps you to understand the system's performance, state the set of problems to consider, classify the problems, and determine the TRIZ Methods to be applied according to the TOP-TRIZ Flow Chart.

TOP-TRIZ Flow Chart



Ideal Ways is an analytical method made up of the ideal directions for improving a function. It is a part of problem formulation. Ideal Way 1, for example, guides you in stating problems related to the possibility of elimination of the function and its tool. The TOP model of the analyzed useful function provides the possible ways — eliminating the need for the product of the function or eliminating the object of the function.

Standard Techniques

TRIZ Standard Techniques is a further improvement of Standard Solutions, developed by Zinovy Royzen. Standard Techniques are step-by-step guides for applying generic solutions to your problem and developing specific solutions by utilizing the resources of the system, its supersystem, and its environment.

Integration of TRIZ Methods allowed separating of all Standard Solutions based on applications of Laws of Evolution into separate class called Technological Forecast in the TRIZ Flow Chart.

Integration of TRIZ Methods allowed simplifying a TRIZ method to reveal the causes of a failure so that the method was included it in Standard Techniques.

Sub-classes of Standard Solutions of Class 1 were separated to simplify problem classification and determination of the corresponding Standard Solutions.

Some Standard Solutions were reformulated. Some new Standards for eliminating harmful functions were added.
Standards solutions were supplied with step-by-step checklists.

Standard Techniques for eliminating harmful functions include the following.

Direct Ways

Six Direct Ways provide a set of generic techniques for preventing an unwanted function from producing its unwanted product.

Indirect Ways

Indirect Ways is a set of techniques for bypassing an original problem.

- Techniques for removal of the tool of a harmful function
- Techniques for removal of object of a harmful function
- Technique for elimination the cause of a harmful function
- Techniques for elimination of the consequences of a harmful function
- Techniques for converting a harmful function into a useful function

Further Development of ARIZ

Integration of ARIZ and initial function analysis of a system has improved conflict definition and eliminated repetition. TOP function modeling improves understanding of the conflict, its opposite versions, the function of X-resource and its product. One of the most difficult steps in ARIZ – formulation of the physical contradiction — is simplified significantly. Techniques for Physical contradiction separation are reformulated and an additional technique was added.

Integration of TRIZ Methods allowed reducing the number of steps in ARIZ and improving its effectiveness.

Case 1. Plating Steel Rods and Pipes with Aluminum

Background of the problem

An old system for plating steel rods and pipes with aluminum included a well in the ground of a shop filled with molten aluminum at 700-740 C and a conveyer moving steel pipes and rods.
Preheated pipes and rods were submersed into molten aluminum for a short period of time and then removed with a coat of aluminum which protects steel pipes and rods against corrosion.

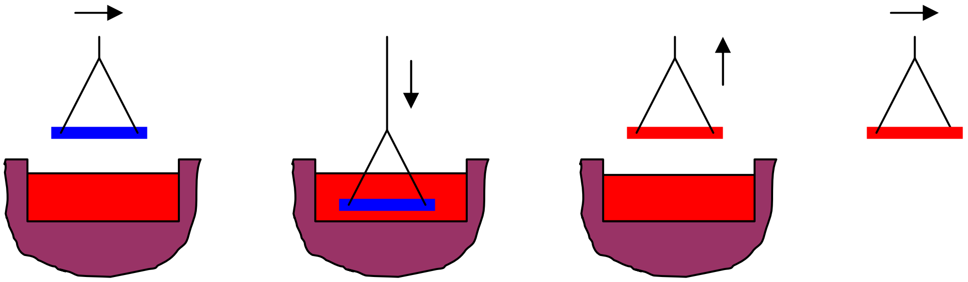


Figure 6: Old process of plating steel rods and pipes with aluminum

A new system for plating steel rods and pipe with aluminum was developed in order to increase the rate of production.

The new system includes a tube and two pumps utilizing the magnetohydrodynamic (MHD) phenomenon. When a magnetic field and an electric current intersect in a liquid, their repulsive interaction propels the liquid in a direction perpendicular to both the field and the current.

The pumps keep molten aluminum in the tube, and a rod passing through the tube is plated with aluminum.

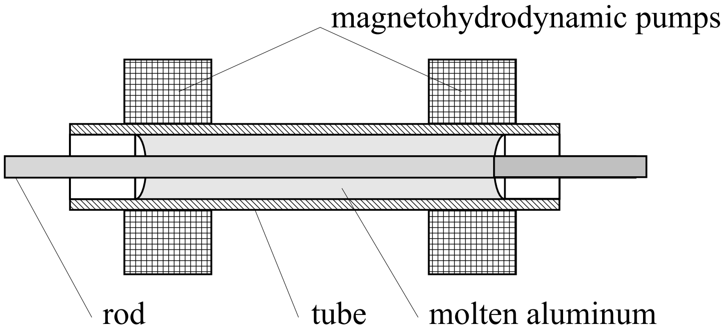


Figure 7: Plating steel rods

The test of the new system was a success for plating rods.
Strait line motion of the rods increased productivity of the process. In addition, the new system removed excess of aluminum, decreased loss of aluminum due to oxidation, decreased energy loss and improved the shop environment.

However, there was a problem with plating pipes. High temperature (700-740 C) molten aluminum was pumped out of the tube through the pipe inserted in the tube.

The cause of the failure was understood. A steel (ferromagnetic) pipe does not allow a magnetic field to pass through it, thus there are no forces to keep molten aluminum inside.

