# Application of Triz Tools in a Non-Technical Problem Context

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## INTRODUCTION

Although initially conceived as a systematic creativity and innovation methodology for engineers and scientists, TRIZ has recently been recognised as having much to offer the non-technical, business and management communities. Indeed, the term 'systematic innovation' has as much to do with the improvement in business processes and services as it ever has to the conception of new products.

Accepting that the aim of any innovation is to increase 'value' to the receiver, Joe Pine in his book 'The Experience Economy (1), defined four elements through which businesses are able to create value. These four elements are:-

1) Origination – generating value from the *new*
2) Execution – generating value from the *done*
3) Correction – generating value from something *improved*
4) Application – generating value from something *used*

This article discusses TRIZ's applicability to the solution of management and business problems in the context of these four elements, and in the context of a global economic climate in which change is happening at an ever increasing pace (Figure 1), and competition has never been more fierce.

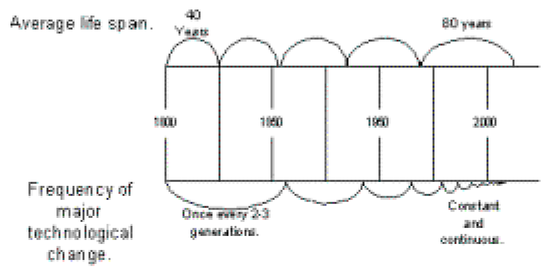


***Figure 1: Two Change Phenomena***

Innovation is seen as the principal long-term business success driver. Systematic innovation is the route by which organisations effectively mange risk and thus become business leaders.

This article examines the growing role of TRIZ in the non-technical dimensions of this systematic innovation arena. The article is split into two main areas; the first examining some of the main technical TRIZ tools and their analogous application in a non-technical, business and management environment, and the second examining case study applications of those tools.

## TRIZ TOOLS FOR NON-TECHNICAL APPLICATIONS

Although very much founded on technical foundations, all of the TRIZ tools have something of value to offer the definers and solvers of non-technical problems. This section of the article will examine some of the main TRIZ tools, methods and strategies with respect to the benefits they present in a non-technical problem context. Specifically, the following will be discussed:-

- Inventive Principles
- Contradictions
- S-Fields
- Ideality
- Trends of Evolution
- Law of System Completeness
- Multi-Screen Approach
- Trimming
- Subversion Analysis

**Inventive Principles**

Recent work (2) has begun to demonstrate that the 40 Inventive Principles currently contained in the most popular versions of TRIZ apply in a non-technical as well as a technical context. More specifically, a comprehensive search of the finest published management practises has not revealed any inventive steps which does not somehow fit into the 40 Principle framework.

That there are currently just 40 Inventive Business Principles, is considered to be a significant finding, from the perspectives of both establishing boundaries on business problems, and further confirming the universality of the TRIZ findings.

## Contradictions

The TRIZ concept of Contradictions is often quite unnatural to occidentals brought up in an environment dominated by 'trade-off' and 'compromise'. Early applications of the Contradictions tools within TRIZ in a business context – initially looking at the increasingly important 'Mass Customization' market trend (Reference 3), but also other cases – has demonstrated that for technical contradictions at least, the TRIZ methodology is only partially successful in driving problem solvers towards good solutions.

As far as business related Physical Contradictions are concerned – as will be shown in the later inventory case-study – the existing TRIZ solution strategies are rather more successful.

For both Technical and Physical Contradictions, however, it has already been observed in several instances that merely expressing a problem in terms of a contradiction – as opposed to using traditional problem definition strategies – is often enough to provide a sufficiently new perspective that good solutions begin to appear seemingly automatically.

Definition of business-related problems in accordance with TRIZ Contradictions principles is thus felt to be an extremely powerful problem solving strategy.

## S-Fields

While perhaps not immediately obvious, the substance-field problem solving tools contained in TRIZ offer powerful analogies in a business context.

