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Systematic Innovation

e-zine

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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**

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Motivating Staff

Judging by the sorts of problems that managers bring to our systematic innovation workshops, problems of motivation – whether it be of staff, workers, peers, students or whoever – appear to be everywhere. Tackling what is obviously a very big and complex issue requires strategies with somewhat more substance than can be found in sayings like 'a manager cannot motivate people; he/she can only de-motivate them'. This is not to say that these kind of statements are either incorrect or invalid; simply that they are insufficient to allow us to actually *do* anything.

To do something about the problem, according to the problem definition steps recommended in our main Hands-On Systematic Innovation texts requires us to do five things:-

1) complete a 'problem explorer' questionnaire – a series of questions aimed at eliciting information on where we are trying to get to, how we know when we have successfully got there, what resources we have available and what constraints we have to work within. Electronic versions of this 'explorer' can be downloaded at www.creax.com at the 'Free Resources' page.
2) definition of the 'Ideal Final Result' outcome and identification of the solution directions on the route between the current situation and that Ideal Final Result.
3) assessment of the maturity of the current system
4) construction of a function analysis map of the problem situation
5) construction of a perception map of the problem situation

We will focus here on the last of these five elements. Before we do that, however, it is useful to think a little more about the Ideal Final Result definition part of the process. In simplest terms here, we may use the IFR concept to derive a statement something along the lines of 'the people motivate themselves' as our ideal solution. This would be consistent with the earlier idea that people cannot be externally motivated, and would also quickly lead us on to the important follow-on question, 'what is stopping us from reaching this IFR outcome?' Why, in other words, don't people motivate themselves?

The perception mapping part of the problem definition process can hopefully help us to identify answers to this type of question:

Everyone sees problems differently to everyone else. This is because we all bring our own unique background and perspectives to a situation. Whether these perspectives are factually correct, or merely our perceptions of fact, they need to be dealt with appropriately during the problem solving process. Perception mapping is a tool facilitating the definition and management of the complexities inherent to processes involving different people with different perspectives of a problem. It is a process aimed at making sense of situations that may otherwise be charged with conflicting emotions and the various foibles of the human mind – most notably in our experience, a reluctance to divulge perceptions that might make us unpopular with others, even though those perceptions may be extremely deeply held. The mechanics of the perception mapping process have previously been described elsewhere (HOSI for Business, Chapter 8 or the October 2003 issue of TRIZ Journal) and so will not be repeated here. The overall perception mapping process has five basic stages:-

a) formulation of the focus question
b) creation of lists of perceptions

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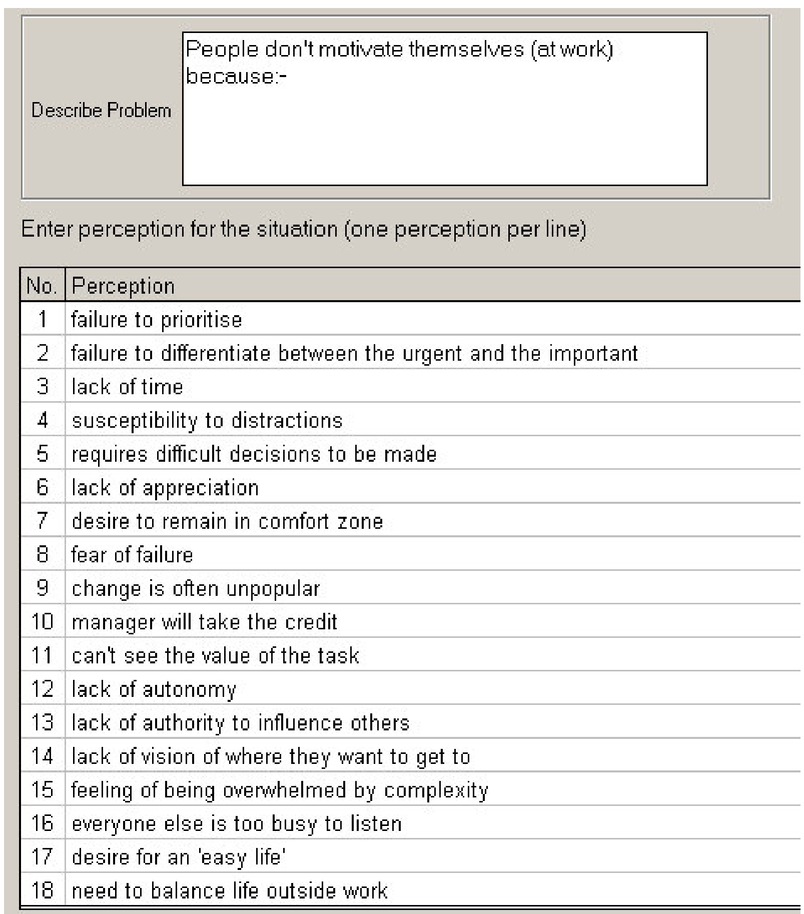
c) identification of what each of the perceptions ‘leads to’
d) identification of conflicting perceptions, and
e) construction of the perception map

