How to have your TRIZ cake and eat it too?

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ABSTRACT

It is often said that it takes effort to achieve something worthwhile, but it seems with TRIZ we often can't afford to put in the effort we need to get the innovation result we desire. Often individuals cite the shear intellectual effort required as a reason not to continue with the use of TRIZ, in other words it is just too hard. As human nature is unlikely to change, what can be done to make TRIZ more efficient from the investment vs. impact perspective? This paper reviews a number of standard TRIZ tools in terms of impact against investment and impact against effort to apply and presents conclusions for key improvement areas. Finally, this paper puts forwards suggested ways to deliver these improvements without compromising the inherent power of the methodology.

BACKGROUND

The idea for this paper came from conversations between the author and several experience TRIZ users and champions. The problem of getting more return from TRIZ for a specific training investment is well known. Many TRIZ trainers have already developed tools and approaches which have significantly increased the impact of TRIZ in their client organisations. Many TRIZ champions have also put in place structures to support widespread adoption of TRIZ within their own organisations. Nevertheless, the analysis in this paper provides a fresh way of looking at the various TRIZ tools and challenges the TRIZ community to take the next steps to establish TRIZ as a mainstream innovation technique.

LISTING OF TRIZ TOOLS

In order to analyse the various tools of TRIZ, a listing of various TRIZ tools was prepared. The tools listed were:

Knowledge base of effects
Action mapping
Ideality and trimming
ARIZ
Laws and lines of evolution
Technical contradictions and 40 inventive principles
Substance field analysis and basic su-fi solutions
76 Standard solutions
Physical contradictions and separation principles
Intensification

Smart little people

Here is a brief summary for each tool:

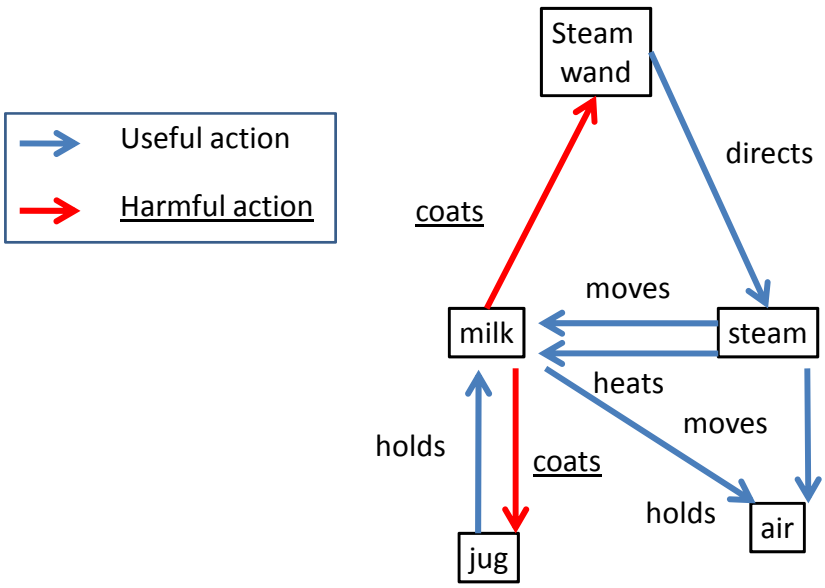
Knowledge base of effects

This refers to the listing of physical, chemical and geometric effects which is accessible through such software packages as Invention Machine “Goldfire”. The investment rating is factored to take into account the initial cost of purchase for this sort of package.

Action mapping

Action mapping refers to the method which is commonly used to show interaction between system components in terms of basic physical actions. Useful, harmful and insufficient actions can be charted on this type of diagram. Figure 1 shows a typical set of interactions for the preparation of a hot foamed milk drink (e.g. cappuccino – reference 1).