One such analogy – relating 'substances' to 'customers' and 'suppliers', and 'fields' to 'communications' (Figure 2) – appears to fit extremely neatly with ideas of two substances and a field making a minimum viable system, and many of the 76 Inventive Standards associated with S-Fields.

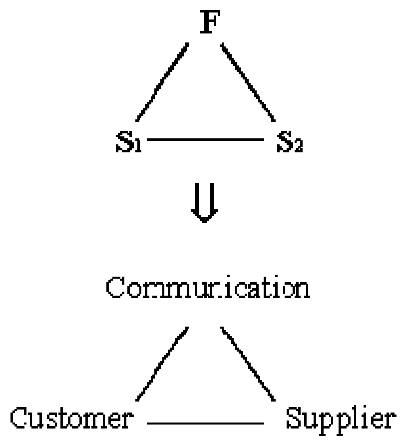

*Figure 2: 'Customer-Supplier-Communication' S-Field Analogy*

As with the substance-field model, all of the terms in the business analogy need to be utilised in the most generic sense possible. Thus 'customers' and 'suppliers' can be both internal and external to the organisation, and 'communication' refers to any form of interaction between the two 'substances'. Such a model certainly passes the test that all three elements must be present if a system is to be viable. As will be demonstrated later, the model also holds true with respect to the Inventive Standards, and hence may be seen as a potentially potent new business innovation tool.

**Ideality**

The TRIZ concepts of ideality and Ideal Final Result (IFR) are both directly applicable in the business as well as the originally intended technical sense. The IFR definition 'achieve the function without the resource' has particular relevance to the likely future evolution of organisation structures.

**Trends of Evolution**

The evolution trend towards increasing ideality also applies in both technical and non-technical contexts. As in the technical context, this trend has a strong influence on many of the other evolutionary trends observed by TRIZ researchers.

Some of these trends may be seen to possess direct relevance in the non-technical, business and organisational contexts:-

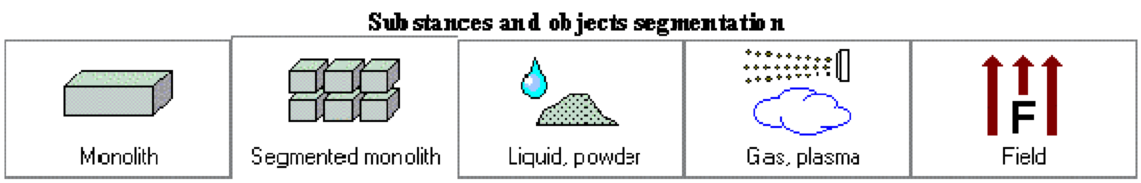


***Figure 3: 'Substance and Object Segmentation' Trend***
(taken from TOPE 3.01)

**Substance and Object Segmentation** – the trend which shows objects transition from the macro to the micro-scale (Figure 3) applies to business evolution from the perspectives of both customers ('mass customization' again) and organisations (evolution from 'blue-collar' to 'machinist' to 'work team' to 'worker' to 'person' for example).

The evolution towards 'fields' has relevance in the non-technical context if the term is considered analogous to 'emotions' or 'feelings'. For example, thinking of customers, many products are now beginning to be tailored to be responsive to not just individual customers, but to individual customer moods – e.g. hotel rooms which allow the occupant to alter the feel of a room through use of variable colour lights.

**Geometric evolution of linear constructions** – Figure 4. Another trend with direct non-technical corollaries.

The trend may be seen to apply in a number of contexts in connection with both customers and internal organisation and communication structures – for example the evolution from individual artisans, to 1D hierarchical organisations to 2D matrix-management structures to the emerging 3D ‘spherical organisations (Reference 4), to – if ‘time is interpreted as a fourth dimension – the idea of time-variant organisation structures.