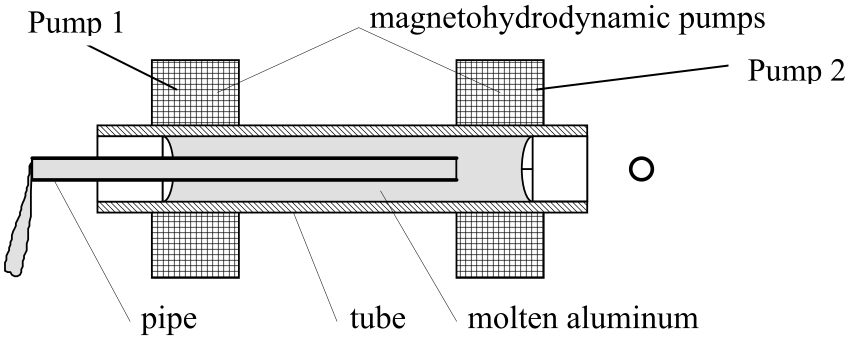


Figure 8: Plating steel pipes

The pipes have to be plated outside and inside.

After working on the problem for a half a year, Dr. Verdirevsky who led the development of the system in Moscow called to the author with invitation to help him and his team.

He explained the problem and ideas his team had developed. Some of ideas related to collecting aluminum from the pipe and returning it back to the system. Other ideas suggested sealing the pipes for plating the outside surface and different methods of plating the inside of the pipes.

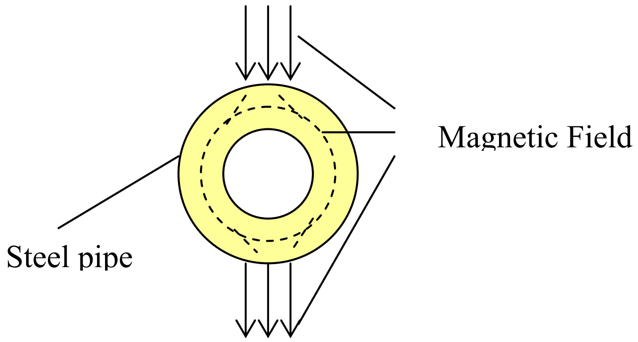
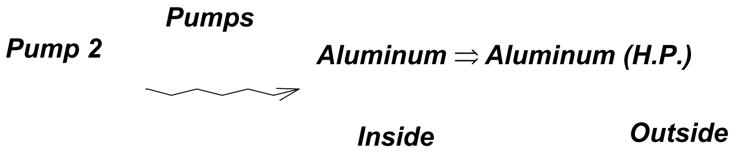


Figure 9: There is no magnetic field inside a steel pipe

TOP Function Modeling

Pump 2 pumps molten aluminum out from the pipe.



The harmful function is caused by disabling the pump 1 to hold aluminum.

Pump 1 is unable to hold aluminum because a steel pipe blocks magnetic field.

According to Altshuller, Substance-Field model has to have two substances and a field. This approach limits function modeling.

TOP Function Modeling can be used to describe any function.

From TOP Function Modeling became the root cause of the problem.

It is a harmful function and we need to apply techniques for harmful function elimination.

In classical TRIZ, Altshuller combined his standard solutions to build Su-Field Models and to destroy Su-Field Models in one class of Standard which complicate the flow chart of using standards.

Class 1. Building and Destroying Substance-Field Models

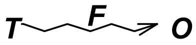
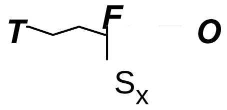
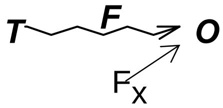
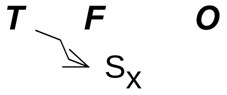
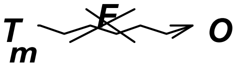
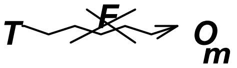
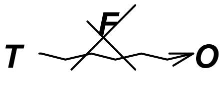
The class offers

1.1 Building a Su-Field Models
1.2 Destroying Su-Field Models

1.2.1 Elimination Harmful Interaction by Introducing S3
1.2.2. Elimination Harmful Interaction by Introducing Modified S1 and/or S2.
12.3. “Drawing Off” a Harmful Action
1.2.4 Counteracting a Harmful Function with F2
1.2.5 “Switching Off” a Magnetic Influence

Steel Pipe $\rightsquigarrow$ ***Magnetic Field*** ⇒ ***Magnetic Field (H.P.) Blocked***

Direct Ways

Problem ➡ Solution	Description
There is a harmful action on an object O Eliminate the harmful action 	
 S_x =?	Insulate O from the harmful action by a substance-insulator S_x.
 F_x =?	Counteract the harmful action with the opposing field F_x.
 S_x =?	Protect O from the harmful action by a safety substance S_x which attracts the harmful action on itself.
 T_m=?	Modify the tool (source) of the harmful action T to turn off the harmful action. **It was recommended to heat pipe over its Curie temperature which is 770 C.**
 O_m=?	Modify O to be non sensitive to the harmful action.
	Alter the amount of the zone of the harmful action, its duration or both to decrease the harmful action or eliminate it completely.

