

Systematic Innovation



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The Systematic Innovation e-zine is a monthly, subscription only, publication. Each month will feature articles and features aimed at advancing the state of the art in TRIZ and related problem solving methodologies.

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Readers' comments and inputs are always welcome.
Send them to darrell.mann@systematic-innovation.com

More On Root Contradictions

(Links Between Perception Mapping And Contradiction Matrix Tools)

Issue 22 of the e-zine (November 2003) featured an early example of the Perception Mapping tool being deployed to help determine which conflict pairs from a list are more significant than others. Figure 1 reproduces the Perception Map for the exercise to establish which of the conflicts and contradictions present in a coffee cup (a standard workshop exercise!) were more significant than others.

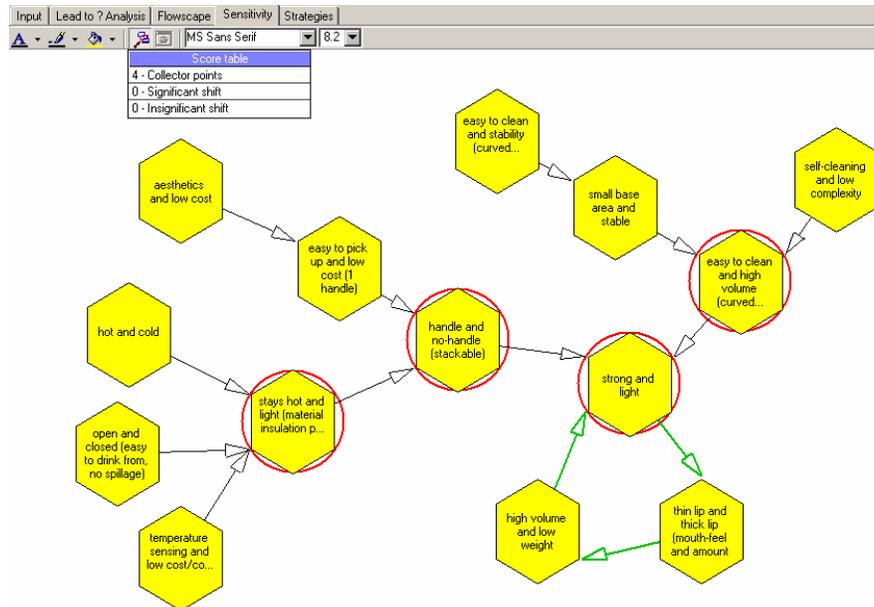


Figure 1: Perception Map For Prioritising Coffee-Cup Conflict Pairs

As per standard Perception Mapping convention, any conflict pairs that form a closed loop or act as collectors are deemed to be more significant than others. Taken further, any entry in the map that satisfies both the loop and collector test is deemed to be even more significant. For the Figure 1 map, therefore, we may observe that since the 'strong and light' pair is both in the loop *and* acts as a collector, that it is the most significant of all of the perceptions identified for the cup.

The simple aim of this short article is to make a connection between this kind of conflict map and the Contradiction Matrix. Specifically the 2003 version of that tool. We make the distinction between this version and the classical version because a part of the work to create the new matrix involved sequencing the Parameters into a more logical arrangement.

What we did during the research to re-sequence the Matrix Parameters was, firstly to cluster them into more logical groupings – i.e. physical, performance, efficiency, 'ility, manufacture and measurement. The sequence of these groupings was then arranged so that there was a correlation to the evolution of systems through an s-curve. The aim, then, was to create a progression from the start of an s-curve – where physical parameters dominate (top left corner of the matrix) – to the end, down in the bottom right corner, where matters of cost reduction and optimization come to dominate improvement activities.

The simple underlying idea of this article is to explore what happens when we draw the Figure 1 Perception Map onto the Contradiction Matrix. We can do this relatively simply by translating the specific words used to describe the coffee cup conflict pairs into the form recognized by the Matrix. Figure 2 represents the result of conducting such a re-framing.