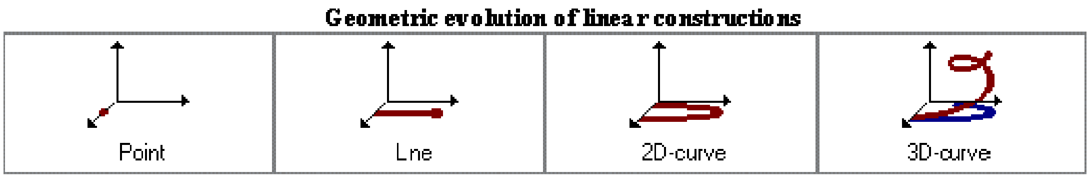


*Figure 4: ‘Geometric Evolution of Linear Constructions’ Trend*

**Action Co-ordination** – a trend with links to various business and organisational issues, notably, in line with the S-Fields analogy, relating to communication flows, and interface issues between adjacent parts in a process flow . The trend is illustrated in Figure 5.

That many current organisational communication and process flows are still at the ‘uncoordinated’ or ‘partially co-ordinated’ stages in the evolution path suggests there is still much scope for improvement in these areas.

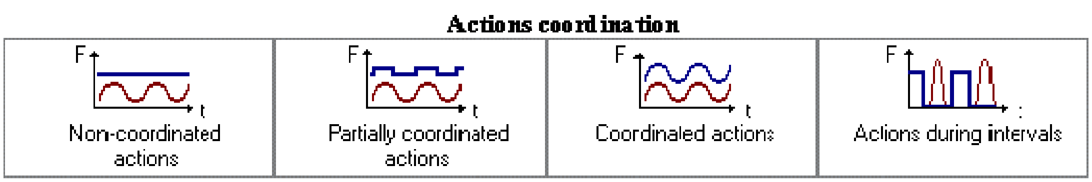


*Figure 5: ‘Action Co-ordination’ Trend*

**Mono-Bi-Poly** – another trend with direct applicability in a non-technical system evolution context.

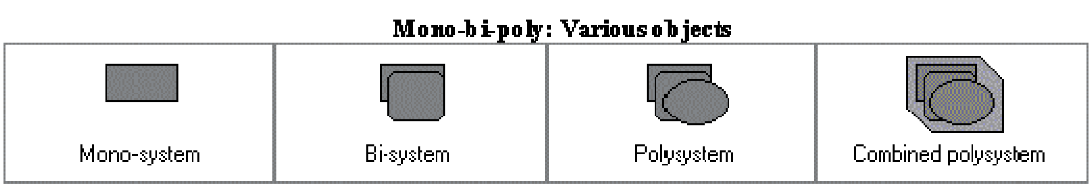


**Figure 6: ‘Mono-Bi-Poly’ Trend**

The mono-bi-poly trend is particularly evident in symbiotic marketing applications such as the integration of film, soundtrack and merchandising in the entertainment industry, or in a number of multi-media applications.

Collectively, the trends offer much to business developers and managers with respect to both organisation and business evolution paths but also, used in their original technical sense, to identify future product, process and service opportunities. There is much synergy here between TRIZ and, particularly at the concept definition stage, QFD. Much has been written about the two methodologies being used in an integrated manner, but little of tangible benefit appears to have emerged at this time. One area in which the two are beginning to be used successfully together, however, centres around possible means of overcoming the usual QFD criticism that the output from the method is degraded by the inability of most customers to foresee the future evolution possibilities of a product (no surveyed SLR camera user is going to ask for a digital camera, for example). The trends of evolution provide powerful means of overcoming such deficiencies, in that the engineers and marketeers are able to use the trends to define what the future development possibilities are – in some parlance 'defining the sales brochure x-years hence'. An outline of the envisaged sequence of such a process is illustrated in Figure 7.