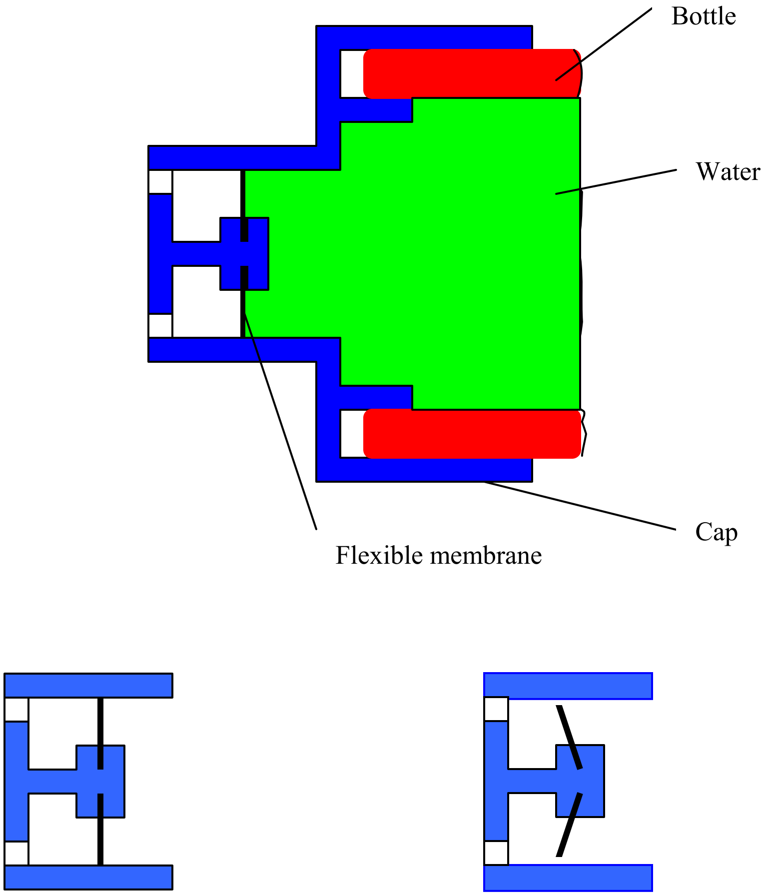
Case 2. Water Bottle Cap Problem

A water bottle cap which avoid the need for manual positioning of the valve and which permits dispensing water by application of suction, should open easily at suction pressures less than -0.38 psi.

The problem is that under normal use, sometimes internal container water pressure can be greater than 0.38 psi, and thus the valve can leak water.

Also, water has to be released by squeezing the bottle with pressure applied to the valve not less than, for example, 1 psi.

What should be done?



Valve closed

Valve opened

Figure 10: Water bottle cap with a flexible membrane

Initial Situation

1. The purpose of the system is to seal water in the bottle and release water by sucking.

2. The objective of the project is to design a closure that meets the following requirements.
    - One hand bottle use
    - Opening the valve by sucking with ΔP not more than 0.38 psi
    - Dispensing water by squeezing the bottle.
    - No leakage

3. Current problem. Valve designed for easy opening by sucking leaks under normal conditions of use.

4. State known solutions. State advantages and disadvantages of known solutions.

    - Push to open valve. Eliminates leakage. It takes two hands to operate.
    - Twist to open valve. Eliminates leakage. It takes two hands to operate.
    - "Stiff " Valve. Eliminates leakage. It does not open by sucking.

Analyze the Situation

1. The basic function of the system is to seal and dispense water.

2. Describe the system, supersystem and environment.

The system:

Cap

- Case
- Stem
- Valve

Water Bottle

Water

Air in the bottle

The supersystem:

Customer

The environment:

Air

Outside Forces

3. Analyze functions and formulate problems.

The Current Problem (Problem 1)

Water leaks through the cap under normal conditions of use because ΔP applied across the valve could be more than 0.38 psi.

Model of the harmful function.

Lets
Valve ⇝ ***Water*** ⇒ ***Water***
Open ***Inside*** ***Outside (leakage)***

Problem 2.

The Problem 1 is caused because the Valve is opened.
Model of the harmful function.

Pressures
Water ⇝ ***Valve*** ⇒ ***Valve***
Pressurized ***Closed*** ***Opened***

The harmful function is caused because water in the bottle is pressurized by an outside force. However, the valve was designed to be opened when 0.38 psi applied across it.
The open valve causes leakage of water.

The useful functions of the valve are to open and to seal water.

1. The function of the valve is to open water.

Model of the function.

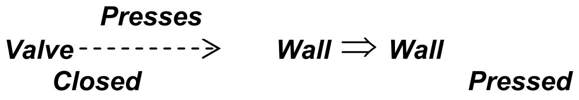
Lets
Valve ⟶ ***Water*** ⇒ ***Water***
Open ***Inside*** ***Outside (dispensed)***

In order to perform the function there is a need to apply suction with *ΔP=0.38 psi*.

2. The function of the valve is to seal water.
Model of the function.

Seals
Valve - - - - - - - - -> ***Water P*** ⇒ ***Water P***
Closed ***Sealed (does not leak)***

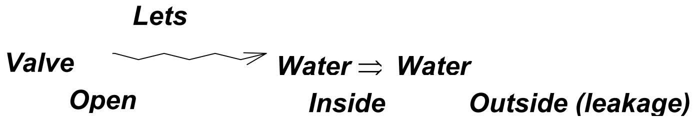
It is also possible o say that the function of the valve is to press the wall in order to seal water.



The function is insufficient. The valve is flexible in order to open it easily. A known solution is to make it "stiffer."

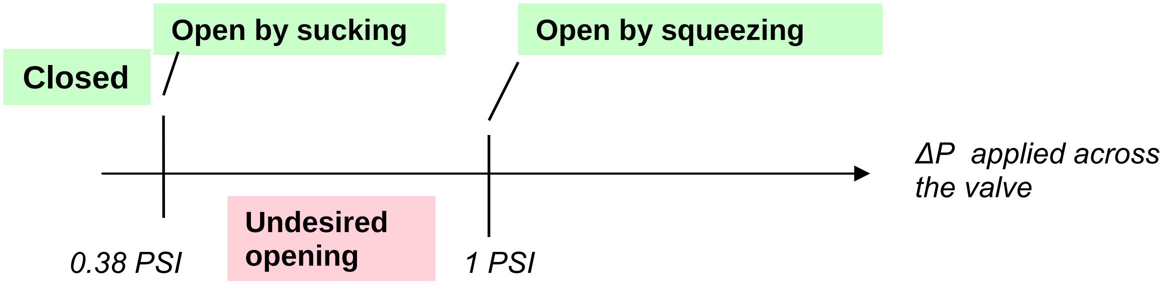
List of Problems

Problem 1.



Problem 2.