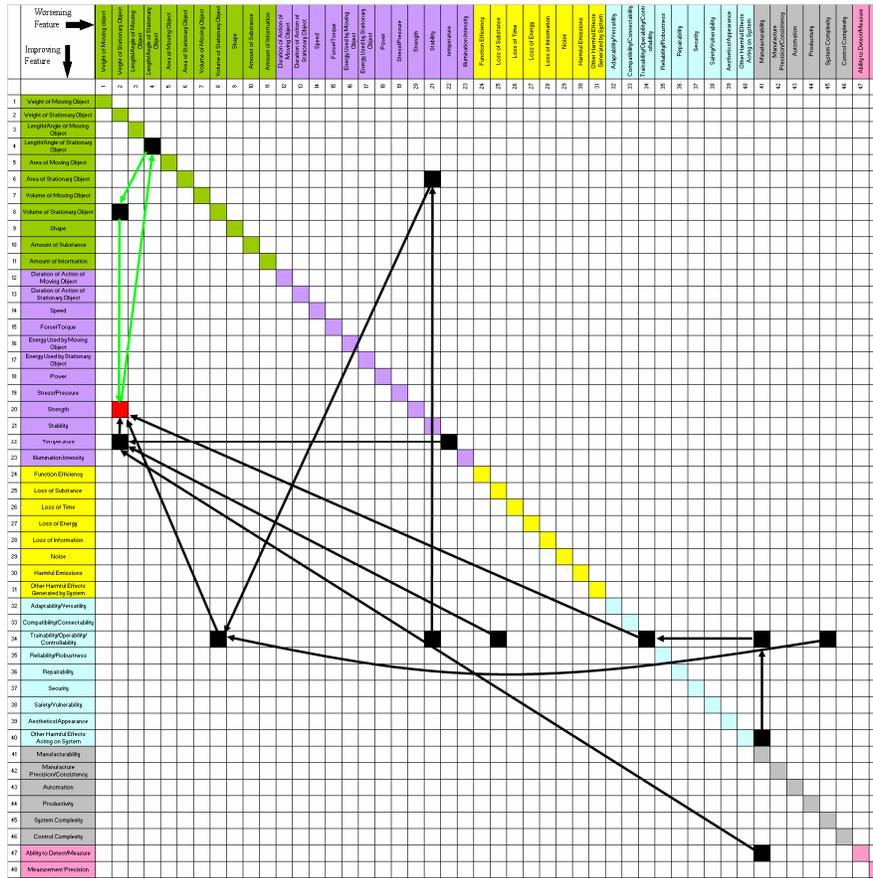


Figure 2: Mapping The Coffee Cup Conflict Map Onto The Contradiction Matrix

The main loop of the Perception map is reproduced with the green arrows. The significant ‘strong and light’ conflict pair (mapped on the Matrix as ‘strength’ versus weight of stationary object’) is highlighted in red. What is significant about the result is that the arrows predominantly point in the direction of the top-left corner of the Matrix. What is in turn significant about this, is that it is the top-left corner where we should expect to find the ‘root contradiction’ of a problem situation.

The technical version of the Hands-On Systematic Innovation book talks more about the idea of ‘root contradictions’. If we care to plot some of the root-contradiction examples presented in the book onto the same Matrix structure, we get the same arrow motion to the top left of the Matrix. Figure 3 below, for example, highlights the simple root contradiction analysis performed for the bicycle saddle example.

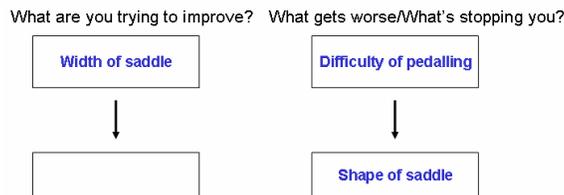


Figure 3: Bicycle Saddle Root Contradiction Example

This is a simple one to plot onto the Matrix structure – see Figure 4. Again we see a clear arrow trajectory towards the top-left corner of the Matrix.