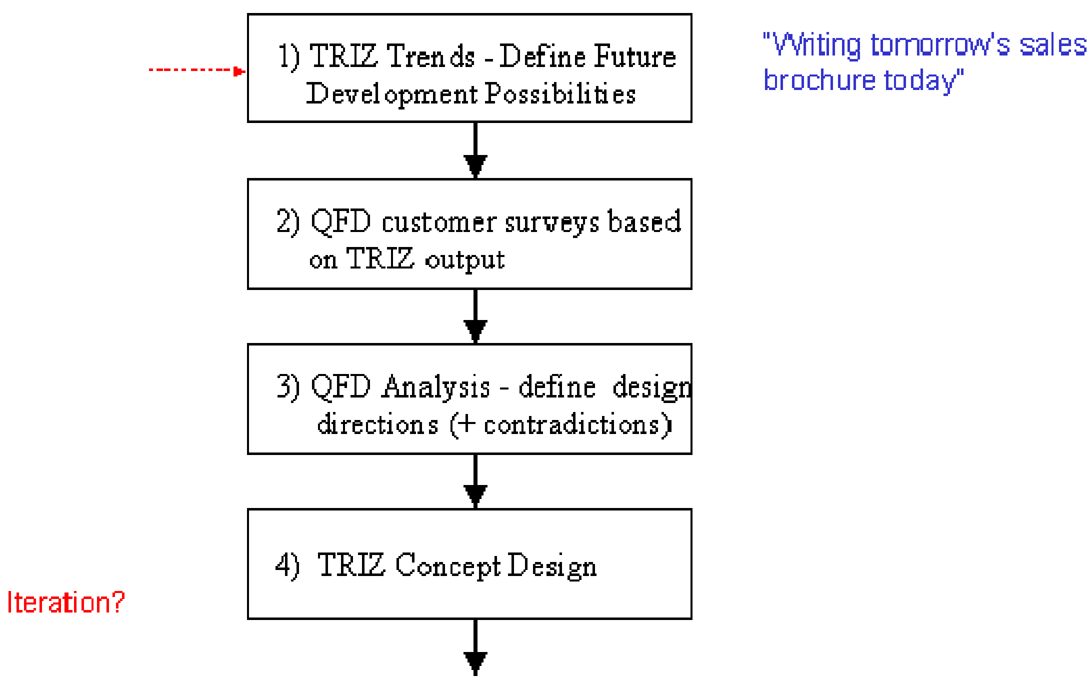


***Figure 7: Defining The Customer Needs Using QFD and TRIZ***

The need for the above process to be iterative can only be speculative at this point in time. It is difficult to find any organisation willing to commit the often copious amounts of time demanded by a thorough QFD analysis, never mind suggesting that there may be a benefit in doing more than one analysis. The proof will come only through demonstrable success.

**Law Of System Completeness**

The TRIZ Law of System Completeness states that every technical system can only be complete if it contains the four elements; *engine*, *transmission*, *control unit*, and *working unit* (Reference 5). In many senses, this model also has relevance in an organisational context. The Law, in fact, correlates very well with the organisational study work of Stafford Beer. In Beer's Viable System Model (Reference 6, 7), there are in fact shown to be five key elements which must be in place if an organisation is to be able to operate effectively. The correlation between the TRIZ Law and the VSM model is illustrated in Table 1.

Comparisons between the two models highlight a number of points of interest:-

1) Co-ordination – the fifth essential test of viability in Beer's model has no equivalent in the TRIZ Law. Specifically in the VSM model, the Co-ordination requirement refers to the means by which the system communicates with other systems and, more importantly in TRIZ terms, with the super-system. Beer's justification of the need for this fifth element as a test of system completeness is comprehensive in its organisational context. Further work will be required to establish whether the Co-ordination parameter also has merit in the technical context. One suspects that, because any technical system has at some point got to interface with an outside entity, it must have.

| TRIZ Law of System Completeness | Stafford Beer Viable System Model |
|---|---|
| Engine | Policy |
| Transmission | Intelligence |
| Control Unit | Control |
| Working Unit | Implementation |
| | Co-ordination |

**Table 1: Comparison of TRIZ and VSM 'System Completeness' Laws**

2) The idea of recursion in systems is an important idea within the VSM philosophy. In an organisational context the recursion idea means that the model for each viable system needs to be repeated at different levels in the system hierarchy (thus also helping to re-enforce the importance of the co-ordination element acting between the various different viable systems). The recursion idea appears to offer much to TRIZ thinking with respect to both technical and non-technical problems.