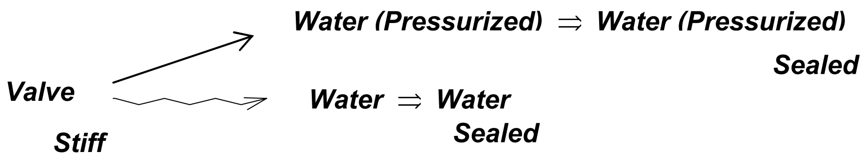
Problem 2 is the proffered problem to start.



Known Solution

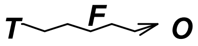
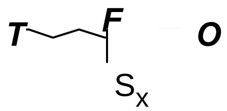
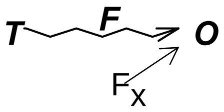
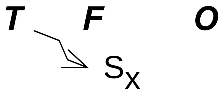
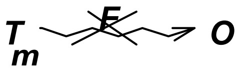
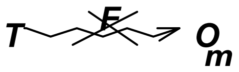
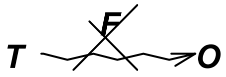
A "stiff" valve eliminates leakage by sealing water; however, water will be sealed even when suction is applied.

Problem 3. Conflict



Problem 2

Direct Ways

Problem ➡ Solution There is a harmful action on an object O Eliminate the harmful action 	Description
 S_x =?	Insulate O from the harmful action by a substance-insulator S_x.
 F_x =?	Counteract the harmful action with the opposing field F_x.
 S_x =?	Protect O from the harmful action by a safety substance S_x which attracts the harmful action on itself.
 T_m=?	Modify the tool (source) of the harmful action T to turn off the harmful action.
 O_m=?	Modify O to be non sensitive to the harmful action. *A stiff valve.* *Problem 3.* *A stiff valve will not be opened by sucking.*
	Alter the amount of the zone of the harmful action, its duration or both to decrease the harmful action or eliminate it completely. *In order to reduce total amount of the harmful action we need to decrease the area of the valve exposed to water.* *Problem 4. A smaller area of the valve exposed to water will not be sufficient to open the valve by sucking.*

According to Direct Ways, there are two solutions to Problem 2.

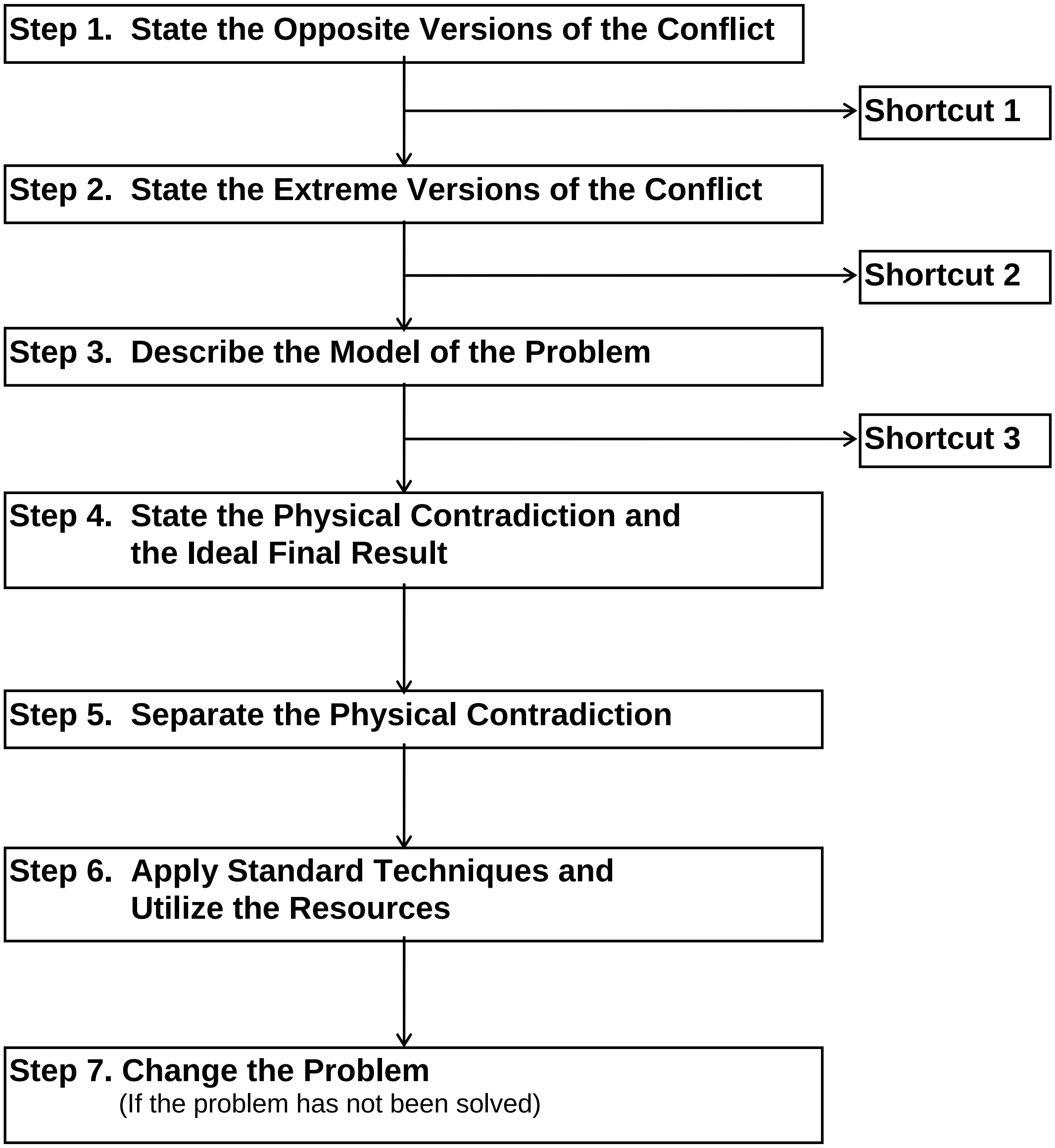
A. A stiff valve. This solution causes a new problem. A stiff valve will not be opened by sucking.