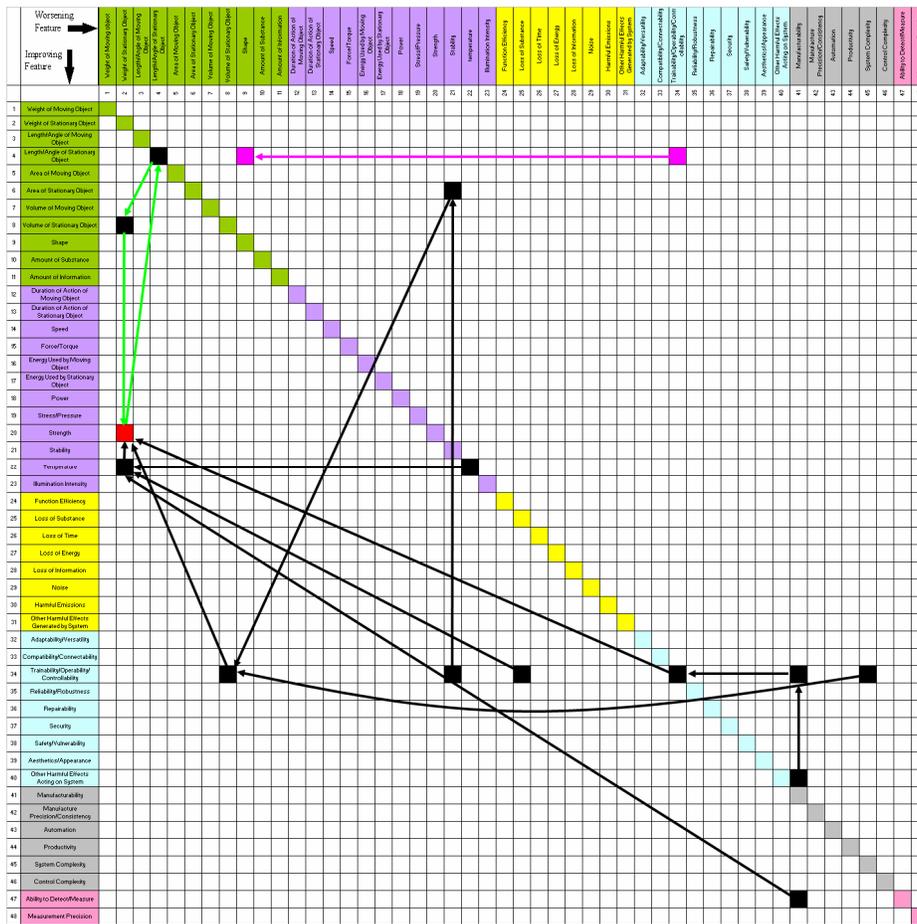


Figure 4: Mapping The Bicycle Saddle Root Contradiction Example Onto The Matrix
(bicycle saddle case is pink line)

The same thing happens when we take the next example from the HOSI book – the wind turbine problem. Here again, the ‘why’ questions used to get to the root contradiction may be seen to point us in the direction the top-left corner of Matrix as we shift from the starting requirement to stop the blades breaking (i.e. reliability/robustness) to a root contradiction involving strength.

In many ways this ‘root-contradiction-equals-top-left’ finding should not come as any great surprise. The more we home in on a problem, the more likely it becomes that we will find ourselves looking up conflict pairs in the top-left portion of the Matrix. It is not clear that this is a general rule, but there is certainly enough evidence to suggest that when we try and map a specific trade-off situation onto the Matrix, the closer we can get to finding a match of parameters up in the top-left, the more likely it is that we are getting to the root cause of the trade-off, and therefore, the more likely it is that we are heading towards the strongest possible solution.

Business Contradictions: Moving A Library

*>I would like to hear from folks who have been involved in moving a
>library from one location to another. Our library will be moving into a
>new building after October 1996 and has a collection size of 52,000. Our
>new site is approximately 1 mile from the current site.*

On-line bulletin-board posting

In this article, we present a short case study to illustrate the use of the business conflict matrix and the physical contradictions part of the TRIZ toolkit. As described above, the problem situation under investigation involves moving the stock of a public library from one location to another.

Clearly we have a desire to move the books, but we don't necessarily want to have to pay for the move to take place. From a contradiction perspective, therefore, we wish to 'move the books and not move the books'. Figure 1 shows the way that we might map the problem based on the structure described in the business version of our Hands-On Systematic Innovation book.