3) The Corollary to the Law of System Completeness within TRIZ – that to make a technical system controllable, at least one of its components must be controllable (Reference 5, pp83) – in turn then offers a useful addition to both application of the law in a non-technical context (effectively saying that at least one of policy, intelligence and/or implementation must be variable), and to the Viable System Model.

The TRIZ law is often utilised only implicitly in an engineering context – if only because it very quickly becomes apparent that a system fails to function if it does not possess the four necessary elements. The Law -–and it's VSM equivalent – is usually far less well understood in an organisational context.

The common ground between TRIZ and VSM, and their combined significance in the organisational context justifies further investigation in this area.

**Multi-Screen Approach**

As with its use in its original technical context, the multi-screen tool (Figure 8) offers a very powerful method of breaking psychological inertia, and getting problem solvers to think in terms of time and space.

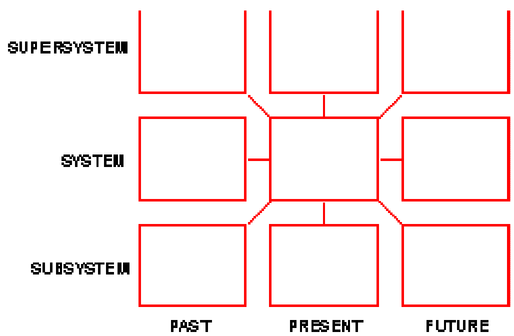


***Figure 8: Multi-Screen Approach***

The idea of thinking in space has several commonalities with the previously discussed Viable System Model and the concept of recursion at the various levels in a system hierarchy.

The idea of thinking in time also has particular significance in terms of organisational structure definition. Very few organisation structures, for example, appear to be constructed with any view towards future evolution requirements. This is a phenomenon discussed at length in Reference 8.

**Trimming**

The concept of Trimming is perhaps one of the most widely used of the TRIZ tools in the West. The concept of trimming may be seen to apply equally well in both technical and non-technical applications when combined with due consideration of functionality issues.

Related trimming techniques such as the ARIZ 'x-component' are also useful from the perspective of breaking psychological inertia in non-technical problems – e.g. introduction and trimming of the x-person or x-department.

The trend in which system evolution progresses through a period of expansion (increase in complexity) followed by a period of trimming as the system matures beyond a certain point in its S-curve (Reference 9) is seen to also apply in an organisational context, and as such, also therefore offers important models for management system improvement.

**Subversion Analysis**

Few if any of the 'design for reliability' and 'robust design' tools developed for use in engineering applications has yet found their way into use in a non-technical context. Of all these tools, the TRIZ-originated subversion analysis methods appear to offer the most direct and beneficial application in a business management and organisational environment. Organisational structures are often shown to be extremely non-robust systems and thus anything which forces managers and organisational developers to ask questions like 'how can I destroy this system?' in a structured and positive way has got to be seen as a step forward in terms of building robust working methods.

**CASE-STUDIES**

**Economic Batch Quantity**

This example derives from use of the Theory of Constraints to help eliminate trade-offs (Reference 10). The article concerns the trade-offs traditionally associated with the calculation of economic batch quantities (EBQ) in a production manufacture environment. The problem scenario highlights a conflict between a desire to minimise machine set-up times and a parallel desire to minimise inventory carrying cost. The conflict is illustrated in terms of the relationship with EBQ in Figure 9.

As described in a more comprehensive analysis of the problem (Reference 11), the parabolic shape of the net cost curve denotes the presence of a physical contra-diction in which EBQ is required to be both large and small.

