New and Emerging Contradiction Elimination Tools

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The paper discusses a systematic programme of patent and science-based research that has culminated in the production of a range of new matrices for the TRIZ toolkit, in particular, the creation of new generic matrices aimed at technical, business and software applications. The new technical matrix tool updates both the form and content of the original matrix, expanding the list of parameters it contains, increasing the inventive principle recommendations for each contradiction, and also making it easier for users to connect their specific problem to the generic framework. The paper also discusses the creation of a number of company and industry-specific matrix tools based on the mass of research data collected, and discusses the likely future evolution of the contradiction elimination toolkit.

Introduction

The classical TRIZ contradiction matrix (Altshuller, 1999) presents users with a conceptually simple means of tapping in to the successful contradiction-eliminating strategies of the world's most successful problem-solvers, presenting a simple 39 × 39 array of parameters relevant to technical problem situations. To use the matrix, problem-solvers are required only to identify and match pairs of things that they wish to improve and things that get worse or prevent them from making the desired improvement onto one or more of the 39 parameters. Then, at the intersection of the improving and worsening parameters in the matrix, the user is able to identify the numbers of the inventive principles most commonly used to successfully challenge that particular conflict pair. Despite being conceptually simple, however, the classical matrix is in need of some attention in order to make it effective for modern-day problem-solvers. The paper describes some of the output of a programme of systematic research to update and refine the matrix. An earlier paper (Mann and Dewulf, 2003a) the form and content of that research programme, while a complete book (Mann et al., 2003b) offers details of the full output of the research and in particular presents the full new technical matrix in all of its detail.

The aim of this paper is to describe some of the underlying philosophy behind the structuring of the new technical matrix, and the equivalent matrices designed for software and business applications. It is also to describe how the tool fits into a longer-term strategy headed in the direction of the 'ideal contradiction matrix'. The paper is in four main sections. The first section examines the new technical matrix from the perspective of the changes in its design relative to the original. The second and third parts then discuss the business and software matrices respectively. The final section of the paper then goes on to describe the expected evolution of the matrix as the concept evolves towards its ideal final result.

New Technical Matrix

The history of the method of construction and population of the classical TRIZ contradiction matrix is largely shrouded in mythology. Essentially, the original TRIZ researchers abandoned the tool during the early 1970s, focusing their attention instead on other parts of the toolkit (Ideation International Inc., 1999). The basic concept of the tool remains attractive to newcomers to TRIZ, however. This interest unfortunately often turns into frustration when the matrix fails to deliver adequate rec-

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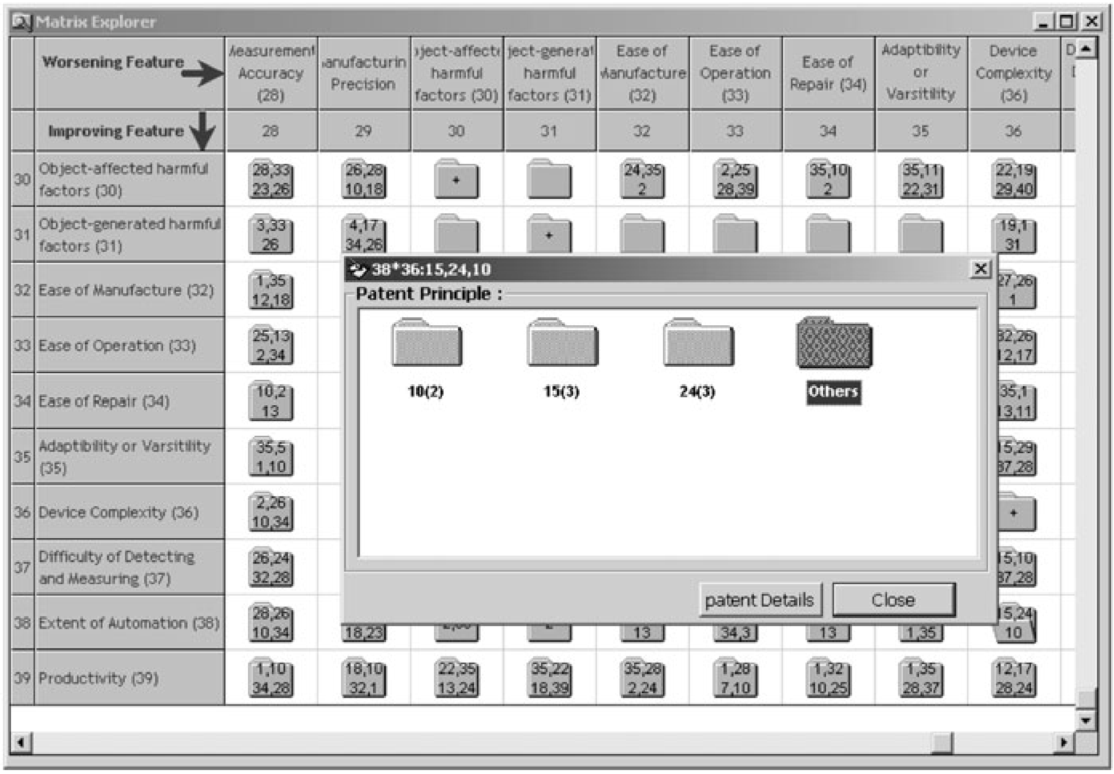