B. A smaller area of the valve is exposed to water. This solution causes a new problem. The valve will not be opened by sucking.

An attempt to solve this problem improves understanding of the physics involved.

Problem 3. Conflict

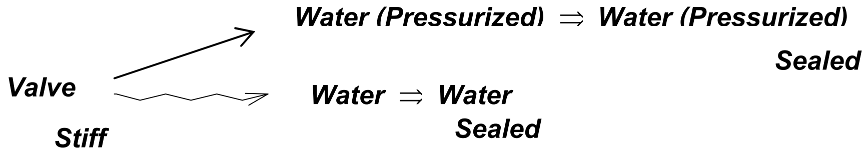
ARIZ Flow Chart



Algorithm for Inventive Problem Solving

Step 1. State the Opposite Versions of the Conflict

- The system for sealing and dispensing water includes a ~~valve~~ ***Membrane***, water and pressurized water.
  Model of the conflict.



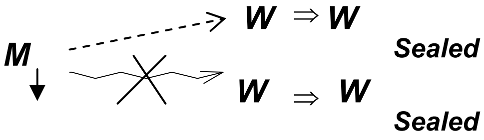
- **State the Opposite Versions of the Conflict**

Conflict 1.

In order to dispense water by sucking

the membrane has to be flexible

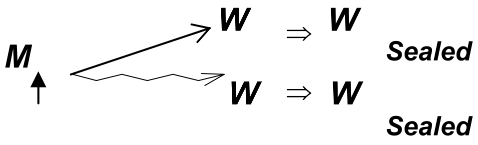
but it does not seal pressurized water.



Conflict 2.

In order to seal pressurized water

the membrane has to be stiff
but it will not dispense water by sucking.



- A minimum alteration of the system has to provide dispensing water by sucking and sealing pressurized water without any complication or deterioration of the system or anything else.

- Shortcut 1. Separate Preliminary Physical Contradiction 1.
  The membrane has to be flexible and stiff.

1. Separation in Space
2. Separation in Time
3. Separation Between the Components
4. Separation Between the Components and the Set of the Components
5. Separation Between Parameters

Separate the Physical Contradiction

The valve has to be flexible to be opened by sucking and has to be stiff in order to prevent its opening by pressurized water.

Separation in Space

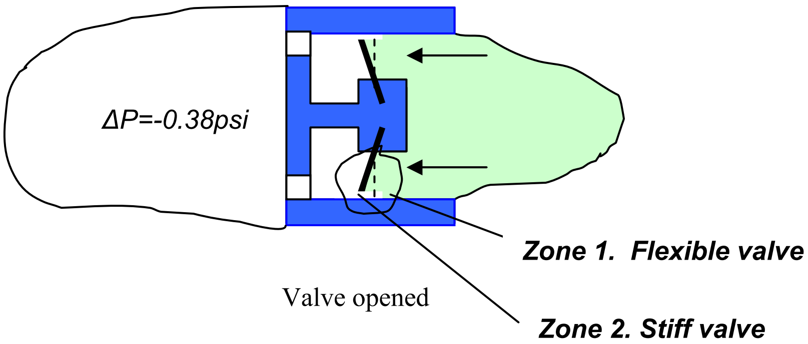
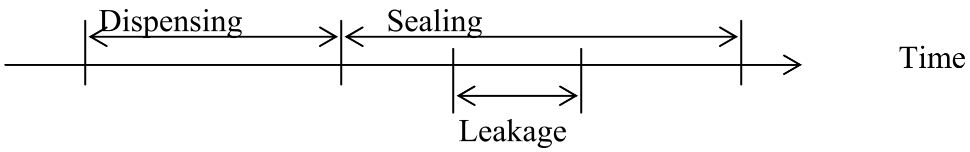


Figure 11: Water bottle cap

Separation in Time



Separation Between the Components

Two valves. Existing valve has to be flexible. A new valve has to be stiff.

Separation Between the Components and the Set of the Components

Both valves are flexible. The system of flexible valves is stiff.

Separation Between Parameters

Opening of the valve depends on the force applied to the valve.

$$F = \Delta P \text{ x } Area$$

Another way to analyze the situation is the following.

$$\textbf{Sucking Air-Water} \xrightarrow{\textbf{Pressures}} \textbf{Valve} \Rightarrow \textbf{Valve}_{\textbf{Opened}}$$

$$\textbf{Air-Pressurized Water} \overset{\textbf{Pressures}}{\rightsquigarrow} \textbf{Valve} \Rightarrow \textbf{Valve}_{\textbf{Opened}}$$

The valve is opened when ΔP =0.38 psi applied across it. Even though the tools of the functions are different, the ΔP is the same.

From this point of view the following conflict can be stated.

$$\begin{tikzcd}
 & & \textbf{Valve}\ \textbf{Opened (for dispensing)} \\
\underset{\textbf{0.38 psi}}{\Delta P} \arrow[r, shift left] \arrow[r, squiggly, shift right] & \textbf{Valve} \arrow[ur, Rightarrow] \arrow[dr, Rightarrow] & \\
 & & \textbf{Valve}\ \textbf{Opened (leakage)}
\end{tikzcd}$$

Algorithm for Inventive Problem Solving

Step 1. State the Opposite Versions of the Conflict

- The system for sealing and dispensing water includes a ~~valve~~ **Membrane** and the pressure across the valve.