Figure 1 – Action Diagram example for foaming cappuccino milk



Ideality and trimming

The concept of Ideality is fundamental to TRIZ and provides a direction for improvement of any technical system. Ultimately the ideal technical system does not exist but still delivers its function. Trimming is a technique which can be used to eliminate system components which create give rise to harmful interactions

ARIZ

The algorithm of inventive problem solving or ARIZ (from the Russian **A**ltgoritm **R**eshenia **I**zobretatelskih **Z**adach) provides a powerful tool for analysing a problem situation. Use of ARIZ helps in three ways: aiding understanding of the problem situation, breaking psychological inertia and bringing together various TRIZ tools to bear on the problem. An example of a typical ARIZ is shown in a paper presented at this conference by the author "Two ways to solve the same problem – a comparison of TRIZ tools in action" with Darrell Mann.

Laws and lines of evolution

The laws and lines of evolution of technical systems, including the law of increasing flexibility, law of transition to a higher level system and the law of transition to the sub-system.

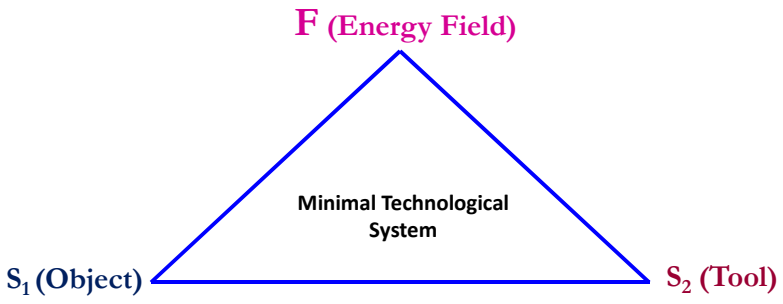
Technical contradictions and 40 inventive principles

This tool includes the formulation of system conflicts (or technical contradictions) in a standardised format to enable use of the contradiction matrix to identify potentially relevant inventive principles to be applied to the problem situation.

Substance field analysis and basic substance-field solutions

Substance-field analysis covers modelling of the interactions in a technical system in a standardised format. Figure 2 shows this basic model.

Figure 2 - Substance-field Analysis



The basic substance-field solutions relate to the following areas:

- Building an incomplete Substance-field model to create the minimal technological system shown above.
- Breaking of harmful interactions within a substance-field model by introduction of new substances, modification of existing substances or introduction of an additional energy field
- Elimination of need for detection

76 Standard solutions

The 76 standards represent an extended set of solutions to problems covering the construction and evolution of subfields, system detection and measurement and standards on the application of the standards to specific problem situations.

Physical contradictions and separation principles

Physical contradictions are used to identify specific properties or parameters on a system component which are in conflict. In a way, a physical contradiction is a sharpened technical contradiction because it relates to the conflicting properties of a component rather than a system. There are three basic separation principles: separation in space, separation in time and separation between the system and its components.

Intensification

The tool of intensification can be used alone to reduce psychological inertia and to sharpen understanding of a problem situation or it can be used as part of a larger process (e.g. ARIZ). In classic TRIZ, intensification was applied through the Size, Time and Cost (STC) operator.

