

Application of the Contradiction Matrix and the 40 Solutions

One of the earliest tools that people get acquainted with during the education of TRIZ is the contradiction matrix and the 40 principles. While on the initial looks this tool looks very simple and easy to apply in actual application of the tool, people often struggle. The primary reason for the creation of the tool was to reduce the unnecessary trials that an inventor would often go through using classical trial and error approach. The contradiction matrix was a tool invented so that the inventor would reach to potentially strong solutions in a short while, however often psychological inertia of the person applying the tool often prevents a person from getting strong results from the contradiction matrix.

Some of the problems faced by people applying the matrix as follows

1. Formulation of system conflicts is often not structured. The matrix itself offers no guidelines on how to correctly define system conflicts as a result many system conflicts can be suggested for the same initial situation, a correct system conflict however may not necessarily be among them. This often takes us away from the precision that we intended to obtain by using the contradiction matrix thus making the selection of correct parameters itself a trial and error approach.
2. The finite set of predefined typical attributes in the matrix often makes it difficult to associate a specific attribute of a particular system with some of the typical ones in such a case the specific attribute has to be stretched at times to beyond recognition to fit the matrix.
3. For a given system conflict the matrix proposes certain inventive principles in this not however recommend any tactics for using these principles for example what part of the system these principles be applied to? Is there any process to be followed in application of the principles? Should the principles be applied separately or together?

In this article the author will show how to overcome the above problems in the application of the matrix through a systematic algorithm, that will help us get rid of psychological inertia and associated in problem solving and would step-by-step proceed in building solutions to the problem rather than conventional random brainstorming. Systematic application of the algorithm would result in the strong solution generation. To understand the algorithm application better be will take up a problem and would look at that problem as a novice TRIZ user, and show you the various problems faced and later demonstrate an algorithm that would make the entire process of application of the contradiction matrix a systematic approach.



How to prevent orange plantations from being eaten by monkeys if installing fences around the plantations would be too expensive?

As mentioned earlier for this problem selecting and choosing the parameters is a bit difficult however analogically thinking as they are trying to protect the oranges from the monkeys one of the parameter chosen is parameter **30** that is harmful factors acting on object as the improving factor and the worsening factor can be complexity of device parameter **36**(if we were to use a fence) notice for this particular problem it is extremely difficult to identify the correct corresponding parameters, what is recommended is identify all possible parameters and identify all the solutions that are recommended by the matrix and apply them to the problem. Notice how different persons might formulate different conflicts leading to different set of solutions.

Based on the matrix they would obtain the solutions as 22, 19, 29, 40. With the sequence given in the descending order of usage

22. Convert harm into benefit

- a. Utilize harmful factors or environmental effects to obtain a positive effect
- b. Remove a harmful factor by combining it with another harmful factor
- c. Increase the amount of harmful action until it ceases to be harmful

Based on the recommendation we would try to think of how to convert the harmful effect of the monkey to benefit, after we have brainstormed and have not found an idea we would move on to the next principle, some talented people might get some idea and apply however in that case it is the talent that is working, like in this case we would not be able to think of any solution and hence go to the next

Notice that there are no recommendations towards where to apply the principle

19. Periodic action

- a. Replace a continuous action with a periodic (pulsed) one
- b. If an action is already periodic, change its frequency
- c. Use pulsed between impulses to provide additional action

We would not obtain any strong solution at this point and would proceed further

29. Pneumatic or hydraulic construction

Replace solid parts of an object by gas or liquid. These parts can use air or water for inflation, or use air or hydrostatic cushions

This solution would prompt us of some inflatable fences etc and we would proceed further

40. Composite materials

Replace a homogeneous material with a composite one

We would conclude that not applicable

Please note the author is not trying to spend too much time on trying to use the above principles as we want to demonstrate the correct application ahead. However the illustration above is the most common method that people would apply and use towards generating solutions.