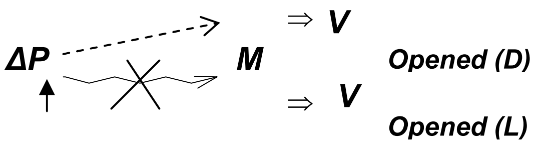
- Model of the conflict.

$$\underset{\textbf{0.38 psi}}{\Delta P} \;\overset{\longrightarrow}{\rightsquigarrow}\; \textbf{Membrane} \Rightarrow \underset{\textbf{Opened (leakage)}}{\overset{\textbf{Opened (for dispensing)}}{\textbf{Membrane}}}$$

- **State the Opposite Versions of the Conflict**

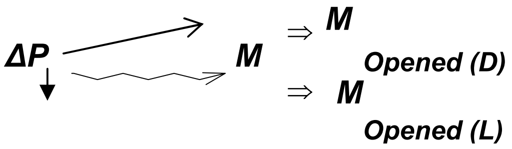
Conflict 1.

In order to eliminate opening of the membrane (leakage) the ΔP across the membrane has to be increased, but the membrane will not be opened by sucking.



Conflict 2.

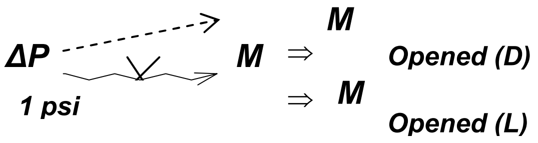
In order to open the membrane by sucking the ΔP across the membrane has to be decreased, but the membrane will be opened by pressurized water (leakage).



Step 2. State the Extreme Versions of the Conflict

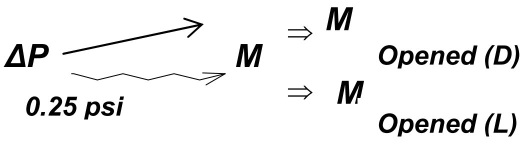
Extreme Conflict 1.

If the ΔP across the membrane is 1 psi in order to eliminate opening of the membrane (leakage) completely, the membrane will not be opened by sucking.



Extreme Conflict 2.

If the ΔP across the membrane is less 0.25 psi in order to open the membrane by sucking easily, the membrane will be opened by pressurized water (leakage)

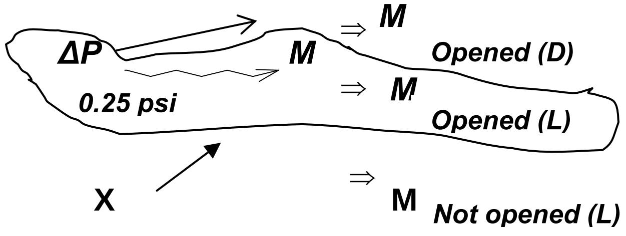


Step 3. Describe the Model of the Problem

- Conflict 2 is better for the basic function of the system.
- It is necessary to identify an *X*-resource:

A. X-resource has to eliminate opening of the membrane by pressurized water (leakage).

B. X-resource must not deteriorate easiness of opening the membrane by sucking.



Step 4. State the Physical Contradiction and the Ideal Final Result

- **Define Macro Level Physical Contradiction.**

  In order to eliminate opening of the membrane by pressurized water (leakage), the membrane has to have no opening force **and** the membrane has to have an opening force in order to be opened by sucking.

  .

- **State the Ideal Final Result**

  During the operating time, the zone of the conflict itself has to provide *membrane with an opening force and no opening force.*

Step 5. Separate the Physical Contradiction

Separation in Space

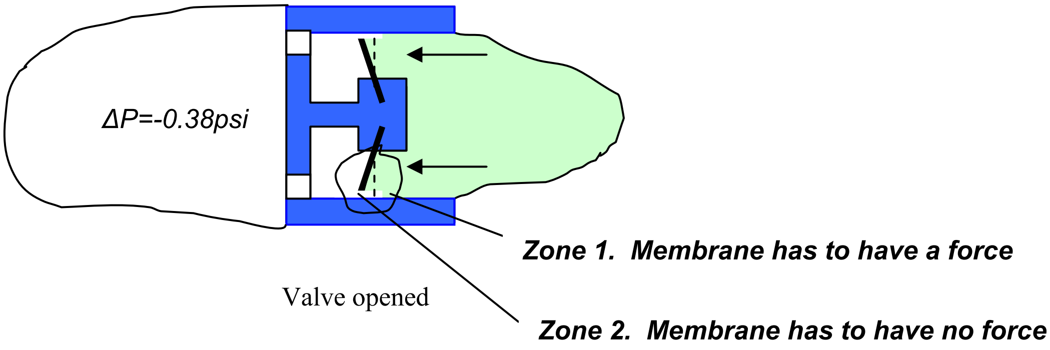
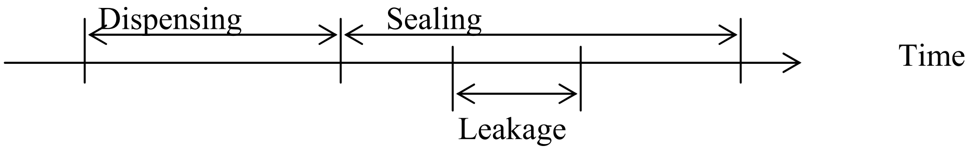