Figure 1. Matrix Explorer Software Tool Screen Shot

ommendations. As a consequence, an extensive programme of research to update the tool was instigated. Starting in the year 2000 and completing in mid-2003, over 150,000 additional successful contradiction-breaking solutions were analysed and codified. The results of the research were recorded in a specifically constructed matrix explorer tool.

The matrix explorer was primarily developed as an internal facilitation tool, but it now seems that there is a value in making uninterpreted, raw TRIZ data available to users. Specifically, there has been a desire to relate a given pair of conflict parameters not just to a series of inventive principle solution suggestions, but also to the specific patents that feature that particular conflict pair.

Figure 1 illustrates the basic configuration of the Matrix Explorer. It has been written in the Java language, and as such is intended to be usable in an online form.

The basic structure contains a number of hyperlinks that first enable a user to click onto a particular box within the matrix to determine what principles have been used to solve that conflict. This is the view shown in Figure 1 – where we see the 'extent of automation' versus 'device complexity' conflict pair being opened to illustrate the fact that in addition to finding examples of patents using the inventive principles suggested by the classical matrix (10, 15 and 24), there are a variety of other patents that have successfully challenged this conflict pair using other principles. Figure 2 illustrates the consequence of hyperlinking from this 'other' folder. It may be observed that a new screen opens up. This screen contains further hyperlinks to the specific patents that involve the conflict pair under consideration. Not shown on the screen due to lack of space, the screen containing the hyperlinks to the patent database, also describes the inventive principles used by each of the patents listed.

The screen-shots shown in these two figures illustrate the form of the matrix when using the 39 parameters as described in classical TRIZ. The next section describes the alternative structuring of these and other new parameters in the new matrix structure.

New Matrix Parameters

The principle guiding features we used when determining the form of any new matrix structure were (a) to include parameters that were not adequately addressed in the original matrix (specifically those parameters were not considered to be important when that