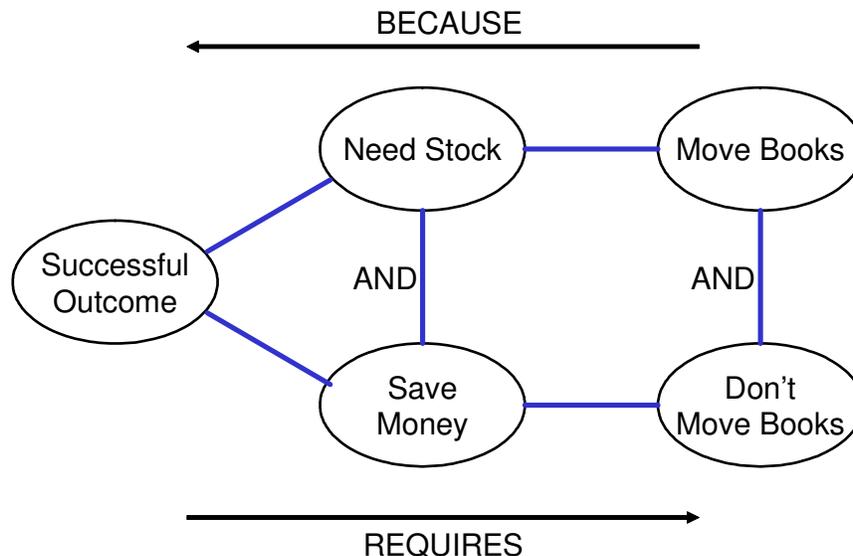


Figure 1: Describing The Library Problem As Both Conflict And Contradiction

What this structure tries to make clear is the strong relationship between conflicts and contradictions, and the means by which we can convert from one type to the other. Whether we choose to solve a particular problem by one strategy or another (or indeed both) is largely dependent on personal preference. We shall examine each option here.

Solving As A Conflict

In order to see how other people have solved problems like our library situation, we need to convert the 'need stock' and 'save money' pair into parameters that feature in the business conflict matrix. Definitions of the parameters present in the matrix found in the Hands-On book reveal that issues related to 'shipping' and movement of goods are

typically placed into the ‘Supply Quality/Means/Spec’ row of the Matrix. Since the other side of the conflict – cost – is also related to the shipment of books, we ought to map this onto the matrix as ‘Supply Cost’.

As soon as we have mapped this pair, the matrix presents us with the following suggestions on the page for ‘improving Supply Quality/Means/Spec’:

List of Principles relevant to each specific worsening parameter:

11	Supply Spec/Capability/Means	(see Physical Contradictions section)
12	Supply Cost	7 35 19 1 10 29
13	Supply Time	35 1 13 2 24

Additionally, the Matrix tells us that we should always examine Principles 5 and 35 for problems involving the desire to improve the ‘Supply Quality/Means/Spec’ parameter.

Solving As A Contradiction

When we think of the library problem from the contradiction perspective, we are looking at the ‘move books and don’t move books’ part of Figure 1. The Hands-On book chapter on contradiction resolution points us towards a number of possible strategies for overcoming the contradiction:

- separation in space
- separation in time
- separation on condition
- separation by transition

Within the ‘transition’ category are directions involving re-focusing the problem to the sub-system or super-system, or inverting the system.

Since in this case it is difficult to see how to solve the problem by separating the contradiction in either space, time or condition (i.e. when we ask the questions ‘where’, ‘when’ or ‘if’ we don’t obtain a difference in answer between the two opposing sides of the contradiction) , possible solutions are most likely to emerge from the ‘transition’ category. Within this category, we are offered the following options and links to the Inventive Principles:

Transition to Alternative System	
1. Transition to Sub-System	1. Segmentation 25. Self-Service 40. Composite Structures 33. Homogeneity 12. Reduce Tension
2. Transition to Super-System	5. Merging 6. Universality 23. Feedback 22. Blessing In Disguise
3. Transition to Alternative System	27. Cheap/Short Living
4. Transition to Inverse System	13. Other Way Around 8. Counter-Balance

Generating Solutions

Before we start using the Inventive Principles suggested by the conflict and contradiction approaches, it is worth having a look at the solutions suggested by respondees to the initial bulletin-board question. In fact there was only one particularly useful one:

The Montclair (NJ) PL just went through such a move to temporary quarters to enable construction work. We used volunteers (college football team etc., local residents, township employees) to move 30,000 volumes to a site about 3/4 mile away. Temporarily closed a main road and used a front loader from Public Works filled with books to lead the parade. Another 120,000 volumes were moved to a warehouse by professional book movers. The 30,000 move was accomplished in a few hours -- the books had been packed before by library personnel. The library was closed for a couple of weeks before the move to pack and re-catalog. No horrors -- all success!