Figure 12: Water bottle cap

Separation in Time



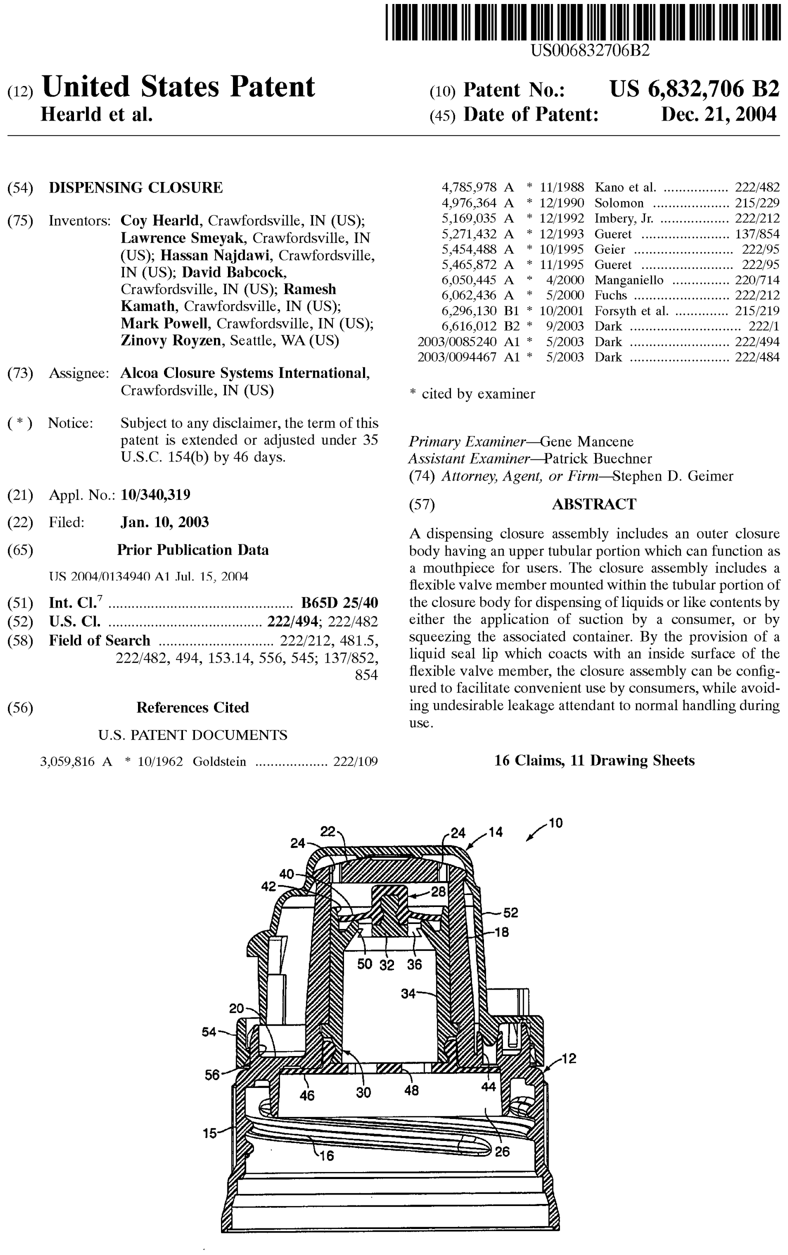
Separation Between Parameters

Opening of the membrane depends on the force applied to the valve.

$$F = \Delta P \text{ x } Area$$

In order to have opening force and no opening force having the same ΔP across the valve when sucking and when water pressurized, area of the valve exposed to pressurized water has to be smaller than the area of the valve exposed to suction.

"It is clear that through the application of TRIZ we were able to generate more concepts in two days than the contracted inventors were able to accomplish in over a year. Also the concepts and approaches we developed with your help are founded in sound engineering principles."
Larry Smeyak



US006832706B2

(12) **United States Patent**
Hearld et al.

(10) **Patent No.: US 6,832,706 B2**
(45) **Date of Patent: Dec. 21, 2004**

(54) **DISPENSING CLOSURE**

(75) Inventors: **Coy Hearld**, Crawfordsville, IN (US); **Lawrence Smeyak**, Crawfordsville, IN (US); **Hassan Najdawi**, Crawfordsville, IN (US); **David Babcock**, Crawfordsville, IN (US); **Ramesh Kamath**, Crawfordsville, IN (US); **Mark Powell**, Crawfordsville, IN (US); **Zinovy Royzen**, Seattle, WA (US)

(73) Assignee: **Alcoa Closure Systems International**, Crawfordsville, IN (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 46 days.

(21) Appl. No.: **10/340,319**

(22) Filed: **Jan. 10, 2003**

(65) **Prior Publication Data**

US 2004/0134940 A1 Jul. 15, 2004

(51) **Int. Cl.**^{7} **B65D 25/40**
(52) **U.S. Cl.** **222/494**; 222/482
(58) **Field of Search** 222/212, 481.5, 222/482, 494, 153.14, 556, 545; 137/852, 854

(56) **References Cited**

U.S. PATENT DOCUMENTS

3,059,816	A	*	10/1962	Goldstein	222/109
4,785,978	A	*	11/1988	Kano et al.	222/482
4,976,364	A	*	12/1990	Solomon	215/229
5,169,035	A	*	12/1992	Imbery, Jr.	222/212
5,271,432	A	*	12/1993	Gueret	137/854
5,454,488	A	*	10/1995	Geier	222/95
5,465,872	A	*	11/1995	Gueret	222/95
6,050,445	A	*	4/2000	Manganiello	220/714
6,062,436	A	*	5/2000	Fuchs	222/212
6,296,130	B1	*	10/2001	Forsyth et al.	215/219
6,616,012	B2	*	9/2003	Dark	222/1
2003/0085240	A1	*	5/2003	Dark	222/494
2003/0094467	A1	*	5/2003	Dark	222/484

* cited by examiner

Primary Examiner—Gene Mancene
Assistant Examiner—Patrick Buechner
(74) *Attorney, Agent, or Firm*—Stephen D. Geimer

(57) **ABSTRACT**

A dispensing closure assembly includes an outer closure body having an upper tubular portion which can function as a mouthpiece for users. The closure assembly includes a flexible valve member mounted within the tubular portion of the closure body for dispensing of liquids or like contents by either the application of suction by a consumer, or by squeezing the associated container. By the provision of a liquid seal lip which coacts with an inside surface of the flexible valve member, the closure assembly can be configured to facilitate convenient use by consumers, while avoiding undesirable leakage attendant to normal handling during use.