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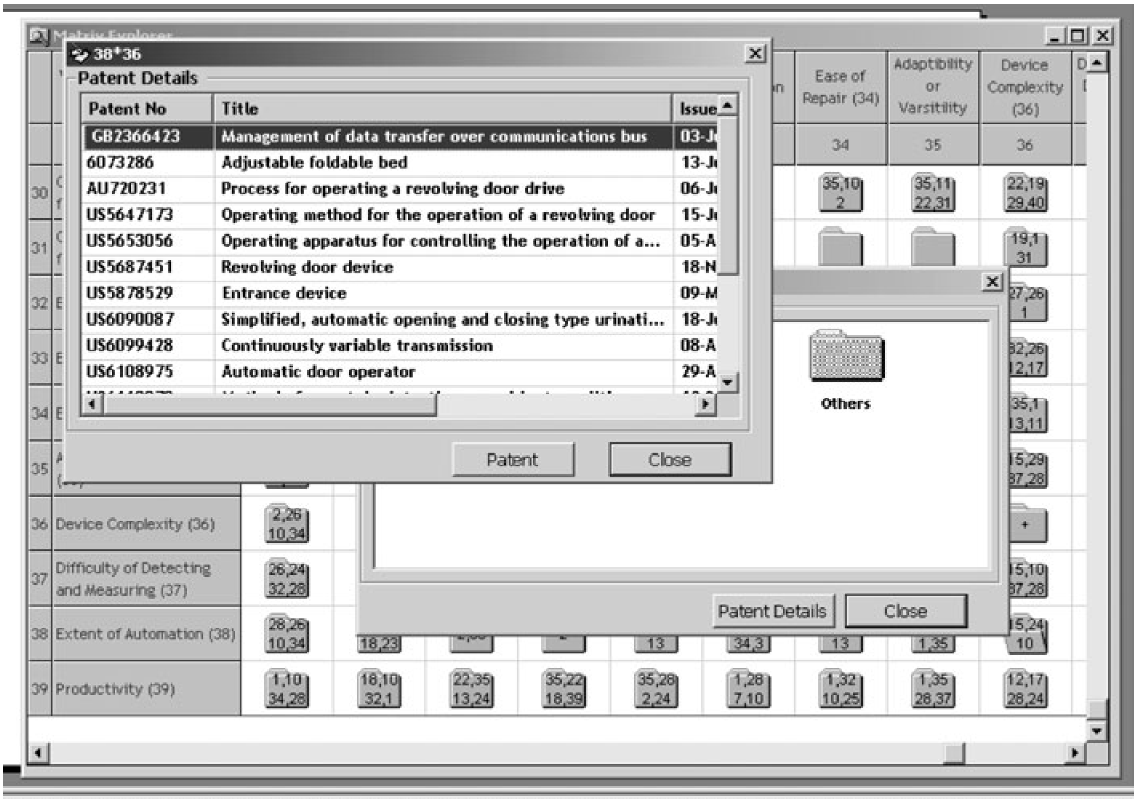

Figure 2. Matrix Explorer Software Tool – Hyperlinks to Patent Database

matrix was devised), and (b) to re-order the parameters into a more logical and informative sequence. With regard to the first issue, it is evident from the original matrix – and specifically the 'amount of information' parameter (for which the matrix contains many blank entries) – that the growth of matrix is a story of a gradually unfolding world of innovation in which new parameters become important in the design process. Issues like safety, noise and environmental factors, for example, are considered to be much more important today than they were during the 1970s.

With regard to the second issue, we have tried to re-sequence the matrix parameters in line with a general progression and shift of focus as systems evolve from their conception and infancy through to maturity and retirement (see Figure 3).

The full list of parameters in the new matrix and some of the detailed definition underlying how we placed different solutions into the different classifications is illustrated in Figure 4 below.

The new categories are:

- physical parameters
- performance-related parameters
- efficiency-related parameters
- 'ility (reliability, durability, etc) related parameters
- manufacture/cost-reduction parameters
- measurement parameters (special category)

The parameters shown in italics are the ones that were introduced into the new structure relative to the original matrix. The new parameters give an indication of how the focus of engineers and problem-solvers has broadened since the original work of the Soviet TRIZ researchers. New parameters were only included provided that a statistically significant quantity of solutions could be found to permit the recommendation of a valid array of inventive principle suggestions.

The new 'Matrix 2003' was first published in June 2003. More recent work (Mann, 2004a, 2004b) has sought to compare the new and original matrices against solutions from patents granted after the publication of the book. The overall findings of this work suggest that the likelihood that the new matrix will feature the inventive principle recommendations of the inventors of the sample successful patents is over 95 per cent compared to a figure of less than 30 per cent obtained using the original matrix.