The correct application would follow the algorithm as below

1. Analytical stage: where, you try to analyze the situation, identify objects and their functionality and their hierarchy, what is the main useful function of the system
2. From the analysis identify the problem you want to solve, conduct root cause analysis using cause and effect chain analysis
3. Then identify the contradiction, in a situation there can be many contradictions, identify those that you want to work with, ie. the core of the problem
4. Determine the causes of the contradiction
5. What is the desired result
6. What is the tool what is the product
7. Identify the Main production process
8. Choose the technical contradiction that will help achieve the main production process
9. Identify the substance field resources
10. Identify the IFR
11. Look for analogies
12. Apply the matrix

1. Analytical stage: where, you try to analyze the situation, identify objects and their functionality and their hierarchy, what is the main useful function of the system
 - The main functioning of the system in this case is to grow oranges
 - the primary function of the fence is to protect oranges
2. From the analysis identify the problem you want to solve, conduct root cause analysis.
 - Oranges are sweet and sour and the monkeys like them hence the attack
 - if fences are installed then they would have to be installed at a very high heights and maintaining such fences will be extremely expensive
3. Then identify the contradiction, in a situation there can be many contradictions, identify those that you want to work with, i.e. The core of the problem
 - TC1: if we install a fence then we will be able to protect the oranges from the monkeys but installing such fences will incur a huge cost along with maintenance.
 - TC2: if we do not install a fence then we will not incur a huge cost along with maintenance but will not be able to protect the oranges from the monkeys
 1. note: eliminate the jargon
 - TC1: if we install a mechanical obstacle then we will be able to protect the oranges(citrus fruits, fruits, eatables) from the monkeys(Mammals, Living things) but installing such obstacles will incur a huge cost along with maintenance.

- TC2: if we do not install a mechanical obstacle then we will not incur a huge cost along with maintenance but will not be able to protect the oranges(citrus fruits, fruits, eatables) from the monkeys(Mammals, Living things)
 1. Self test:
 2. TC1: If <A> then is positive but <C> is negative.
 3. TC2: If <A> is opposite then <C> became positive, but became negative

In an event where the self-test would fail we have to again draft the TC1 AND TC2

- 4. Determine the causes of the contradiction
 - the main cause of the contradiction is mechanical obstacles that are expensive to install and also maintain
- 5. What is the desired result
 - it is desired to protect oranges from monkeys without incurring costs of installation and maintenance of the mechanical obstacles
 1. Note: the desired state is reflected in the positive statements of TC1 and TC2.
- 6. what is the tool what is the product
 - The product is the element that need to be processed (manufactured, moved, changed, improved, protected from a harmful influence, revealed measured etc.) according the problem conditions. For problems about detection and measurement some element considered as tool (according its base function), can be considered as product (e.g., grinding wheel).
 - The tool is the element that directly interacts with the product (e.g., mill rather than a milling machine; fire rather than a burner). In particular, a part of the environment can be considered as a tool. The standard parts from which the product is assembled can be considered as a tool
 1. Note: Tool and Product is very important models. Do not be in a hurry. Be careful. Product and Tool must be mentioned in system of contradiction and in desirable result
 - If not we have to reformulate contradiction and desired result
 1. Hint: in the technical contradiction “ If we do” statement will contain the tool and the positives and negatives are associated with the product
 - The tool : The Fence, or the mechanical obstacle
 - The product: Oranges

- 7. Identify the Main production process
 - The main production process is different than the main functions. The main production process might be several hierarchies above the main function
 - Note think a lot before identifying main production process, this is a common mistake done by many where they confuse the main function and the main production process
 - the main production process in this case is to grow oranges

- 8. Choose the technical contradiction that will help achieve the main production process

- From the two models of conflict it is necessary to choose the one, which provides the best performance for the Main Manufacturing Process (i.e., the main function of technical system as indicated in the problem description). Indicate what the Main Manufacturing Process (MMP) is.
- When choosing one of the two conflict model, it is chosen one state of the tool from its two opposite states. Further problem solving efforts should be related to this state
- in this problem TC2 as given below meets requirement
- TC2: if we do not install a mechanical obstacle then we will not incur a huge cost along with maintenance but will not be able to protect the oranges from the monkeys

The tool: absent mechanical obstacle

Product: oranges

Notice that by this stage of problem solving we have narrowed down and redefined problem more appropriately than what we had stated it as

9. Identify the substance field resources

- Define the Substances and Fields Resources (SFR) of the analyzing system, the environment, and the product. Compose a list of SFR. (For the case of the article we are not getting into details the process of identification of SFR and the algorithm of application of SFR)
- We do not have to list all substance and fields. It is enough to list just objects with different nature
- Tool- Absent
- Product- oranges
- Environment- trees, jungle, other animals, birds, etc
- Supersystem- Gravity, sunlight, wind etc

10. Identify the IFR

- using the template and the structured approach of utilization of resources (not discussed in this article)
 1. Utilization of resource sequence Tool, Product(if change allowed), Surrounding environments, Super Systems
- The SFR of Tool: Absent
- The SFR of Product: The orange by itself without any complications resists the monkeys
- The SFR of the environment: The trees by itself without any complications resist the monkeys
- The SFR of the Super system: The gravitational forces by itself without any complications resist the monkeys
 1. Note: for illustration purposes we have only listed the above three statements, in reality all resources have to be used
 2. Notice we now will have 4 parallel paths to solve the problem and we should proceed in analysis step by step
 3. In practice, the problem conditions cut off some directions. When solving the Problem, it is enough to develop analysis up to the point where a solution concept is obtained; for instance, if a concept was

obtained on the "tool line" (first line, above), then the other directions need not be considered.