The use of volunteers seems like a nice suggestion, but even so 80% of the books were moved by a method that involved a payment to 'professional book movers'.

Let's see what TRIZ might suggest:

A good place to start is Inventive Principles that feature in both the conflict and contradiction resolution strategy lists. In this case, the only Principle common to both is number 1, Segmentation. Segmentation hopefully gives us the idea of segmenting the collection of books into smaller clusters.

We might observe, then, that Principle 1 is found in the 'Transition to Sub-System' group of contradiction solution strategies. This ought to get us thinking about precisely what we mean by 'system' in this case. What elements does the system called library contain? Books clearly. Staff. The library building and its internal structure of bookshelves, etc. Readers. Book suppliers. And that's about it. Note that all of the solutions used in the Montclair response involved adding something to this basic system. As such that solution has not used the next of the 'Transition to sub-system' suggestions, Principle 25, Self-Service. This Principle encourages us to 'enable an object or system to perform functions or organise itself'. So maybe we could get the staff to make the move themselves? Probably not. How about the readers? Hmm. This sounds more interesting; why not get the readers to move the books?

Fine if they volunteer, but how do we get lots of readers to volunteer? Perhaps there is a clue to this problem in Principle 10 – one of the suggestions from the conflict matrix. Principle 10 is about 'Prior Action' and 'introduction of a useful action into an object or system (either fully or partially) before it is needed'.

Hopefully this suggests to us the idea that we get readers to take out books from the old library and return them to the new library. This way we have what looks like a very nice win-win situation where nobody has to volunteer to do anything different to what they would normally have done. In fact, if we are smart about the way we present the suggestion to readers, we can get them to take out more books and keep them for longer in order to allow the smoothest possible transition from one building to the other (Principle 19 – 'change the periodic magnitude or frequency to suit external requirements'). And how about (Principle 7) inserting the information about the new library – and where to return the books – inside the books that people take out of the old library?

The point being that by thinking about what we mean by 'system' and looking to deploy multiple Inventive Principles when we are trying to generate solutions to a problem, we can end up with a solution that presents genuine win-win outcomes.

Humour – Museum Of Bad Art

Sometimes we need to experience the bad in order to fully appreciate the good. This is one of the reasons why the 'Increasing Differences' trend exists in TRIZ. Think of a function and someone, somewhere, sooner or later finds a use for the 'opposite system'. How happy were we, then, to discover that someone already thought of a solution to the problem of art appreciation.

Welcome to the Museum of Bad Art. An actual place in Dedham, Massachusetts. A place where one can experience not just the bad, but also the truly awful art of our times:



If you can't get there in person, then check out the website at www.museumofbadart.org. The world of Picasso, daVinci and Monet will never feel the same again.

Patent of the Month

We head into the world of composite materials for our patent of the month this month. US6,916,355 was awarded to NGK Insulators in Japan on July 12. Here is the abstract taken from the invention disclosure:

A composite material in which a dispersing material is dispersed in a matrix is provided. The composite material is producible by steps of

- *filling said mixed material in a space forming region to be defined by at least two container elements when said at least two container elements are integrated into one body, and*
- *then infiltrating said aluminum (Al) being molten due to heat generated by said self-combustion reaction into pores inside said mixed material through at least one hole formed in an upper part of a reaction container formed by combining said at least two container elements in which said mixed material is filled in said space forming region in a state being fixed to a predetermined shape, thereby an aluminide intermetallic compound is formed by self-combustion reaction between said metal powder and said aluminum (Al), and a dispersing material is dispersed into said matrix.*

Then, from the invention summary:

An object of the present invention is to provide a composite material having a densified fine structure with a reduced production cost (due to reduced need for high pressures), and a method for producing a composite material with less number of the steps by which any desired final shape, especially large sized and complicated shape, and densified fine structure may be obtained.

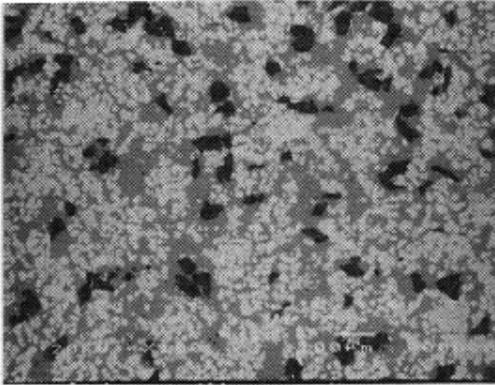
Namely, according to the present invention, provided is a composite material producible by filling a mixed material containing a metal powder capable of inducing a self-combustion reaction upon contacting aluminum (Al) and a dispersing material in a reaction container and infiltrating molten aluminum (Al) into pores inside said mixed material, thereby a dispersing material is dispersed in a matrix...

