An Introduction to TRIZ: The Theory of Inventive Problem Solving

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Teoriya Resheniya Izobreatatelskikh Zadatch or TRIZ is the Theory of Inventive Problem Solving. TRIZ is a philosophy, a method and a collection of problem definition and solving tools and strategies. The whole emerges from one of the biggest studies of creativity ever conducted with over 1500 person years of research and the study of over two million of the world's most successful patents built into it.

The key findings of TRIZ research are:-

- that all innovations emerge from the application of a very small number of inventive principles and strategies
- that technology evolution trends are highly predictable
- that the strongest solutions transform the unwanted or harmful elements of a system into useful resources.
- that the strongest solutions also actively seek out and destroy the conflicts and trade-offs most design practices assume to be fundamental.

TRIZ offers users access to the knowledge and experiences of the world's finest inventive minds. It is intended to complement and add structure to our natural creativity rather than replace it.

TRIZ can be used in a number of different ways. An overall process enables users to systematically define and then solve any given problem or opportunity situation. Some users will rigorously apply this process. Others are happier extracting individual elements from the overall structure and using those. Although TRIZ is easily the most exhaustive creativity aid ever assembled, it inevitably contains some gaps and holes. In keeping with TRIZ philosophy, TRIZ researchers are actively looking outside TRIZ at the best of creativity practice from all disciplines and integrating them together into a seamless whole. The overall aim of TRIZ has been to construct a problem definition and solving process that works for any situation users may care to throw at it – whether that be technical or non-technical, simple or complex, highly constrained or clean-sheet, step change innovation or incremental improvement, or focused on products, processes or services. TRIZ effectively strips away all boundaries between different scientific, engineering and creative disciplines and its effectiveness has been proved across a broad spectrum of fields and problem types.

TRIZ is both simple and complex. To learn and gather a working knowledge of the whole structure will require a considerable investment of time. Some people are prepared to make this investment, and others are not. Those that are not usually take great comfort from the fact that they will be able to learn and realise significant benefit from just a short exposure to individual elements of the overall structure. In many instances these benefits are enough to create substantial benefits in both personal creativity and bottom-line business benefit. The TRIZ philosophy tries to accommodate the full range of possible individual requirements. The aim of the articles to be published in this and future volumes of *Creativity and Innovation Management* is to offer readers an insight into the big 'systematic innovation' picture, how that picture is changing in light of ongoing TRIZ research, and how companies are achieving benefit from the widespread application of TRIZ, as well as providing state-of-the art information on the development, evolution and application of individual tools and strategies within the armoury of TRIZ and other innovation and creativity methods.

TRIZ is different to most other creativity aids, and may appear a little unnatural at first. Here are some of the things that may help how to think about TRIZ and the way it can be used:

TRIZ Basics

TRIZ is about providing means for problem solvers to access the good solutions obtained by the world's finest inventive minds. The basic process by which this occurs is illustrated below. Essentially, TRIZ researchers have encapsulated the principles of good inventive practice and set them into a generic problem-solving framework. The task of problem definers and problem solvers using the large majority of the TRIZ tools thus becomes one in which they have to map their specific problems and solutions to and from this generic framework.

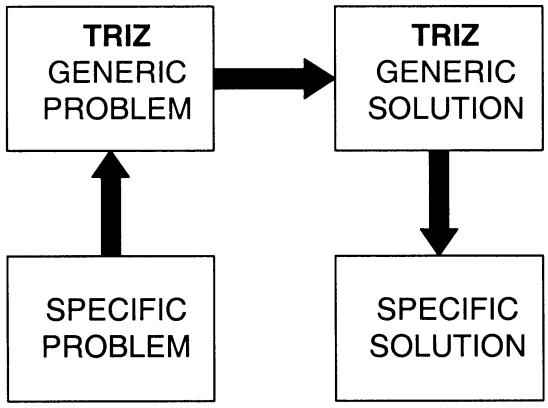

Figure 1: The TRIZ Process

The Four Pillars of TRIZ

1500 person years of TRIZ research have produced a significant number of innovation tools and methods.. This section offers a brief summary of the four main elements that make the method distinct from other innovation and problem solving strategies.

Contradictions

TRIZ researchers have identified the fact that the world's strongest inventions have emerged from situations in which the inventor has successfully sought to avoid the conventional trade-offs that most designers take for granted. More importantly they have offered systematic tools through which problem solvers can tap into and use the strategies employed by such inventors. The most commonly applied tool in this regard is the Contradiction Matrix – a 39×39 matrix containing the three or four most likely strategies for solving design problems involving the 1482 most common contradiction types. Probably the most important philosophical aspect of the contradiction part of TRIZ is that, given there are ways of 'eliminating' contradictions', designers should actively look for them during the design process. A management version of the Contradiction Matrix idea has recently emerged from TRIZ research – and will be described in a future article.