11. Look for analogies

- and Let's consider each line and solve
- The orange by itself without any complications resists the monkeys
 1. how can the above be achieved
 2. if the Orange is extremely sour or bitter or has an ugly look that the monkey will not like, or as an ugly smell that the monkey will not like the above can be achieved
 3. can we think of an object that protects itself, for example Humans protect them selves by their brain, porcupine by spikes, skunk by smell, etc
 4. Using the method of focal objects, Can we create spikes on trees
IDEA: Can we have some kind of thorny plantations around the orange plantation or on the orange trees that will prick the monkey and work like a fence, similarly many ideas can be generated, however for the purpose of this article we are not doing so

12. Apply the matrix

The contradiction always occurs between the Tool and the Object.

What we try to improve is the tool

Tool: Absent mechanical obstruction

Parameter that corresponds to this is parameter 23, Waste of substance where it corresponds to partial or complete, permanent or temporary loss of some of the subsystems materials or elements

What gets worse is the object

Object: Orange

Parameter that corresponds to this parameter is parameter 30 Harmful factors acting on the subsystem where it corresponds to susceptibility of the subsystem to externally generated harmful objects

Notice that we no longer have any problems in identifying the appropriate parameters

Corresponding to this the principles are 33, 22, 30, 40 in the descending order

33. Homogeneity

Make those objects which interact with a primary object out of the same material or material that is close to it in behavior.

This principle is to be applied to each IFR based on the 4 resource analysis paths earlier.

Now remember we are trying to solve the problem

The orange by itself without any complications resists the monkeys and the requirement we have is

1. if the Orange is extremely sour or bitter or has an ugly look that the monkey will not like, or as an ugly smell that the monkey will not like the above can be achieved

We will now have to use the recommendation from the matrix to the orange only to achieve the above requirements

New problem: How to make use of homogeneity of oranges to obtain the above requirements.

Now we will use the Orange resources

- Geometric properties
 - Sizes, shape, volume, weight, etc (Not listed for the sake of article)
 - Structure
 - Elasticity
- Acoustic Properties
 - The natural frequencies, etc
- Thermal properties
- Chemical properties
 - Smell
 - Taste etc
- Electric Properties
- Magnetic properties
- Electromagnetic properties
 - Color etc

Now we have to start thinking on how to apply homogeneity principle to each of the properties listed to achieve the requirement we have defined, Notice that we are no longer random brainstorming.

Example: How can we use homogeneity to size to achieve poor taste, or smell?

Going in this fashion when we reach color

How can we use homogeneity to color to achieve poor taste or smell?

Idea: we can have a lemon that has same color and shape and is sour, so the idea can be surround the orange plantation with a lemon plantation that way when the monkey attacks he eats the lemons , does not like them never to return and the farmer makes money by selling lemons and oranges

Just as we applied the principle to the orange and its properties, we have to apply it to the other resource lines to obtain the IFR identified.

MAJOR CONSTRUCT OF TRIZ: DEFINE WHAT WE WANT TO DO AND THEN MOBLIZE RESOURCES TO ACHIEVE THAT GOAL

Similarly for

22. Convert harm into benefit

a. Utilize harmful factors or environmental effects to obtain a positive effect

b. Remove a harmful factor by combining it with another harmful factor

c. Increase the amount of harmful action until it ceases to be harmful

We will now have to use the recommendation from the matrix to the orange only to achieve the above requirements

New problem: How to make use of convert harm to benefit to meet the above requirements set up by us

Now we will use the Orange resources, and the above steps to be repeated until the Tool line of IFR is completely solved using the analogical and the Matrix applications. Once done then we have to repeat the same for the other three parallel lines of analysis as mentioned earlier.

If you notice this application of the matrix is not random brainstorming, but very structured analysis. The author sincerely hopes that this article will help people understand the correct application of the matrix and the system that TRIZ uses in its thinking model

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