A composite material, in the man-made world at least, is a composition aggregate in which a plurality of materials are macroscopically mixed, and thus complementary employment of mechanical characteristics of each material enables a demonstration of characteristics that was not realized by the material independently. Fundamentally, it is a technique that combines materials and materials together, and has various combinations based on matrixes, reinforcing materials (dispersing materials), purposes of use, and cost. One of the things that traditionally distinguishes man-made from natural composites is the 'macroscopic mixing'. Macroscopic mixing has the main virtue of being simple to achieve. On the down-side, however, mixing things that are all of about the same size tends to result in structures that are relatively weak. Nature, thanks to its several billion years worth of evolutionary trial and error has evolved much stronger composites by introducing considerable variation in the sizes of the constituent parts. These so-called 'hierarchical composites' have traditionally been very difficult to manufacture in any commercial scale. Until now at least.

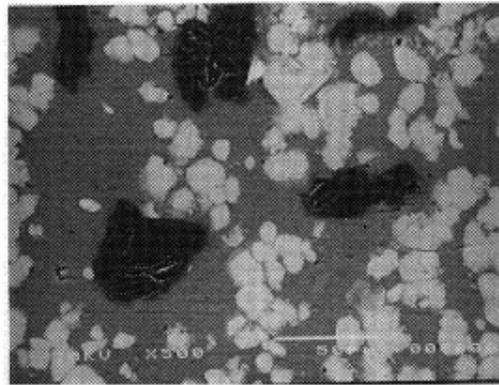
The key inventive steps found in the NGK invention comprise a self-combustion reaction and introduction of a dispersing material (Inventive Principles 25 and 24). We can see the same pair of Inventive Principles in the Matrix 2003 reverse-engineered diagnosis of the invention:

Improving Factor	Worsening Factor	Principles										
Strength (20)	Stress/Pressure (19)	<table border="1"><tr><td>35</td><td>40</td><td>24</td><td>3</td><td>9</td></tr><tr><td>4</td><td>17</td><td>25</td><td>18</td><td></td></tr></table>	35	40	24	3	9	4	17	25	18	
35	40	24	3	9								
4	17	25	18									
We want the strongest possible structure, but we don't want to have to utilise high pressures during manufacture												

The resulting composite is illustrated in electron microscope close-up view below:



100x

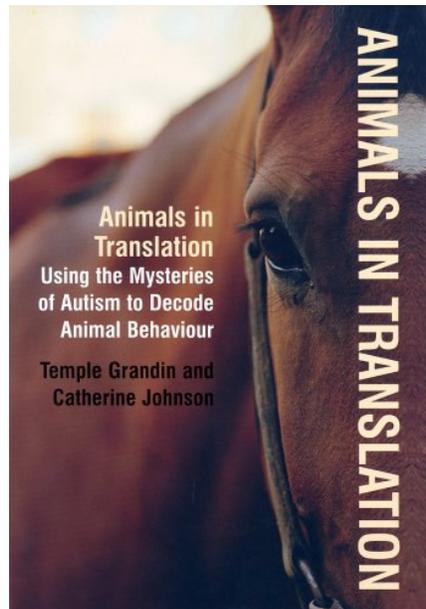


500x

It is exciting to think that such a hierarchical structure has been able to be created by such an apparently simple means. This invention may represent a significant step forward in terms of both increased strength (and more precisely strength/weight ratio) and reduced manufacture cost. Expect to hear more about 'hierarchical composites' in the coming months and years. The number of possible applications looks set to mushroom.

Best of the Month – Animals In Translation

As we know from the TRIZ ‘Levels of Invention’, the higher, more significant, Level 3, 4 and 5 inventions emerge through the transfer of knowledge from one sector to another. We can observe the same phenomenon in books and learned journals; find a connection between two previously separate fields and something important is likely to emerge. The best of the month recommendation this month sees precisely such a bridging of two separate disciplines. Newly published ‘Animals In Translation’ by Temple Grandin and Catherine Johnson is a fascinating account of the links between animal behaviour and autism.