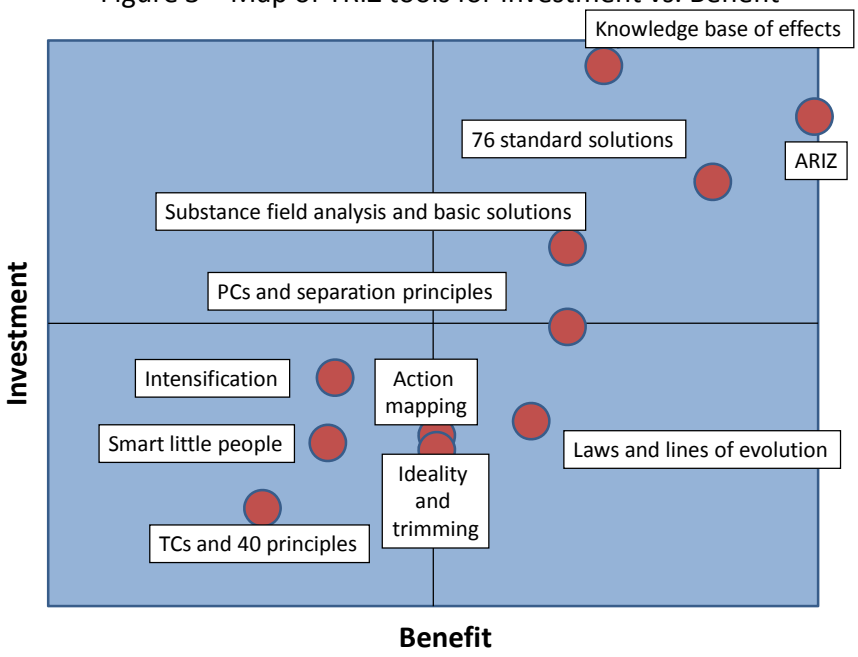
Smart little people

“Smart little people” is a tool to model a problem situation to reduce psychological inertia and to increase understanding of both the physics of the current problem situation and the desired solution. The problem interactions are modelled as if populated by intelligent little people who can be directed to perform the current and required actions.

ANALYSIS

The tools were compared against a 1-9 rating for investment (9 as the highest) and a 1-9 rating for benefit (9 as the highest). The resultant analysis is shown in figure 3:

Figure 3 – Map of TRIZ tools for Investment vs. Benefit



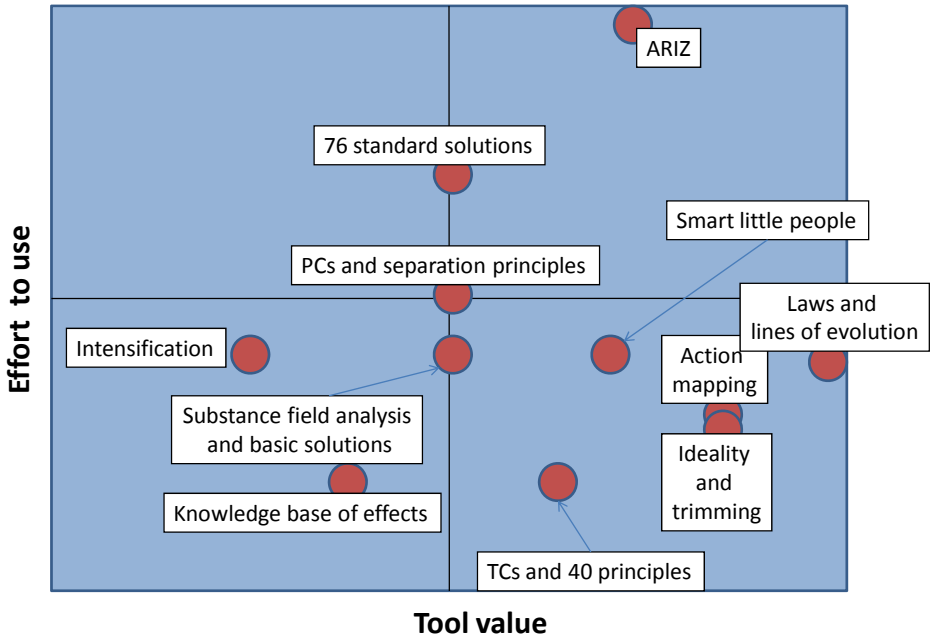
Ideally we are looking for tools which are low investment and high benefit (bottom right box). This plot shows very clearly that across the TRIZ tools there is a strong straight line relationship between benefit and investment required. This backs up the initial premise of this paper – that is; as things stand, you have to invest significant effort into TRIZ in order to get an impactful return. One TRIZ tool which requires a disproportionate investment is the knowledge base of effects. What is needed here is a low cost way to access the effects database.

The tools were also compared against effort to use and tool value. Effort to use was based on a 1-9 rating (9 as the highest) and tool value was derived from the following formula:

$$\text{Tool Value} = \text{Benefit} \div \text{Investment}$$

The resultant analysis is shown in figure 4:

Figure 4 – Map of TRIZ tools for Effort to use vs. Tool Value



This analysis also brings in the everyday effort required to use the tools. Once again the tools of the most interest are those in the bottom right hand box. Only four TRIZ tools are not in or near this box: ARIZ, the 76 standard solutions, intensification and the knowledgebase of effects. From this analysis, these tools, together possibly with PCs and separation principles, are the ones which might best benefit from modification to reduce effort to use and investment to acquire.