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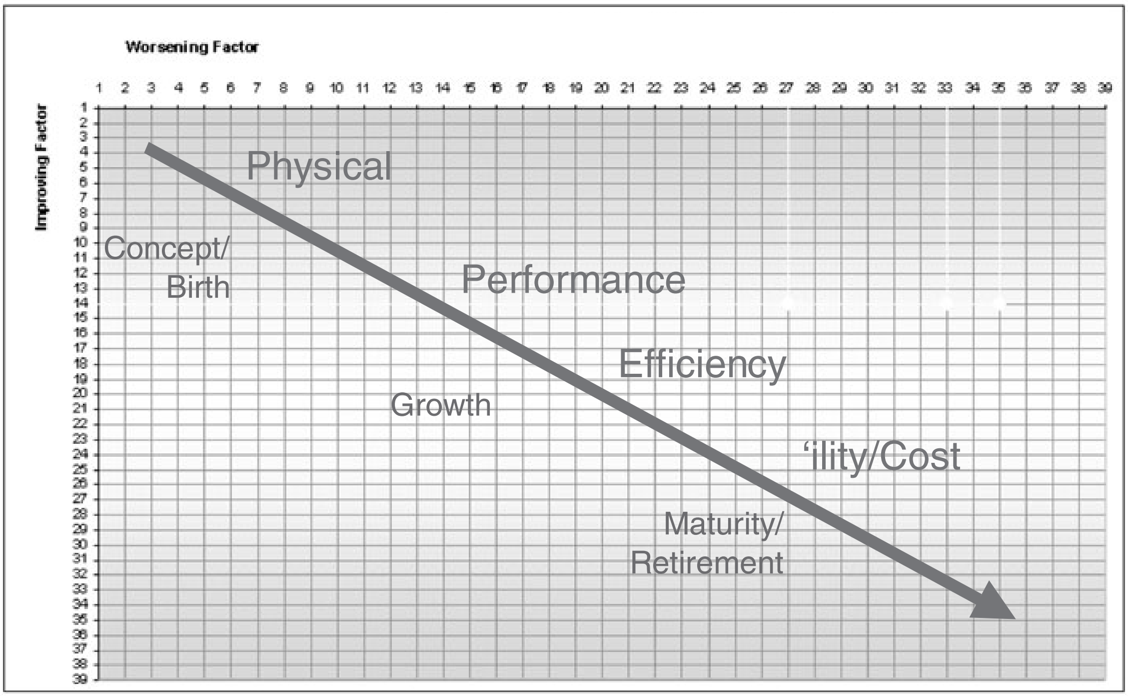

Figure 3. Re-Sequencing of Matrix Parameters

1. Weight of moving object
2. Weight of stationary object
3. Length of moving object
4. Length of stationary object
5. Area of moving object
6. Area of stationary object
7. Volume of moving object
8. Volume of stationary object
9. Shape
10. Amount of Substance
11. *Amount of Information*
12. Duration of action - moving object
13. Duration of action - stationary object
14. Speed
15. Force/Torque
16. Use of energy by moving object
17. Use of energy by stationary object
18. Power
19. Stress/Pressure
20. Strength
21. Stability
22. Temperature
23. Illumination Intensity
24. *Function Efficiency*
25. Loss of Substance
26. Loss of Time
27. Loss of Energy
28. Loss of Information
29. *Noise*
30. *Harmful Emissions*
31. Object Generated Side Effects
32. Adaptability/Versatility
33. *Compatibility/Connectability*
34. Ease of Operation
35. Reliability
36. Repairability
37. *Security*
38. *Safety/Vulnerabilty*
39. *Aesthetics*
40. Object affected harmful effects
41. Manufacturability
42. Accuracy of manufacturing
43. Automation
44. Productivity
45. System Complexity
46. *Control Complexity*
47. Ability to Detect/Measure
48. Measurement Precision