Whereas the traditional approach to the EBQ calculation has involved complex scientific trade-off analysis:-

$$\text{EBQ} = \sqrt{\frac{2 \text{ X Annual Demand X Setup Cost}}{\text{Inventory Carrying cost/unit}}}$$

TRIZ offers a range of solution options which eliminate rather than accept the trade-off answers.

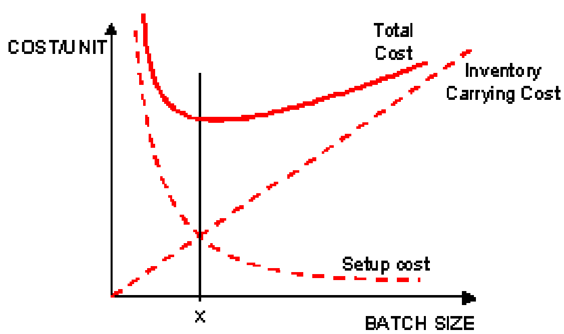


**Figure 9: EBQ Contradiction**

As discussed in the Reference 11 analysis, the TRIZ solution strategies for eliminating the physical contradiction:-

**Separate in Space** – Segmentation (Principle 1) – splitting of batches into different sizes in different parts of the manufacture operation – for example segmentation into ‘process’ and ‘transfer’ batches.

**Separation in Time** – Dynamics/ Preliminary Action – active calculation and re-calculation of EBQ according to prevailing market conditions, time of week, or even time of day.

**Satisfying the Contradiction** – Strong Oxidants (Principle 38) (‘Boosted interactions’ in a non-technical sense – Reference 2) – elimination of ‘batches’ altogether in favour of a much more active manufacture setup in which successive parts of the line communicate effectively with each other – in many senses, much in common with the TOC-founder, Eli Goldratt’s ‘Critical Chain (Reference 12) recommendation.

**Alternative Ways** – Transition to Sub-system – Segmentation – operation of split-batches.

**Food Manufacture Evolution**

Most if not all manufacture operations face a conflict resulting from the ideality equation in which the desire to increase customer benefit contradicts with the desire to minimise costs and harms. In many arenas, because reduced cost is seen by many customers as a ‘benefit’, the conflict is usually resolved in the direction of reducing costs and harms. This usually results in large, centralised manufacture operations. Conversely, taking customer benefits in the mass customization context to mean giving each individual customer exactly what they want, the ideality conflict is predominantly solved by having many, distributed manufacture operations – Figure 10.

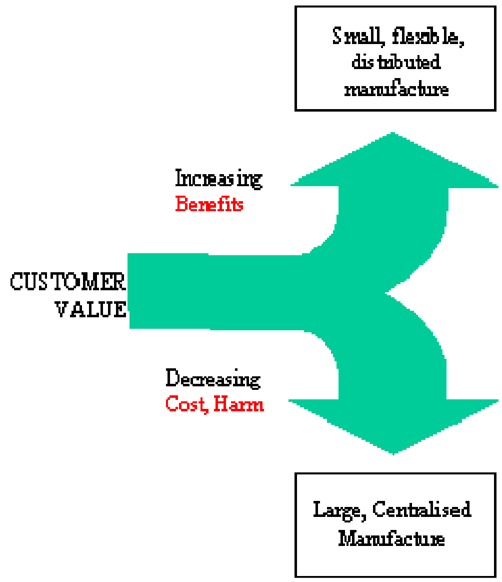

**Figure 10: Divergent Evolution In Manufacture Operations**

The centralised mass-production versus distributed, flexible manufacture debate is particularly evident in the food industry at the present time in Europe and the US.

In relation to the TRIZ observed trend towards ever increasing ideality, and the IFR, it appears clear that ultimately, the conflict must be resolved in favour of increased benefits (IFR = achieve the benefits without cost or harm), and, in turn, therefore, in the direction of small, flexible distributed manufacture operations. This conclusion fits nicely with the work of Schumacher (Reference 13), albeit being derived from a very different perspective.