16 Claims, 11 Drawing Sheets

Acknowledgement

I would like to thank the Alcoa CSI team Involved in the project: Mark Powell, Larry Smeyak, Ramesh Kamath, David Babcock, Nassan Najdawi and Coy Hearld.

Teaching TOP-TRIZ

The program includes three 40-hour courses.

1. Designing and Manufacturing Better Products Faster Using TRIZ.
2. Advanced Practice TRIZ Course.
3. Certified TRIZ Practitioner Course.

Designing and Manufacturing Better Products Faster Using TRIZ

- Basic concepts of TRIZ
- Analysis of a system and problem formulation
- Solving a class of problems called *Insufficient Function*
- Solving a class of problems called *Conflict*
  - Algorithm for Conflict Solving
  - Five techniques for Physical Contradiction Separation
  - Special Ways to introduce new resources without causing subsequent problems
  - 40 Inventive Principles and Contradiction Matrix
- Solving a class of problems called *Harmful or Unwanted Function*
- Solving a class of problems called *Measurement*
- Solving a class of problems called *Revealing the Cause of a Failure*
- Accelerated development of the new generation of products and processes by applying Technological Forecast (overview)
- Concept evaluation
- Combined application of TRIZ Methods
- Solving problems brought by participants.
- Group discussion

Advanced Courses

The objective of the advanced courses is to help TRIZ users in gaining advanced level experience in applying TRIZ and confidence in working on their real-life problems and facilitation of TRIZ facilitation of teams.

Summary and Conclusions

TOP-TRIZ is a user-friendly contemporary generation of TRIZ. It is one of the most advanced and effective versions of TRIZ. It enhances your analytical thinking in problem formulation and problem solving. The power of TOP-TRIZ has been proven by solving many difficult problems.

A set of courses provides the learners of TOP-TRIZ with practical experience sufficient to achieve outstanding results.

References

1. Altshuller, G. S., *Creativity as an Exact Science,* translated by Anthony Williams, New York, Gordon and Breach Science Publishers, 1984.
2. Altshuller, G. S., *To Find an Idea, (in Russian),* Nauka, 1989.
3. Altshuller G. S., ARIZ-85c, 1985.
4. Royzen, Z., *Designing and Manufacturing Better Products Faster Using TRIZ. Basic TRIZ Course,* TRIZ Consulting, Inc. 2008.
5. Royzen, Z., *Advanced Practice TRIZ Course, Case Studies.* TRIZ Consulting, Inc. 2008.
6. Royzen, Z., *TRIZ Practitioner Course, Case Studies.* TRIZ Consulting, Inc. 2008.
7. Royzen, Z., *Tool, Object, Product (TOP) Function Analysis,* TRIZCON99.
8. Royzen, Z. *Application of TRIZ in Value Management and Quality Improvement*. The SAVE Proceedings, Vol. XXVIII, Society of American Value Engineers, International Conference, Fort Lauderdale, Florida, May 2-5, 1993.
9. Royzen, Z. *Product Improvement and Development of New Generation Products Using TRIZ.* The ASI Symposium, Total Product Development, Dearborn, Michigan, November 1-3, 1995.
10. Royzen, Z. *Case Study: TRIZ Solves a Hard Drive Reliability Problem*. The Tenth Symposium on Quality Function Deployment, Novi, Michigan, June 14-16, 1998.
11. Royzen, Z. *Solving Contradictions in Development of New Generation Products Using TRIZ.* The ASI 2nd Annual Total Product Development Symposium, Pomona, California, November 6-8, 1996.
12. Royzen, Z. *TRIZ Solves a Reliability Problem Concerning a Space Shuttle Class Main Engine*. The ASI 4th Annual International Total Product Development Symposium, City of Industry, California, November 18-20, 1998.
13. Royzen, Z. *Ideality of Products and Contradictions, Advanced Tutorial,* TRIZCON1999
14. Royzen, Z. *Standard Approaches to Solving Problems, Advanced Tutorial,* TRIZCON2000
15. Royzen, Z. Algorithm for Inventive Problem Solving*, Advanced Tutorial,* TRIZCON2001
16. Royzen, Z. *Conflict Solving Algorithm, Advanced Tutorial,* TRIZCON2002
17. Royzen, Z. *Maximizing Utilization of New Solutions and Super Effects, Advanced Tutorial,* TRIZCON2004
18. Royzen, Z. *Revealing Causes of a Failure Using TRIZ, Advanced Tutorial,* TRIZCON2005
19. Royzen, Z. *Conflict Solving Algorithm, Advanced Tutorial,* TRIZCON2006
20. Royzen, Z. *Conflict Solving Algorithm, Advanced Tutorial,* TRIZCON2007
21. US Patent No 6,832,706

About the Author

Zinovy Royzen is a Master of TRIZ certified by Genrich Altshuller, the creator of TRIZ. He is the founder and President of TRIZ Consulting, Inc., Seattle, Washington, the first U.S. company to apply TRIZ, cofounder and 1998-2007 Director of Altshuller Institute for TRIZ Studies and affiliate associate professor of University of Washington, Seattle.

Royzen Zinovy has been applying TRIZ to new product development, quality improvement, cost reduction, and inventive problem solving in innovation since 1980. He has been developing and teaching TRIZ since 1984.

He has led workshops and/or provided consultation at numerous organizations, including Alcoa, Boeing Co., Eastman Kodak, Ford Motor Company, Hewlett-Packard, Illinois Tool Works, Kimberly-Clark, Lexmark International Inc., LG Electronics, Lucent Technologies Inc., NASA, Paccar, Plug Power, Philips Semiconductors Hamburg, Samsung, Siemens, Thiokol Corporation, Western Digital Corporation, Weyerhaeuser Company, and Xerox.

He is a MS in mechanical engineering, the author of many TRIZ papers and holds 27 patents.