Evolving The World's Systematic Creativity Methods

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ABSTRACT

Built on over 1500 person years of research and the scientific study of a significant proportion of the world's strongest problem solutions, the Russian originated Theory of Inventive Problem Solving, TRIZ is the biggest study of human creativity ever conducted. The paper describes the pioneering research being undertaken to update and advance this phenomenal piece of work. Evolution of TRIZ is involving a renewed programme of analysis of the global patent database – taking into account the shifting emphasis of the intellectual property database towards markedly increased numbers of electrical and software based inventions – in order to improve the Contradiction Matrix, trends of evolution and other tools. The paper also describes improvements to an overriding systematic creativity philosophy being generated by integration of TRIZ with other problem definition and solution methods like QFD, DFMA, Value Engineering, Robust Design, Theory of Constraints, as well as less-structured approaches like those found in the work of Edward De Bono, NLP and mind-mapping.

INTRODUCTION

The future of TRIZ (1, 2) has been the subject of significant discussion in recent times (3, 4). Opinion differs as to whether it is still at the beginning or has reached the limits of its evolutionary potential. The conflict can be both understood and resolved if TRIZ is recognised as a just a part (albeit a very important one) in a much bigger system. For the sake of providing this bigger system with a label, we will propose the term 'systematic creativity'.

TRIZ places great importance on the existence of evolutionary S-curves. In these terms, the difference between the s-curve for TRIZ (actually, bearing in mind the different TRIZ proponents and variations, such a TRIZ s-curve should be seen as the averages of a cluster of subtly different s-curves) and an average curve that might be constructed for 'systematic creativity' is illustrated in Figure 1. The conflict between 'is TRIZ a mature system or an immature one?' is thus explained by point marked on

the figure illustrating the current evolutionary state. The point suggests that TRIZ is at the mature end of its evolutionary potential (thus concurring with Vertkin's comment (4) that 'there hasn't been a single new concept introduced into TRIZ in the last 12 years'), but that TRIZ and the current position are still at the relative beginnings of the over-riding 'systematic creativity' curve. In terms of 'systematic creativity' it is evident that there have been many new concepts emerging in recent times. This paper discusses the emergence and integration of some of these concepts. The basis for the discussion is that as TRIZ – being both toolkit, method, strategy and philosophy - is by far and away the most comprehensive of any of the available models, it is also the most appropriate foundation for a coherent 'systematic creativity' model.

The idea that TRIZ is one s-curve (system) inside a bigger system for now called 'systematic creativity' emerges from the concept of recursiveness in systems. Recursiveness as discussed in the Viable System Model, NLP and other emerging texts on, not just creativity, but all system evolution is an example of a concept which has not previously existed in classical TRIZ. The current prevailing view is that recursion will be an important element in the successful realisation of a 'systematic creativity' s-curve.

The idea of TRIZ representing one s-curve inside a higher order s-curve explains the s-curve figure constructed by Savransky in reference (3), which suggests that the next stage of 'TRIZ' (but actually 'systematic creativity') evolution is the integration of different methods.

This paper is divided into two unequal parts. The first part describes ongoing work on the development of TRIZ in which we hope to show that, although the system is relatively mature, there is still scope for significant improvement and extension. The second, longer, part of the paper examines some of the main 'other' creativity tools, methods and philosophies and the role they may be expected to play in the bigger 'systematic creativity' picture. To varying degrees all of these other tools, methods and philosophies may be represented as systems with their own series of s-curves. Rather than attempt to position such s-curve approximations relative to TRIZ, the paper focuses only on their role in serving the higher order systematic creativity s-curve development.