Ideality

While studying the patent database, TRIZ founder Genrich Altshuller identified a trend in which systems always evolve towards increasing 'ideality' and that this evolution process takes place through a series of evolutionary S-curve characteristics. A key finding of TRIZ is that the steps denoting a shift from one S-curve to the next are predictable. A number of underlying technology evolution trends consistent with the ideality concept have been identified during the course of research on the global patent database. Used as a problem definition tool, the ideality part of TRIZ encourages problem solvers to break out of the traditional 'start from the current situation' type of thinking, and start instead from what is described as the Ideal Final Result (IFR). The simple definition of IFR is that the solution contains all of the benefits and none of the costs or 'harms' (environmental impact, adverse side-effects, etc). Although there are many instances where systems have been seen to evolve all the way to their Ideal Final Result, many have not. The method gets users to think about these situations by working back from the IFR to something which is practicably realisable. Generally speaking these solutions incorporate the concept of systems solving problems 'by themselves'. The key word is 'self'; things that achieve functions by themselves – self-cleaning, self-balancing, self-heating, self-aerating, etc – all represent, when incorporated in a true TRIZ fashion, very powerful and resource-efficient solutions.

Functionality

Although the functionality aspects of TRIZ owe a significant debt to the pioneering work on Value Engineering, the method of defining and using functionality data is markedly different; sufficient at the very least to merit discussion as a distinct paradigm shift in thinking relative to traditional occidental thought processes. Three aspects are worthy of particular note:-

1) The idea that a system possesses a Main Useful Function (MUF) and that any

system component which does not contribute towards the achievement of this function is ultimately harmful. In a heat exchanger, for example, the MUF is to transfer heat to the working medium; everything else in the system is there solely because we don't yet know how to achieve the MUF without the support of the ancillary components.

2) In traditional function mapping, the emphasis is very much on the establishment of positive functional relationships between components. TRIZ places considerable emphasis on plotting both the positive and the negative relationships contained in a system, and, more importantly, on using the function analysis as a means of identifying the contradictions, in-effective, excessive and harmful relationships in and around a system. Function and attribute analysis thus becomes a very powerful problem definition tool.
3) Functionality is the common thread by which it becomes possible to share knowledge between widely differing industries. A motor car is a specific solution to the generic function 'move people', just as a washing powder is a specific solution to the generic function 'remove dirt'. By classifying and arranging knowledge by function, it becomes possible for manufacturers of washing powder to examine how other industries have achieved the same basic 'remove' function. '*Solutions change, functions stay the same*' is a message forming a central thread in the TRIZ methodology.

Use Of Resources

The Resources part of TRIZ relates to the unprecedented emphasis placed on the maximisation of use of everything contained within a system. In TRIZ terms, a resource is *anything in the system which is not being used to its maximum potential*. TRIZ demands an aggressive and seemingly relentless pursuit of things in (and around) a system which are not being used to their absolute maximum potential. Discovery of such resources then reveals opportunities through which the design of a system may be improved. In addition to this relentless pursuit of resources, TRIZ demands that the search for resources also take due account of negative as well as the traditionally positive resources in a system. Thus the pressures and forces we typically attempt to fight when we are designing systems, are actually resources. By way of an example of this 'turning lemons into lemonade' concept, TRIZ users often think of resonance as a resource. This is in direct contradiction to most Western practice, where resonance is commonly viewed as something to be avoided at all costs. TRIZ says that somewhere, somehow, resonance in a system can be used to beneficial effect. In effect, resonance is a potent force lever capable of amplifying small inputs into large outputs. Resonance is currently being used to generate beneficial effects in a number of new product developments from vacuum cleaners, paint stripping systems on ships (firing a pulsed jet of water – existing resource! – at the local resonant frequency of the hull), and in helping to empty trucks carrying powder-based substances more quickly.

Thinking in SPACE and TIME

While not strictly speaking a TRIZ development, TRIZ researchers have also recognized the enormous importance of thinking about situations from all angles. Experienced TRIZ users are continuously changing their perspective on problems – zooming in to look at the fine details, zooming out to see the bigger picture, and thinking about how the situation is affected by changing time – whether that be nano-seconds or decades – in both the past and future. This is not a natural process for most people – our brains aren't wired that way – and so TRIZ contains tools to help in the process of thinking in TIME and SPACE.

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