POTENTIAL DIRECTIONS FOR IMPROVEMENT

Knowledgebase of effects:

The fundamental issue with the current method of accessing the knowledgebase of effects is the cost of the associated software. A strong direction to solve this problem would be "segmentation". Why not separate out the knowledgebase of effects as an individual product sold at a far lower cost. Apart from the initial cost, the usability and effectiveness of the current tool are satisfactory.

Another approach would be to create an open source effects database which could be built up co-operatively by the TRIZ community. Such a resource could be accessed potentially at very low cost and without needing any other connected software.

Intensification:

The issue with intensification is that as a stand-alone tool it doesn't offer sufficient value. In this case a strong direction would be "merging", that is, combining Intensification with some of the other TRIZ tools when analysing problems. A Good candidate for this would be technical

contradictions and the 40 principles. The intensification tool can be used as a way to test the technical contradiction generated, sharpen understanding and reduce psychological inertia.

76 Standard Solutions:

There are two problems with the 76 standard solutions from the perspective of this analysis – the level of investment needed to learn about the tools and the effort required to use the tool. A simplified way to learn about the 76 standards is to learn about basic substance-field solutions in generalised form first and then categorise the standard solutions in line with these basic solutions. In terms of improving routine use of the standards, as the selection of the most appropriate standard is directed by a logic tree, it should be very possible to automate this into a simple Q&A logic format.

ARIZ:

As with the 76 standard solutions, there are two problems with ARIZ from the perspective of this analysis – the level of investment needed to learn about the tools and the effort required to use the tool. There has been a lot of discussion in the past about the application of ARIZ as a sequential process (reference 2) but this argument doesn't address how to replace the real functions of ARIZ which are to formulate the problem in a standard way, to remove psychological inertia, and to combine the power of a number of TRIZ tools. The primary function of ARIZ, in fact is "to solve complex problems". While it is true that a full ARIZ analysis of a difficult problem situation will produce a large amount of useful information about the problem – most likely, enough to solve the problem, many users will be uncomfortable about the time and intellectual investment needed. A basic analysis of the problem situation shows that there is a contradiction between the amount of information derived about the problem and the time taken to apply ARIZ or the trainability of ARIZ. Using the 2003 Matrix (reference 3), these two conflicts link to the following inventive principles:

Amount of information vs. Loss of time

Suggested Principles: 3, 25, 19, 1, 2, 10

Amount of information vs. Trainability

Suggested Principles: 25, 10, 17, 6, 1, 7, 2, 4

Applying the principles which were suggested most frequently first:

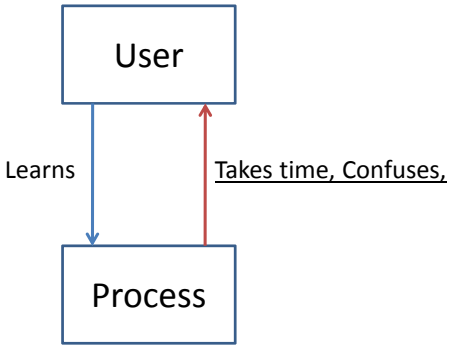
Principles and Potential Solutions:

Solution Trigger	Ideas Generated
Principle 25/Self-Service	Automate ARIZ to adapt to input generated during the analysis to steer the user to the only sections which are relevant for that specific problem Automate ARIZ to generate specific problem statements such as IFR, system conflicts and substance-field resource listings based on an initial problem situation questionnaire. This questionnaire may also be able to indicate if the problem can be solved without use of ARIZ Use memory tools such as mnemonics to aid application of ARIZ
Principle 10/Preliminary action	Pre-train earlier TRIZ topics with ARIZ application in mind Pre-arrange the problem so that ARIZ can be applied more rapidly Pre-arrange the ARIZ steps to give the best analysis of a specific type of problem
Principle 1/Segmentation	Separate the sections of ARIZ and use as required. Give guidance to indicate where one tool can logically complement another tool Train ARIZ in sections and design ARIZ so that each section can be used independently
Principle 2/Taking out	Allow user to edit ARIZ to create their own process which misses out stages that they find are less productive. Leave in prompts for missing sections to give the user a chance to adapt their ARIZ to different problems Focus specifically on the interactions in the problem situation. Pare down ARIZ to its essence
Principle 3/Local Quality	Make each section of ARIZ have a specifically defined function
Principle 19/Periodic action	Space out the ARIZ activity into short bursts of activity using each tool in turn Use rhythm to enrich the learning process. This could be