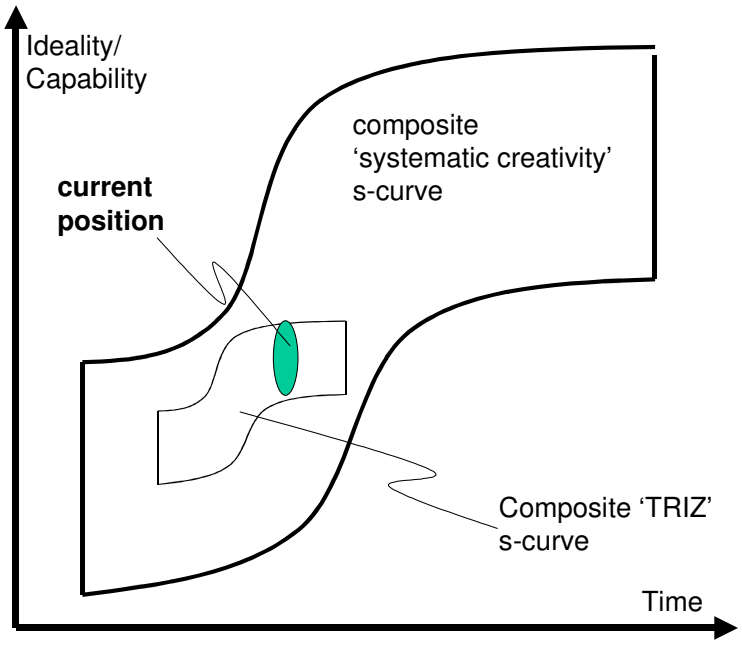

Figure 1: Systematic Creativity Evolutionary S-Curve

EVOLVING TRIZ

If Igor Vertkin's statement about the absence of new concepts in TRIZ in the last 12 years is correct, it should not be taken to also mean that there has been no new work in TRIZ over the same period. The success of TRIZ Journal, for example, should provide ample evidence of the spread and expansion of TRIZ in recent times.

Much of this 'new' work on the other hand may be seen as refinement and re-arrangement of knowledge that is largely the same as that extracted through early TRIZ analysis of scientific and patent databases. One of the consequences of this is that TRIZ tools like the Contradiction Matrix and Inventive Standards often fail to handle certain types of problem. One of the underlying problems here is that the world has moved on significantly since the original analysis was conducted. One manifestation of this progress is that the Matrix, for example, often sends users looking to solve software or electrical problems in directions that are significantly different to those being used by the most successful inventors of the last 15 years. The world was simply 'more mechanical' when the initial analysis was taking place.

An extensive programme of work was instigated at the beginning of 2000 by CREAX to begin to rectify this situation. A team of researchers is now undertaking a patent-by-patent analysis of invention disclosures over the period 1985 to 2000. The aims of this research are to:-

- update the Contradiction Matrix in terms of both its form (updating the list of 39 parameters for example) and content. Initial results suggest that in several key contradictions, inventors are now using significantly different strategies to those of their pre-1985 predecessors.
- identify the emergence of new Inventive Principles
- identify the emergence of new trends of evolution. In this regard, we believe that we have already uncovered at least ten trend patterns not previously found in TRIZ.
- identify the emergence of new Inventive Standards (we have already identified and incorporated two to add to the original list of 76).
- identify and incorporate new tools.

In line with an increasing tendency for individuals and organisations to not patent their good solutions, and in order to extract strong solutions from fields not involved in patents (e.g. architecture, business/management, industrial design), we have also introduced a programme of systematic search of other knowledge sources. The overall idea is to ensure that we can offer users access to the most effective solutions from wherever they occur.

At this point in time, the analysis team is around 25 strong. In keeping with the importance of 'existing resources', we are also embarked upon and actively looking for a number of collaborative programmes with academic institutions around Europe.

EVOLVING 'SYSTEMATIC CREATIVITY'

A systematic programme of research to compare and contrast different creativity tools, methods and philosophies in terms of their relevance to primarily scientific, engineering and business applications (5) has concluded that TRIZ currently offers the most useful foundation for a higher order systematic creativity model and that given this foundation, the other available methods that are best able to complement and help deliver the higher order model are those shown in Figure 2.

To varying degrees, all of these additional methods have already been the subject of some form of work to explore the benefits of integration with TRIZ. The paper briefly reviews such work and projects how and why such integration should progress in the future.