Although perhaps not immediately obvious why such subject matter might be of interest to readers of the Systematic Innovation e-zine, we nevertheless recommend the book highly as both a cracking good read and one full of useful insights. Particularly for those interested in psychology and people management type issues. Page 100 of the book, for example, sees the beginning of an exploration into correlations and causes (a theme also discussed in great detail in Stephen Leavitt’s book ‘Freakonomics – our best of the month recommendation from last month). Quote: “our brains are wired to see connections and correlations, not coincidences and happenstance. Moreover, our brains are wired to believe that a correlation is also a cause.” Therein lies a great deal of wisdom about why so many of us get so many things wrong when we are trying to find the root causes of problems, or make predictions about what things might happen in the future.

Other seeds that should cause you to seek out the book include the paradoxical state of ‘curiously afraid’ that affects much of the behaviour of animals and humans alike, and a good root-cause summation of the psychological inertia phenomenon in the following – “we live permanently a few milliseconds in the past; our brain is wired to predict what will happen a few milliseconds into the future.” Great to learn that evolution has given us at least a (Principle 1, Segmentation) partial solution to this problem by equipping us with both high-speed, low-resolution and low-speed, high-resolution sense systems, and even greater to explore how this millisecond-predictive capability can often lead to us making some seriously wrong diagnoses of a situation.

Main author, Temple Grandin relays some amazing stories of her ability to empathise and

relate to a variety of animals thanks to her autism. Key to the similarities between dogs, cows and horses and people with autism appears to be their 'hyper-specificity'. Humans who are not autistic think verbally and process raw information into pre-defined categories. This is very useful when we need to make rapid fight-flea type decisions based on past experiences. It also serves to explain why people *without* such averaging-circuits find everyday life so difficult. As with animals, according to Grandin, to an autistic person, every visual scene has to be taken on its face value and interpreted each time. Not so great from a fight/flea decision-making perspective, but great from a savant-skills one. And great also when we try to understand why animals behave in the way that they do.

On so many levels, then, a wonderful book. We say it most months of course, but, really, you should give this one some serious consideration.

Conference Report – TRIZ Congress

The 4th European TRIZ-Conference/QFD-Symposium was held in Frankfurt, Germany between 30 June – 1 July 2005. The main conference was preceded on June 29 with a number of TRIZ tutorials and seminars – including a half-day ‘TRIZ for Business’ session by us, that was attended by around 20 delegates.

The conference itself saw the presence of around 100 delegates, with an encouraging number from the TRIZ user (as opposed to consultancy) community. Papers were presented in three parallel streams – two primarily focused on TRIZ and one on QFD. 42 different papers featured on the conference programme. Alas English-only speakers were in for something of a disappointment when it transpired that a third of the authors of the 15 English presentations failed to attend the event. Given too that we presented two of the remaining 10 papers, the learning opportunities were a tad thin on the ground.

As ever, Ellen Domb and Sergei Ikonenko gave the audience value for their money in terms of new things to think about. Sergei was one of the few presenters abiding by the original conference theme of sustainability – in almost identical fashion to the earlier TRIZCON event in Detroit, most authors appeared to ignore the sustainability theme. The only other sustainability-linked contribution in fact was a paper presented by good-friends Juergen Jantschgi and Johannes Fresner, our partners on the recently completed ‘SUPPORT’ programme. As a very definite sign of the times, anyone listening to Sergei’s paper couldn’t help noticing that the term ‘eco-contradiction’ had a suspicious looking registration mark next to it. Surely this kind of move is the very antithesis of what both TRIZ and sustainability are supposed to be about? Perhaps the race is on to now also start registering other eco-x phrases? Put us down for ‘eco-conflict’, which I think we have been using in workshops for about 4 years now. Make that ‘eco-conflict®’. Or should it be ‘eco-conflict™’? Or maybe we should leave this kind of commercial nonsense on a waste tip somewhere and get on with real job of solving a few problems.

Elsewhere, the other (English-speaking) highlight appeared to this author to be the two papers presented by the six-man delegation from the POSCO steel corporation in Korea. A couple of quite nice mini-case studies for those interested in such things.