	combined with mnemonics to make the learning “stick” more easily. What about an ARIZ song?
Principle 17/Another Dimension	Make progress possible through ARIZ in a multi-dimensional way. Make it possible for the analysis to start in different places and execute “sideways” steps to specific tools. Create a multi-layered ARIZ with sub-processes which can be executed or skipped.
Principle 6/Universality	Create a more functional single step or combine specific actions into one or a few compound steps
Principle 7/”Nested Doll”	Place one step inside another step
Principle 4/Asymmetry	Make the ARIZ more “ergonomic” to the user’s thinking so that it can be more easily understood and used. Consider modifying overly academic terms to make the meaning clearer. Perhaps an ARIZ board game format might increase the usability of the tool –this might be an excellent team problem solving tool. Inject fun or competition into using ARIZ so people are increasingly motivated to use it

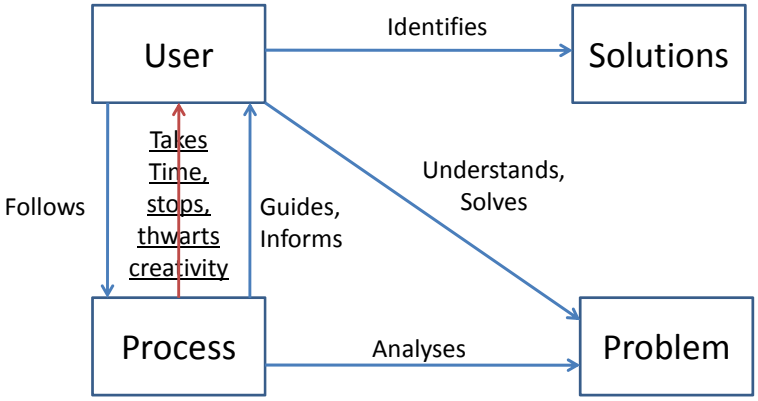
In many ways ARIZ represents an intensification of a fundamental issue with all TRIZ tools, that of the effort to learn and to use. In order to understand this issue more clearly, let’s study the interaction between the user and the TRIZ tool or process. Mapping the functional interactions in the problem situations for training the TRIZ tools (see figure 5) and for using the TRIZ tools (see figure 6), we can see that there is a fundamental useful and harmful interaction.

Figure 5 - Training in ARIZ (or any other TRIZ tool)



IFR: the user learns about the process without it taking any time or confusing the user

Figure 6 - Use of ARIZ (or other TRIZ tool)



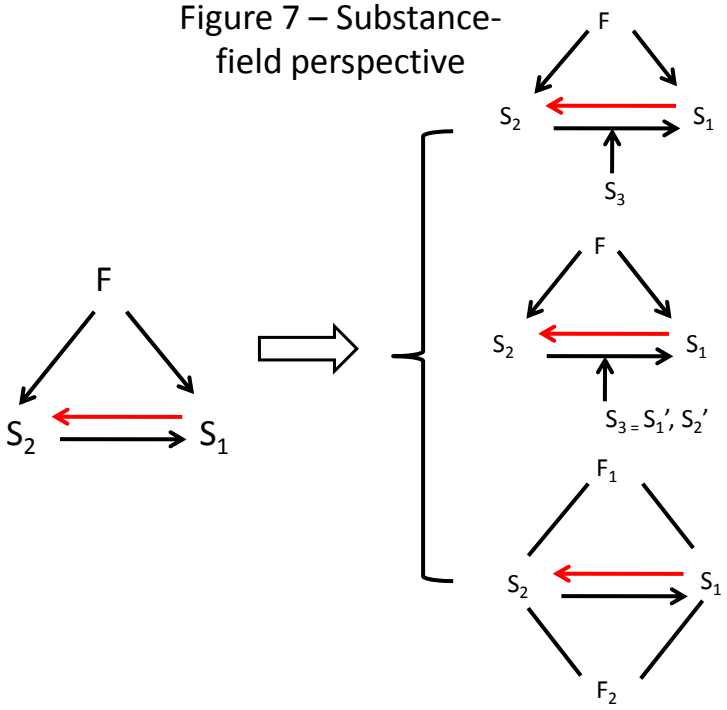
IFR: the process informs the user about the problem without it taking up the user's time, stopping the user or thwarting creativity