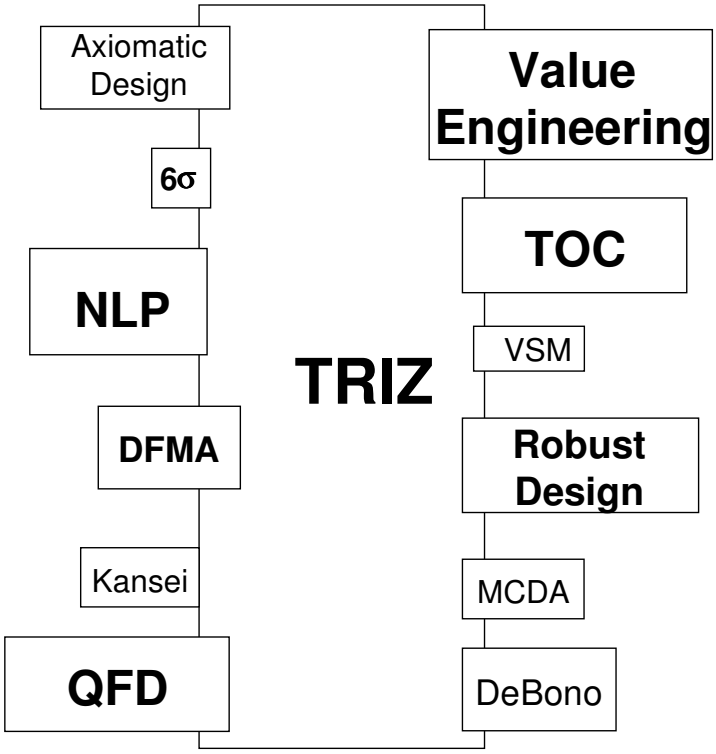

Figure 2: Integration of Innovation Tools

TRIZ and Function Analysis/Value Engineering

The function analysis/value engineering methodology initially developed by Larry Miles (6) is probably the method most closely linked with and integrated into TRIZ. Reference 7 is probably the first text to talk about both function analysis and TRIZ in the same place (albeit the understanding of TRIZ is woefully inaccurate). It does not make any mention, for example, of the simple but profound conceptual addition to function analysis made by TRIZ – that of using the function analysis to describe the harmful, ineffective and excessive functional relationships in a system as well as the useful ones drawn in classical function analysis. This simple shift in thinking transforms a method that is useful into one that offers an extremely effective means of both modelling complexity and defining problems. Reference 8 describes how the current TRIZ addition to function analysis is being further evolved by incorporation of new concepts such as modelling of system attributes, time-variant problems and transition between problem definition and the selection of the most relevant tools to help solve the problem.

The definition of 'value' in value engineering is close enough to the TRIZ concept of ideality as to interpret them as similar. The more complete vision of ideality – and particularly the Ideal Final Result concept – in TRIZ means that value engineering appears to offer little else to enrich a 'systematic creativity' model.

Of all the methods considered, the integration of function analysis/value engineering into TRIZ is to date the most comprehensive and complete. Future evolution thus looks set to occur at the detailed implementation rather than conceptual level.

TRIZ and QFD and Robust Design

The integration of the 'holy trinity' of TRIZ, QFD and Taguchi methods was the subject of Reference 9. Theoretically, the three complement each other very well; QFD is about capturing the voice of the

customer and translating it into design specification; TRIZ is about generating solutions that fit the specification; and Taguchi/Robust Design tools are about optimising the implementation details of the solutions offered by TRIZ. The practice is currently seen to be some considerable distance away from the theory for the large majority of users.
The biggest problem encountered by these authors involves the usual failure of QFD to accurately capture that customer voice. Customers are frequently unable to describe what it is that they want other than in terms of 'better' than the thing they already have. Few if any customers would ask for a digital camera given a conventional film camera and a request for ideas on creating a better solution. This is an area where TRIZ – and particularly the technology trend prediction elements – is emerging as a more effective start point than QFD.
Integration of QFD and Robust Design techniques into TRIZ looks set to continue. At least one significant conceptual level integrative step remains unexploited at this point in time. That step sees its roots in the inadequate ability of TRIZ to handle problem non-linearities. The strengths of Robust Design in this area and their integration into TRIZ is the subject of Reference 10.