Less appealing were the papers and discussion sessions on SIT and simplification of TRIZ. The discussion session in particular was a rather depressing affair, with seemingly no-one looking to apply any TRIZ to the problem. Anyone can simplify TRIZ by taking stuff out of it (as SIT has somewhat randomly done). If memory serves us correctly, another word for ‘simplifying by taking stuff out’ is ‘trade-off’. Doesn’t TRIZ have something to say about trade-offs and compromises? Apparently not as far as the discussion went. Can you remember the sound of finger-nails scraping down a blackboard? That’s what the discussions started to sound like to these jaundiced ears.

Important finally, though, to end on a positive note seeing as that is the net feeling we came away with. As with the previous event, the 4th European TRIZ symposium was very well organized and managed. The vagaries of the TRIZ community aside – surely there is no other group of people anywhere on the planet with less regard for publication deadlines (‘herding cats’ anyone?) – the organizers did a fine job of covering the cracks in the programme. As ever the atmosphere was friendly and convivial, and there was as much if not more to be learned during the informal discussions as there was during the formal presentations.

Anyone wanting to see a copy of either of our presentations can download them from our new ‘downloads page’.

Investments – Luminous Asthma Inhaler Cap

Our investment feature this month is a glow-in-the-dark asthma inhaler cap. The cap was created by Grant Taylor, aged 38, from Telford in the UK, and incorporates a glowing material manufactured using man-made photo-fluorescent crystals that need just eight minutes of exposure to daylight to stay illuminated for 18 hours during an estimated lifespan of 12 years. It is speculated that the new cap could help save around 3,000 lives a year.



Above and beyond its application in the inhaler cap, when used as an additive, the photo-fluorescent crystal technology can make plastics, inks and textiles glow in a variety of colours – and could be used across a broad range of devices in the medical industry, where location in darkened conditions may be required.

The photo-fluorescent properties of the crystals were apparently discovered thanks to a chance accident. According to Mr Taylor, ‘the postman dropped a pack of the crystals onto the carpet. I brushed most of them up but when I turned the lights out at the office, some of the crystals were still there, glowing away - and I realised the product could be used in emergency or critical care products which could save lives.’ Other products already being manufactured using the crystals include life hammers, which are used to smash car and rail carriage glass in emergencies, Swiss army knives, fire extinguishers and diving torches. The non-radioactive additive is also marketed by IBS2000 Ltd in a set of environmentally friendly fishing tackle for night-time anglers called “Carp Nights”.

We suspect this is the mere tip of the total possible iceberg of possible applications.

Biology – Animal Plus Tool

There are many examples of life-forms making use of tools to assist them in their daily life. Several species of ape, for example, are known to make use of stripped twigs to catch termites. Our book of the month this month describes an example of a crow that not only made use of a tool (a length of wire), but had also learned how to form the tool (bending the end to form a hook) to improve its efficiency.

Most of the known examples come from land-based creatures. Recent studies in the marine environment have, however, shown that dolphins have also learned to make use of tools. Or at least a small number of them have: Female bottlenose dolphins are taught by their mothers to use marine sponges to look for food, according to a study. The finding represents the first case of material culture observed in a marine mammal species. Biologists observing the dolphins in eastern Shark Bay in Western Australia saw the animals break marine sponges off the seafloor and wear them over their snouts to probe into the seafloor for fish. Sponging was mostly confined to females - only one out of the 13 regular spongers looked at by the study was male.

"It looks like the animals use the sponge as a kind of glove to probe the sediments. It might just give them protection against some noxious critters hiding in there," said Michael Krützen, of the University of Zürich in Switzerland, co-author of the study. "But they might also be able to chase other fish living on the seafloor."



Examples of tool use in nature represent the use of Inventive Principle 24, Intermediary. A closer examination of the conflict resolved by the above dolphins reveals the following conflict pair and resolutions strategies found in Matrix 2003:

Improving Factor	Worsening Factor	Principles
Ability to Detect/Measure (47)	Other Harmful Effects Acting on System (40)	19 28 22 3 30
female dolphin forages for food but may be harmed by life-forms hiding on seabed		29 24 9

Encouraging to note that the presence of Principle 24 in this list shows additional evidence to suggest that there is significant overlap between the strategies being utilized in nature and those being deployed by engineers and scientists.