Internal Logic of TRIZ, Non-linear Algorithm of Inventive Problem Solving

Internal logic provides a key role regarding how key concepts of TRIZ (systems, ideality, contradictions and resources) form a problem solving process. At the same time, this logic is not always clear. Therefore, I suggest that we examine the topic from a different angle: consider an alternative algorithm for the creative problem solving method, and applying this new approach as our solution basis. The proposed algorithm is expressed in a tabular form, which offers not only a clear and straightforward structure but also non-linearity, as it allows the solver to decide which directional path to apply at a certain point in the problem solving process.

The key concepts of TRIZ relative to the proposed methodology are:
Systemic Thinking – where is the problem?
Ideality – what is the way (works as a compass both to choose and to check the direction)?
Contradictions – where are the barriers (on the way towards ideality)?
Resources – where are the solutions (how to overcome the barriers)?

The *key concepts* form the rows of the algorithm table, while the *key stages* form the columns:

Stages ▶ Concepts ▼	Picture	System	Element	Element in the System
Systemic Thinking				
Ideality				
Contradictions				
Resources				

Figure 1

The stages, applied progressively throughout the solving process, are:

Stage 1: Picture — The problem as a complete picture, with no parts of the picture out of focus. Specifically, the initial problem, with its causes and effects forming a central row of the System Analysis Technique (SAT).

Stage 2: System — The problem is dissected to find its main systems, their functions, elements, limitations (ineffectively interacting pairs[1]) and possibilities to eliminate contradiction of the interactions[2].

Stage 3: Element — If the contradiction of interaction is not resolved, we try to eliminate the contradiction of the qualities of separate element(s), choosing the easiest manageable and changeable element(s) of the ineffectively interacting pair(s).

Stage 4: Element in the System — Do we have an applicable solution? If yes: is the system ready to embrace the modified element(s)? Are the resources involved in the solution the most applicable ones? If not: the problem should be reformulated from the position of the system of a higher level or a different stage of causality

"The full scale" solution would require going through all the cells, starting from the upper left corner of the table and finishing in the lower right corner with major stages described in the columns. This means that a "normal" solution progresses from top to bottom of a column and then jumps to the upper cell of the next column when reaching the bottom of the previous one (see Figure 2).

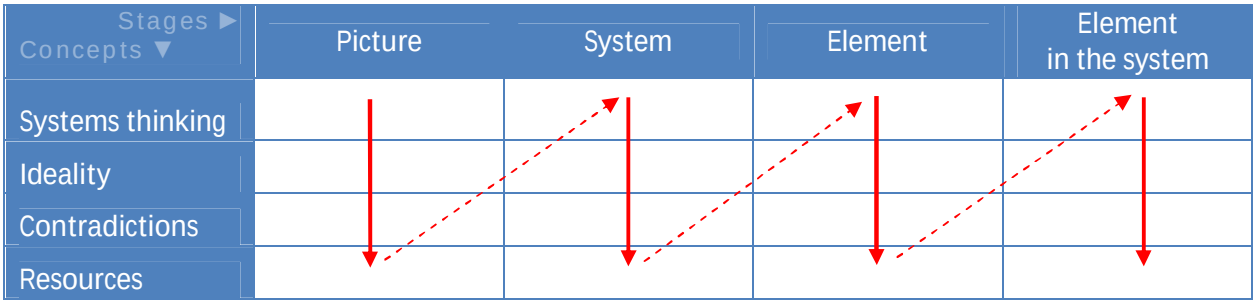

Figure 2

However, it can occur that the development of the solution process prompts us to choose a non-traditional track, e.g. making several rounds through the sequence of just one column and then traversing through other cells. In the below example, the solution analysis makes multiple trips through the *Picture* column then moves along the *Resources* row to the top of the *Element in the System* column, bypassing the *System* and *Element* stages. Given this capability, I thus refer to the algorithm as a non-linear one: the solver has both the freedom and understanding of what is left behind by making jumps through the problem solving process stages.