TRIZ and Design for Manufacture and Assembly (DFMA)
DFMA shares the same problem as a good number of the other tools and methods described here, in that it contains what can be seen from a TRIZ perspective as the 'insert miracle here' moment. DFMA is very good at defining problems and even better at quantifiably evaluating solutions, but between the two, it offers users little more than the suggestion 'now generate some ideas'. That being said, the method does have something to add to TRIZ. The already mentioned solution evaluation capabilities – basically providing a framework allowing users to benchmark manufacture and assembly times for an object and thus provide quantified improvements between 'before' and 'after' situations – are a useful addition, as are the questions developed within DFMA for identifying whether parts are actually needed in a system. This part of DFMA is closely linked to the 'trimming' ideas contained in TRIZ. Combined together, a problem solver is offered a more comprehensive list of questions to ask when considering the simplification of technical (or indeed business) situations. Figure 3 reproduces the combined DFMA/trimming question list.

- Do I need the function offered by the part?
- Can something else in or around the system perform the function?
- Can an existing resource perform the function?
- Can a low cost alternative perform the function?
- Must the part move relative to other parts
- Must the part be of a different material or isolated from its mating parts?
- Must the part be separate from mating parts to facilitate assembly or dis-assembly

Figure 3: Combined TRIZ/DFMA Trimming Questions

There appears little scope for additional high level conceptual integration between TRIZ and DFMA. The creation of combined DFMA plus function analysis plus trimming tools appears to offer benefits in terms of use-ability.

TRIZ and Axiomatic Design (AD)
The integration of AD and TRIZ has already been discussed in Reference 11. TRIZ can be used to show that the AD 'axioms' have some very useful exceptions, and that they are thus not axioms, but nevertheless, axiomatic design still offers designers a series of useful rules to help define and achieve 'good design'. The likely future complementarity between AD and TRIZ currently appears to be

restricted to the incorporation of these 'useful rules' into the solution evaluation part of TRIZ, although the AD scheme for correlating the functional requirements of a system to the selected design parameters to the subsequent method of manufacture may offer some additional benefits to TRIZ.

TRIZ and Viable System Model (VSM)
Stafford Beer's Viable System Model emerged from the study of organisation structures and resulted in two very important conceptual findings. The first involved the identification of five essential elements that a system had to contain if it were to be 'viable'. The second involved the idea of recursiveness – and the discovery that the five element viability test still applied at different hierarchical levels of consideration of a system organisation structure. Reference 12 describes how this first finding contradicts the TRIZ definition of 'system completeness' and how it ultimately therefore provides a stronger definition of completeness than TRIZ. The second concept of recursion is still only just being introduced into TRIZ (and the higher order 'systematic creativity' system hypothesised in this paper), and is believed to offer significant scope for fundamental conceptual evolution of systematic creativity.

TRIZ and Multi-Criteria Decision Analysis (MCDA)
There are a growing number of available methods for enabling problem solvers to make legitimate, recordable and reproducible 'apples versus oranges' comparisons between different systems. Several such techniques – most notably the logarithmic scaling techniques of Lodge (13) – offer the potential to enhance the solution evaluation aspects of TRIZ. Software implementations of integrated TRIZ/MCDA can be expected to appear in the very near future.

TRIZ and Six Sigma
As described by Domb (14), Six-Sigma is more a decision than a method. Perhaps the greatest thing it can teach TRIZ is the highly effective manner in which it has marketed and spread itself. At a more detailed level, there are a number of detailed tools and techniques contained in (but not necessarily created by) Six Sigma. These tools centre mainly around the process of problem measurement, and specifically variants of Stewhart/Deming based statistical process control techniques. They offer the potential for some small beneficial advance once incorporated into the problem definition elements of TRIZ.