Evidence to support the direction comes through the evolution in the steel industry of distributed mini-mills, and, even more so, in the brewing industry by the growing popularity of micro-brewery produced beers.

The observed trend from macro- to micro scale also supports the market direction. Taking into account the evolution from the 'individual' to the moods of the individual suggests even more profound evolution towards local manufacture set-ups which are flexible enough to cope with a customer who's needs change in the space of a day or even hours. This is becoming apparent in the case of food manufacture, and particularly so in the area of fast products like burgers ('how would you like your burger cooked?'), ice-cream and beverages.

Other TRIZ findings suggest that it is usually a new player that is able to enter the market with the benefit offerings. The problem for existing, mass-manufacture companies, is that they are forced to take into account the costs of change in their calculations – not least of which is the need for the organisation structure to evolve to match the technological evolutions necessary to achieve economically viable, small, flexible, distributed manufacture operations… which in turn points towards the use of other TRIZ problem solving strategies.

**3-Day Car**

The Japanese motor industry was the first to recognise the importance of an effective car delivery supply chain. The time from a customer ordering a car from a dealer to delivery of the car in the US today is typically 60-90 days, in the EU it is 40-60 days and in Japan it is 3-21 days. In the UK the delivery statistic masks the additional problem of a 75% likelihood that a customer will not be able to get the desired options in the quoted delivery time.

There are two basic routes by which car manufacturers might improve their order to delivery performance; the first involves a rigorous functional analysis of an existing system and a subsequent use of trimming techniques; the second involves a more radical IFR based approach. The trimming approach is actively being pursued in a number of projects around the world, including the work summarised in Reference 14.

The IFR approach, on the other hand opens up a similar debate to the one discussed for food manufacture above. Defining the IFR car delivery process as 'delivery of exactly what the customer wants, when they want it' appears to lead to two very different deployment strategies. The first – eliminating the dealer totally, and making use of virtual sales and a lean, flexible, centralised production capability – is currently being operated by Daewoo too potent effect. The second route involves a considerably greater role for the dealer, in that much of the individual customer specific options are installed at the dealership rather than the factory. The ongoing debate centres around just how far this local production capability should extend.

The issues involved in the ‘3-Day Car’ debate are clearly complex – particularly so when attempting to take into account the (multi-screen) time effects associated with ensuring adequate responsiveness to future market evolution patterns. TRIZ offers much to help quell the complexity and to help define the ‘right’ problems to solve, but it would be fair to say that ongoing analyses are also necessitating use of other tools and techniques (Figure 11) in order to ensure the integrity of the conclusions.

The case for integration of TRIZ with other problem definition and solving tools and methods is forcibly made by the complex issues associated with this problem.