Figure 4. Revised List of Technical Matrix Parameters

Contradiction Matrix for Business Problems

Interest in the concept of resolving conflicts in no-compromise ways has proved to be equally high to those working in non-technical fields as those working to resolve technical problems (Stalk, Pecault & Burnett, 2000). Work to create a business version of the technical matrix consequently began in the late 1990s. The underlying philosophy and method of constructing a business specific tool was first discussed in a paper at the 2002 Altshuller Institute TRIZ Conference (Mann, 2002). Essentially, the

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1. R&D Spec/Capability/Means
2. R&D Cost
3. R&D Time
4. R&D Risk
5. R&D Interfaces

6. Production Spec/Capability/Means
7. Production Cost
8. Production Time
9. Production Risk
10. Production Interfaces

11. Supply Spec/CapabilityMeans
12. Supply Cost
13. Supply Time
14. Supply Risk
15. Supply Interface

16. Product Reliability
17. Support Cost
18. Support Time
19. Support Risk
20. Support Interfaces

21. Customer Revenue/Demand/Feedback
22. Amount of Information
23. Communication Flow
24. System affected harmful effects
25. System generated side effects
26. Convenience
27. Adaptability/Versatility
28. System Complexity
29. Control Complexity
30. Tension/Stress
31. Stability

Figure 5. List of Parameters Found In Business Matrix

strategy adopted was one that involved locating successful applications of win-win in the business context and distilling from such cases what the conflicting parameters were, and what inventive strategies were utilized to resolve those conflicts.

The number of available case studies has proved to be considerably lower than that found for technical problems, but nevertheless, by the end of 2002 the findings had stabilized sufficiently to release a first version of a business-conflict resolution Matrix (CREAX, 2002). An updated version was subsequently published in June 2004 (Mann, 2004c) following the acquisition of several hundred more case studies and, more importantly, findings from real-life case studies in which an expert panel systematically sought solutions from all 40 of the currently known inventive principles and then identified those that gave the strongest solutions.

One stable aspect of the business version of the matrix has been the form and content of the 31 parameters that make up its axes. These 31 parameters are reproduced in Figure 5. They are intended to describe all of the issues relevant to managers and business leaders when they are facing conflict resolution or trade-off elimination situations.

Conceptually, the new business matrix is identical to that found in the technical version; to use it the user has to identify pairs of parameters in conflict with one another, to map these specific parameters onto the closest possible match(es) in the matrix and then extract the inventive principles suggested as most appropriate, based on what other problem-solvers with similar conflicts and trade-offs have used. Like the technical version too, the new matrix has been designed to act as a framework into which new case studies can be fitted. In this way, it offers the ability to permit distillation of knowledge from across all sectors of business, and thus to accelerate the transfer of good ideas from one sector to another. One of the key ideas within TRIZ is that 'someone, somewhere has already solved your problem'; the matrix presents a means through which the 'someone' can be found.

Contradiction Matrix for Software Problems

A lack of relevance of many of the parameters used to make up the axes of either the classical or new matrix to software problems (weight, length, area, shape, volume, temperature for example) has prompted many users to ask us for a bespoke matrix specifically for software problems. In researching the possibilities for such a matrix, researchers have had to conduct an analysis of both patents and (outside the USA – where patents on software are not permitted) examples from journals and trade literature to establish whether the concept of conflict elimination was being practiced at all. Very soon into this research in fact, although in the case of patents the level of invention (as per Altshuller's (1979) codification system) is generally very low, it became clear that all 40 inventive principles are being used to challenge conflicts, and that there were certain emerging patterns of usage that meant construction of a new matrix was going to be possible. The current public form of the new – currently 22×22 matrix – is currently being Beta tested by a number of industry-based lead users. It is expected that the final version will be published in book form during the fourth quarter of 2004 (Mann, forthcoming).

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The Ideal Contradiction Matrix . . .