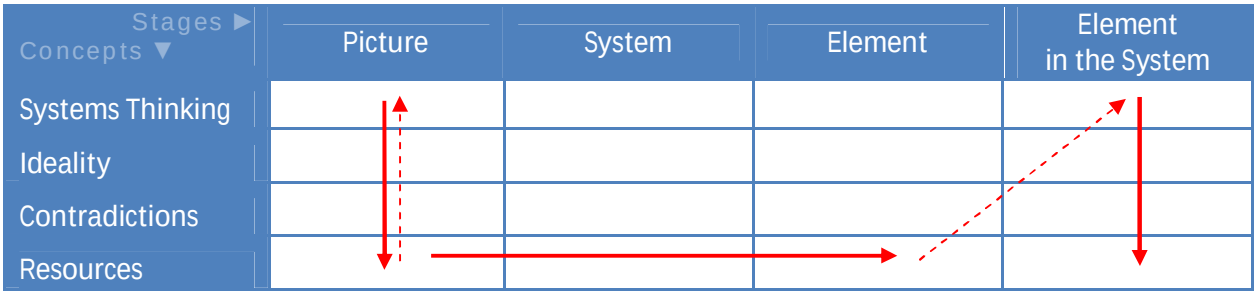

Figure 3

Now we are ready to discuss the "horizontal logic" in more details:

Systemic Thinking	The logic in this row evolves from "the problem as it is given" to an analysis of main systems / functions / elements / obstacles around the problem. For 'make-my-system-better' type problems, the laws for development of technical systems are applied in this row as well.
Ideality	This entire row implies a "self-resolving" approach: the problems, elements or interactions disappear by themselves, execute a required function or skip/prevent the unwanted function/effect.
Contradictions	An attempt to make the system/element move to a higher level of ideality often results in contradictions between the interactions within the system or characteristics of its separate elements. The contradiction is to be resolved by inventive principles, analogies etc.
Resources	The elimination of the contradiction often requires the involvement of resources: energy/force, additional elements, modification of existing elements etc. The analysis of the resources progresses from utilizing hazardous to freely available/inexpensive resources already present within the system and its potential for constructively employing more expensive ones.

A short version of the non-linear algorithm is presented below. The author is ready to present a more detailed description and examples of the algorithm in use later – should there be further interest among the readers.

Alexey Beschastnov
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Non-linear Algorithm of Inventive Problem Solving

Stages ► / Concepts ▼	Picture	System	Element	Element in the System
SYSTEMIC THINKING the context of the problem; checking the results	The final goal, causes and consequences of the problem. Direct/concise terminology; Size-Time-Cost; analogies	Operative space/time (OS, OT); ineffectively interacting pair(s)[1]; system analysis technique (SAT); attribute and morphological analysis	Diagram and laws of (technological) system evolution; elimination of the problematic element with re-delegation of its functions…	Is the system ready to embrace the modified element(s)? If there is no applicable solution yet – reformulate the problem[3]
IDEALITY the goal is achieved all by itself	How to reach an ideal final result (IFR)? (No actions are needed; the problem is solved by itself)	OS fulfils the necessary functions by itself within the OT. IFR for every cell of the SO. Intensified contradiction of interactions	…or the element (the most manageable, changeable and motivated one) performs the required functions within the OT/OS all by itself	Are there any macro effects (to include new applications of the new/modified/inverse solution)? Try to resolve main future contradictions
CONTRADICTIONS transformation without compromises or aggression	What prevents one to achieve the ideal final result (IFR)? Form a full scientifically correct definition of the obstacles' causes. How to remove them?	Inventive principles for eliminating contradictions of interaction: merging, segmentation, universality, skipping, intermediary, etc.	Inventive principles for eliminating contradictions of characteristics: merging, segmentation, universality, skipping, intermediary, etc.	Analysis of the resolved contradictions – are there better (closer to the IFR) solutions? Is the direct/inverse solution replicable?
RESOURCES everything is a resource, including the problem	…using simple resources (residues, hazardous, free, inexpensive, already available) and simple effects (geometrical, physical, etc.)	Standards of a su-field analysis for incomplete and simple su-fields. Resources of the SAT and its environment. Value engineering[4] principles	Standards of a su-field analysis for complex su-fields. Resources of the element, additions, fields, copies, chemical/physical effects	Minimal spending of resources, substitute expensive resources with free ones. Use the solution as a resource, make the impact wider

[1] An ineffectively interacting pair is – in my opinion – a better word combination here compared to the widely used "conflicting pair", as often there is no conflict, the pair is often ineffectively interacting from the point of view of the solver only, with no conflict within the pair.
[2] I use terms "psychological contradictions", "contradiction of interaction" and "contradiction of characteristics" instead of widely used but quite incorrect "administrative contradiction", "technical contradiction" and "physical contradiction" respectively.
[3] If there is no applicable solution, the problem should be reformulated from the point of view of a higher level system or different stage of causality. The problem solving process in this case should be restarted (from the first cell) for the new problem.
[4] Value engineering: check if the main approach of value engineering is useful for the problem - if yes, it starts a separate branch in the inventive problem solving process.