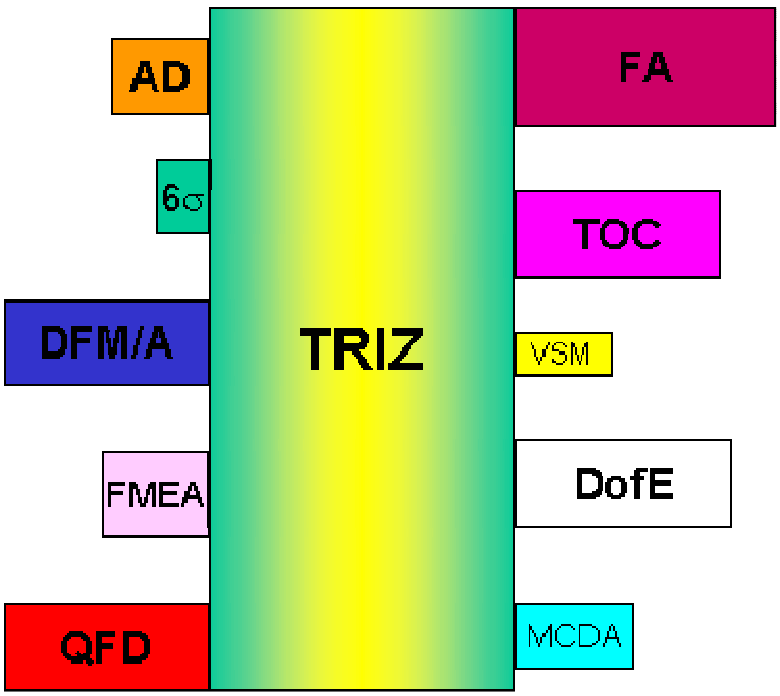


***Figure 11: Integration of Systematic Innovation Tools***

## Improving Communications

Achieving effective communications between different parts of an organisation is a perennial problem. Group 2.2 (‘Evolution of an S-Field model’) of the 76 Inventive Standards, when interpreted in a non-technical context, offer a number of useful triggers to help improve such communications. For example – 2.2.1 - replacement of an uncontrolled field (word of mouth) with a controlled one (Intranet) is becoming very common. Similarly, increasing the degree of fragmentation (2.2.2), increasing dynamisation (2.2.4), shifts from uniform fields with unordered structure to non-uniform fields with ordered structure (2.2.5) (e.g. virtual brainstorming), etc have all been used to good effect.

Group 2.3 Standards – Evolution by Co-ordinating Rhythms – have likewise been seen to be effective, especially in instances where the customer and supplier making up the S-Field are remotely situated. The idea of matching the frequency of the field (communication) with the natural frequency of the customer (Standard 2.3.1) is used in many Just-In-Time supply operations for example. Similarly matching of the frequencies of customer and supplier (2.3.2) or performing of actions during intervals (2.3.3) are effective strategies when customer and supplier are separated by several time zones.

Group 3 Standards – Transitions to Supersystem and Micro-Level – also contain a number of useful communication improving triggers when seen in relation to either multi-partner collaborative activities or different levels of an organisation hierarchy.

Standard 3.1.3 – 'efficiency of bi- and poly systems can be increased by increasing the difference between system components' was recently used to good effect in a recent, high risk, high value R&D project in which two parallel running project teams were formed. The first project team was sized along very traditional project team lines in accordance with the perceived task size, and contained a traditional balance of different skill types. The second team, on the other hand, was deliberately and significantly under-staffed and was assembled along very non-traditional lines with known 'maverick' types. The results from the project demonstrated an extremely effective (and, incidentally unanticipated) level of two-way idea transfer between the two teams.

## FUTURE WORK

Use of TRIZ in a business and organisational context is still at a relatively unexplored stage in its evolution. During the course of using and researching the method, a number of areas requiring further development have been identified. These include:-

a) means to improve the solution of non-technical problems – probably through a new version of the Contradiction Matrix

b) means to improve the problem definition process - through integration with Axiomatic Design methods (Reference 15) in a non-technical context

c) means to improve the problem definition assumption challenge, and problem constraint handling processes – through integration of TRIZ and the various tools contained within the Theory of Constraints

d) means to improve the solution down-select process – most likely through integration of TRIZ with Multi-Criteria Decision Analysis (MCDA) methods (Reference 16)

e) better integration of TRIZ and VSM methods.

Several of these – including a project to generate a non-technical Contradiction Matrix – are presently underway at the University of Bath.

**CONCLUSIONS**

1) TRIZ provides a powerful framework from which to systematically define and solve business, organisational management and human relations type problems.

2) Most if not all of the TRIZ tools, methods and strategies originally configured for use in solving technical problems have direct or analogous application in a non-technical context.

3) In combination with other management problem definition and solving methods, TRIZ offers already offers a uniquely powerful systematic creativity and innovation methodology.

4) A significant amount of work is still required to develop and deploy the methodology.

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