TRIZ and Theory of Constraints (TOC)
The process of integration of Eli Goldratt's Theory of Constraints into TRIZ has also begun (15). The Theory of Constraints matches TRIZ in its recognition of the importance of defining and eliminating contradictions and while it offers less in terms of strategies to overcome contradictions, it does offer the Evaporating Cloud tool which does offer increased richness in terms of increasing problem understanding and entry points for breaking the contradictions. Related to this, but also a much more important area where TOC can be expected to enhance TRIZ comes with its emphasis on modelling causes and effects inside systems. This area looks set to be the main conceptual enhancement to TRIZ, but several other important TOC ideas (identification of bottlenecks, strategies for overcoming bottlenecks for example) can be expected to find their way into future TRIZ/'systematic creativity' models.

TRIZ and De Bono
The work of Edward De Bono is both extensive and widespread in its use. Many of the strategies identified or uncovered by DeBono have direct equivalents in TRIZ – for example the idea of working back from an ideal rather than working forward from the known solution (albeit DeBono has nothing as extreme as the Ideal Final Result strategy in TRIZ), the importance of function, the need to shift from either/or to win/win thinking, the trend for systems to evolve in a manner which sees complexity increase before it can decrease, and the concept of psychological inertia and tools to overcome all exist in some form in both pieces of work.

Elements of Dr DeBono's work that have no direct equivalent in classical TRIZ include the Six Thinking Hats™ idea, water logic versus rock logic, the 'po' operator, and 'sur/petition' concepts. The thinking hats concept – and specifically the idea that different modes of thinking are treated very differently in the human brain and so should be segmented – is particularly useful in the context of being able to use the bigger, more complete TRIZ processes like ARIZ to more potent effect (16).
In several senses, the psychological and physiological elements of DeBono methods offer more to help direct and influence the evolution of 'systematic creativity' than TRIZ, and consequently it would be inappropriate to ignore the opportunities presented by further integration of the two.

TRIZ and NLP

Although instigated more recently than TRIZ, Neuro-Linguistic Programming has evolved from a very similar philosophical startpoint. Both TRIZ and NLP have been built on the idea of the studying and abstraction of excellence. In the case of TRIZ, the global scientific and patent databases provided the basis of method development; in the case of NLP it was cognitive science research into linguistics, psychology, cybernetics and anthropology. Both have sought to study 'creativity' from the perspective of modelling known successful creative personalities. Latterly, NLP has drawn additional knowledge from psychotherapy – including Gestalt and Hypnotherapy. Perhaps these latter two extensions have tended to draw NLP away from the mainstream somewhat, and certainly exploitation of NLP in business or scientific practices for example is practically non-existent in most fields of endeavour. This is undoubtedly a pity as NLP offers significantly greater richness than TRIZ in many areas. Initial research to understand the areas of common ground and opportunities for mutual benefit (17) between TRIZ and NLP have highlighted a significant number of high level concepts that exist in one or the other but not both.
By way of a simple example, reference 18 discusses the 9-window or 'system operator' scheme in TRIZ and how NLP can be used to extend its essentially two-dimensional space and time perspective into a third dimension which might be called 'interface' or relationship. Figure 4 illustrates this new three-dimensional operator as an example of a concept that exists in neither TRIZ or NLP, but emerges purely from the integration of the two.