From the user view point, training takes time and if that time period is shortened, the user can be left feeling confused and lacking the confidence to use the tool. As the tool complexity is increased, the training time is also increased. The user may well be thinking about eventual application of the tool during the learning process. The users attitude to the process of applying the tool can affect not only the process of usage but also learning – if the user cannot see how

they might actually find the time to apply the tool in the real world or if the user doesn't have sufficient belief in the benefit of the tool, they may put less effort into the learning process than if they believed otherwise.

From the substance-field model perspective the initial situation and desirable solution can be described using the diagram shown in figure 7 (reference 4). There is a harmful interaction which must be broken. This interaction can be broken in three main ways, by adding a third substance S3 between S1 and S2, adding a modification of S1 or S2 between S1 and S2 or by applying a field F2 which neutralises the harmful interaction between S1 and S2.

Figure 7 – Substance-field perspective



In practice, all three solutions are applicable to the problem situation – it is perfectly possible to add a substance into the problem situation, be it a thing or a person, it is perfectly possible to introduce a modified user or a modified TRIZ tool into the initial situation and it is perfectly possible to introduce a new field or fields to influence the interaction. Let's spend some more time understanding these potential directions:

Add a new substance:

Options to add a new substance into the problem situation include:

- Appoint an in-house TRIZ proponent who can help other TRIZ users to feel more comfortable with using TRIZ. Agree this up-front so the training participants can visualise how they might be helped to use the tools when back at work.

- Set up a TRIZ portal on the company intranet to support application of TRIZ.

- Get help from an internal TRIZ proponent when planning training so company/industry relevant examples can be used in the training

Add a modified substance based on one of the two existing substances:

- Modify the TRIZ tools to suit the company culture. Consider steps to integrate TRIZ into the corporate innovation process. Perhaps even the name TRIZ may be removed from the tools.

- Bring experienced internal TRIZ users into the training to help provide relevant examples and to support the learning experience

Add a new field:

- Consider what behaviours are valued and rewarded in the organisation and set up a reward structure around TRIZ usage which influences behaviours

- Take steps to make it clear that TRIZ is a key priority for senior management and give TRIZ users the chance to demonstrate the results of their work to senior managers

- Try to avoid cutting spending on TRIZ, even in difficult financial conditions

- Finally, and considering many of the previous solutions outlined above have been applied to TRIZ in the past, one high potential area for improvement relates to increasing the fun level associated with using TRIZ. TRIZ can be perceived by some people as a somewhat academic and dry tool, whereas other creativity and brainstorming tools are often structured to make the process of identifying solutions as enjoyable as possible. TRIZ could adopt some of these approaches to create an increased fun element.

CONCLUSION

While some TRIZ trainers and internal TRIZ champions may have already adopted a number of the practices and approaches suggested in this paper and there are proprietary software solutions can automate the more complex algorithms of TRIZ, the insights from this study give a fresh perspective on training, implementing and using TRIZ tools. This paper also suggests some promising directions to improve the adoption and usage of TRIZ which have yet to be fully embraced. Broadly, these solutions split into three areas: ways to redesign the TRIZ tools, ways to improve the learning experience for the user and ways to influence the user to continue to make use of TRIZ in their daily work.

One key insight which the author gained from this analysis is that TRIZ usage often currently lacks a fun element, or the means to get people to look forwards actively to opportunities to use the tool. This is in marked contrast to many other widely applied other innovation tools. In the author’s opinion, if TRIZ is to become a mainstream innovation tool it ought to be more fun to

learn and use. What is wrong with challenging ourselves to find ways to inject more of the fun element into TRIZ as well?

References:

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