The 2003 publication of the updated version of the technical contradiction matrix, and the recent publication of the new business matrix, and the ongoing creation of the above outlined matrix specifically aimed at software applications, have prompted a number of questions about the longer-term matrix strategy.

What is in fact being experienced with this apparent proliferation of matrices is one of the fundamental trends described within TRIZ – that of increasing complexity followed by decreasing complexity (Salamatov, 1999). Or rather increasing number of components followed by decreasing number of components – see (Mann, 2003c) for more details on why the difference between these two is important. The increasing number of matrices, then, is simply a system in the first half of the trend – see Figure 6.

Why should this characteristic be expected to be relevant to the evolution of the contradiction matrix? There are several answers to this question. The first relates to the needs and desires of users of the matrix: for a long time, the classical contradiction matrix has been viewed as a 'good enough' or 'sufficient' tool (albeit, as hinted at in the Introduction, some TRIZ researchers have since walked away from the concept completely). But then when the business community began to become interested in TRIZ, it very quickly became apparent that the conceptual elegance of the matrix was not matched by its relevance to typical business situations. This phenomenon was the main spur for researchers to create the business matrix. Subsequently, similar relevance problems have been seen in the software-development sector; here too, people have been attracted to the conceptual elegance of the concept, and then disappointed when they find it difficult to relate their particular problems to the generic parameters contained in the matrix. As a consequence, researchers have also been forced to construct the above outlined matrix tailored specifically to the needs of the software sector.

While not being 'new' in the same terms, we are also expecting the Matrix concept to expand further when other sectors (and in some instances, individual companies) seek to produce a bespoke matrix for a particular field. In the majority of cases, these bespoke matrix tools will be subtle variants on the technical, business and software matrix tools with parameters reframed in the terminology and jargon of a particular organization or industry. In other cases, we will simply be deleting lines from a matrix in order to remove parameters that are considered irrelevant to a given type of situation (the legal sector, for example, has generally speaking very little interest in R&D, at least not in those words).

It is important to recognize, of course, with any of these specialized matrices, that we are not trying to *filter out* the ability of TRIZ to transfer ideas from one sector to another, but merely to make it easier for users to translate their specific problem into the generic problem – Figure 7. Beyond that, it is the job of the Matrix to identify the best generic solutions from across all fields that may be used to help solve the specific problem at hand.

So then, what about the second half of the component-count trend curve? What about the ideal contradiction matrix? According to the TRIZ definition (Domb, 1997), the ideal Matrix is the one that delivers the desired benefit without any of the downside. In other words, it presents the users with the best generic solutions, without the matrix actually having to exist at all. At least, it should not exist as far as the user is concerned. In effect, the ideal matrix would offer the shortcut illustrated in Figure 8.

We are beginning to see the emergence of this ideal matrix in the CREAX 'Contradiction Finder' tool. You will find a free version of this

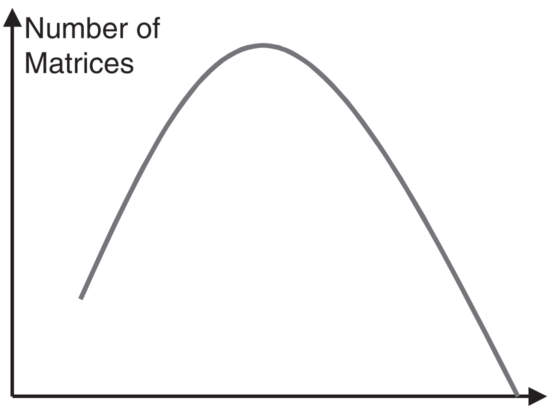

Figure 6. Number of Components Trend in Relation To TRIZ Contradiction Tools

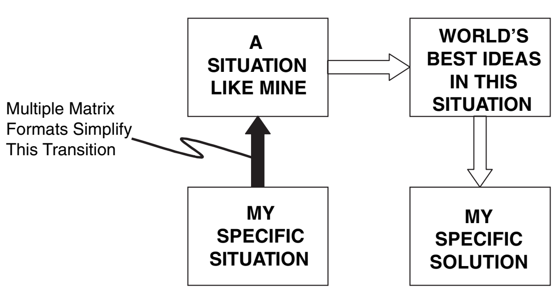

Figure 7. Multiple Matrices Help Make the Transition from Specific to Generic Problem