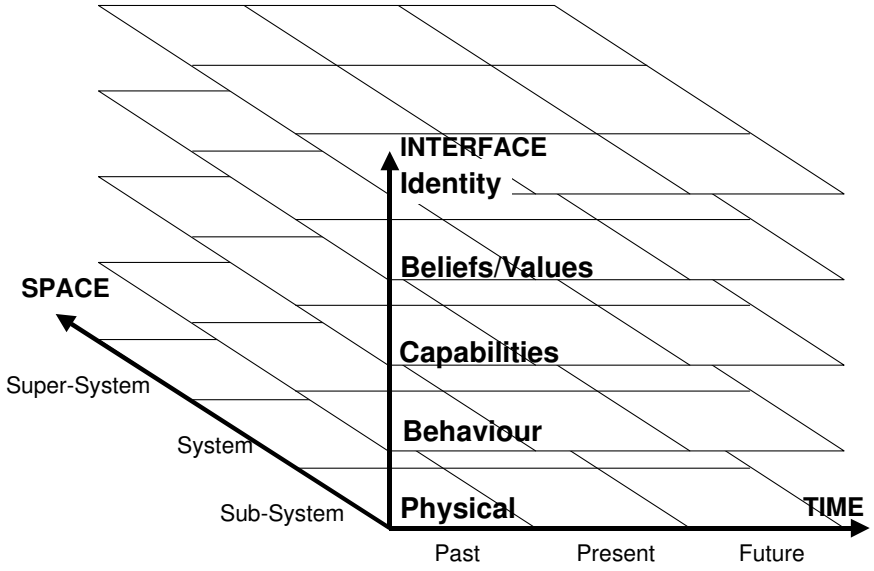

Figure 4: Extension of TRIZ System Operator into 3-Dimensions Using NLP

The integration of TRIZ and NLP tools, methods and philosophies (both rightly claim to feature such hierarchies of application) is very much at the beginning of what may be expected to be a long and fruitful road. Several important conceptual advances can be expected to emerge. Some of the ones already identified include:-

- strategies emerging from NLP research into application of combinations of inventive principles
- explanations of why 'asymmetry' provides such an important inventive strategy
- identification of how the meta-programmes underlying the way the human brain work and how they in turn determine our behaviours both individually and in groups.

TRIZ and Kansei

As TRIZ extends further towards industrial design, architecture and the arts it becomes apparent that issues like aesthetics are not well handled by current models. The idea that it is possible to systematise those elements of design that relate to the things we describe as 'x-factors' and other labels implying that we don't understand what makes one design better than another one, is positively offensive to some. Kansei engineering on the other hand represents an attempt to achieve exactly this kind of understanding of why people prefer one artifact over another one. Kansei is undoubtedly also at the beginning of its evolutionary potential. It is already possible to embody a number of Kansei principles and strategies into a tool integrated into the TRIZ/'systematic creativity' framework, but too soon to speculate on whether the integration of the two will create new high level conceptual benefits. All we can say with certainty, is that TRIZ is weak on aesthetic issues and that Kansei is currently the best available tool to explore as a suitable foundation for integration.

FURTHER AHEAD

We have speculated here that TRIZ is but one component of a higher level creativity capability we have chosen to label 'systematic creativity'. We believe that it is fundamental to the evolution of such a 'systematic creativity' model is that it will emerge – initially at least – from the integration of the different tools, methods and philosophies that currently exist.

There are several emerging creativity models that have not so far been explored in the context of their place in a bigger 'systematic creativity' picture. These include game theory, chaos theory, spiral dynamics and general periodicity. Work to explore the relevance and potential benefits of integrating these models into the TRIZ-based model described here (or, indeed, the other way around) has barely begun at this point in time.

In the meantime we all have problems to solve, and opportunities we wish to explore in inventive ways. Some people may want just a few tools or strategies to help them, others may be looking for a higher level start-to-finish process, and still others are looking for a higher level creativity philosophy from which they hope everything else might emerge. In other words, we are all different, work in different ways and want different things. There is currently no single 'creativity' entity that will satisfy every individual desire. If there ever is, one thing it will have to encompass is due recognition of individual difference, and (to introduce a TRIZ concept) be self-adapting to accommodate those differences. At a practical level, this might simply mean that person A likes DeBono, TRIZ and QFD, while person B uses NLP and TOC and doesn't like TRIZ and that both can still work effectively together. The aim of the CreaTRIZ creativity framework (19) is to achieve this kind of flexibility. As with a 'systematic creativity' s-curve, it is still early days. Our hope is that we've at least realised a framework that offers users the prospect of tangible benefit now.

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