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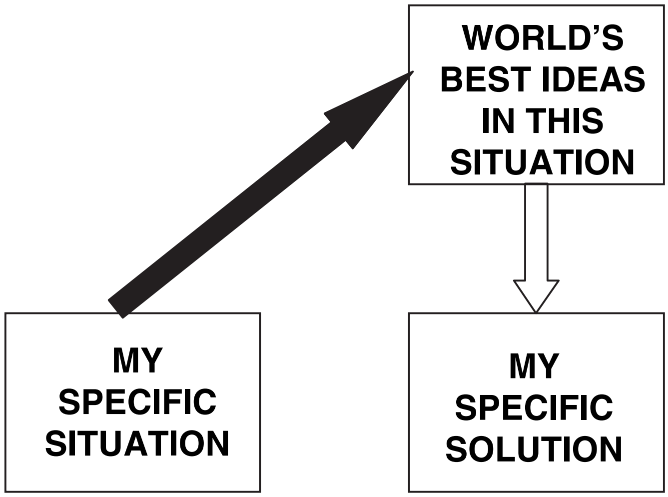

Figure 8. The Ideal Matrix . . . is no Matrix

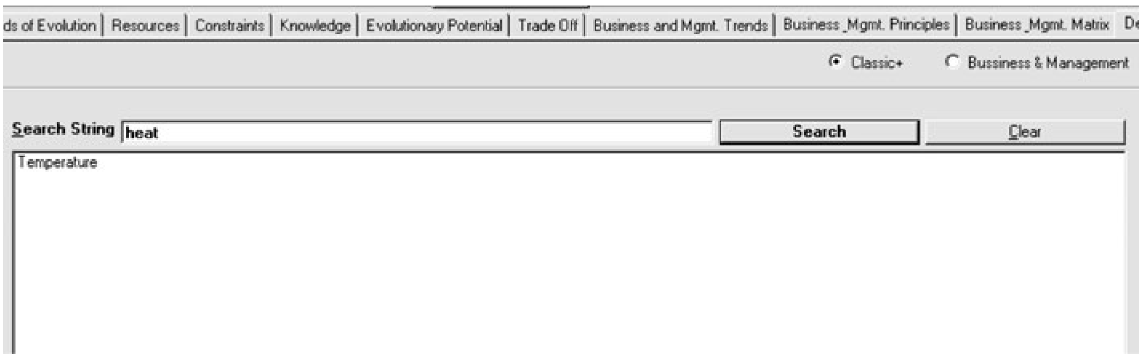

Figure 9. Contradiction Finder Software

tool on the CREAX website, as well as inside the latest versions of the CREAX Innovation Suite software – Figure 9.

The basic idea behind the contradiction finder is that eventually users of any background will simply be able to enter the description of a problem in their own language and jargon. An appropriate algorithm will then analyse this input and provide the most appropriate generic solutions contained in the TRIZ toolkit – whether they be inventive principles, inventive standards, trends of evolution or knowledge/effects.

So why not just go straight to this ideal final result you might be asking? The answer lies in the fundamental phenomena underlying the increasing-decreasing complexity trend. It is simply that without working having worked out the 'right' routes from specific problem to right generic solution, it is not possible to eliminate the matrix. Put another way, it is only by acquiring the data to populate the various different matrices that we will acquire sufficient data to ensure we are making effective recommendations when a user types in their problem. The proliferation, to put it yet another way, is an essential requirement along the road to a more ideal system. At this point in time, it is not clear how long it will take to get to that 'ideal final result' end point. All we can say with any degree of certainty is that the journey from here to there will require as much, if not more research effort, as has been devoted to the updating of the original 1973 version of the tool.

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