The first stage of the process involves the formulation of a good question against which to generate perceptions. ‘Good’ in this sense usually means configuring a question in such a form that entries in the list of perceptions complete a sentence containing the question. Questions like

- ‘Not everyone buys our product because…?’
- ‘Quality problems would disappear if...?’
- ‘The HR problem would be solved by…?’

thus make good start points. Based on the earlier IFR-derived idea that people should motivate themselves, we will use the question ‘People don’t motivate themselves because?’ as the start point for a generalised perception mapping exercise on the motivation problem. Figure 1 lists the perceptions identified in response to this question. There are no absolute rules about how many perceptions should be generated by the process, but generally speaking it is advisable to use 10 as a minimum number (less than this and the perceptions can become so generic as to be useless from a complexity management perspective – for example answering our motivation problem question with a perception like ‘because there are too many de-motivating factors’ is of little value; far better to list each of the perceived de-motivators individually).



Describe Problem: People don't motivate themselves (at work) because:-

Enter perception for the situation (one perception per line)

No.	Perception
1	failure to prioritise
2	failure to differentiate between the urgent and the important
3	lack of time
4	susceptibility to distractions
5	requires difficult decisions to be made
6	lack of appreciation
7	desire to remain in comfort zone
8	fear of failure
9	change is often unpopular
10	manager will take the credit
11	can't see the value of the task
12	lack of autonomy
13	lack of authority to influence others
14	lack of vision of where they want to get to
15	feeling of being overwhelmed by complexity
16	everyone else is too busy to listen
17	desire for an 'easy life'
18	need to balance life outside work

Figure 1: List Of Perceptions For Generalised ‘Motivation’ Problem

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The next part of the process – asking which of the other perceptions any given one 'leads to' – is the single most important step of the process. The only absolute rule during this stage is that each perception must lead to one and only one of the other perceptions. So, for example, when we look at the 'susceptibility to distractions' perception and ask which of the others does it lead to, we have chosen 'lack of time'. In perception mapping language this is then interpreted as 'if we stop being susceptible to distractions, then this will lead to improvement in the lack of time problem'. The overall process is self-correcting in many senses; so if we find that we are unable to find any kind of 'leads to' match for a perception, it means that our list of perceptions is missing something, and so we should find an answer to the 'what does this one lead to?' question (remembering of course, that if we add new perceptions part way through the process, we need to re-commence the 'leads-to' analysis from scratch).

The result of the 'one perception leads to one and only one other' rule is that when it comes to drawing the perception map, there must by definition be at least one self-re-enforcing loop of connecting perceptions. According to the process, these loops should act as the focus for subsequent problem solving activities. Strictly speaking, 'collector points' (perceptions which a lot of other perceptions lead to) and 'conflict connectors (perceptions that form a chain connecting perceptions that are in conflict with one another) will also turn out to be significant. Thus, from a potentially long list of perceptions, those perceptions that are present as loops, collectors or conflict connectors will be more important than other perceptions. The perception mapping process will have managed the complexities associated with which perceptions are more important than others.

Figure 2 illustrates the resulting perception map for the motivation problem perceptions listed in Figure 1.

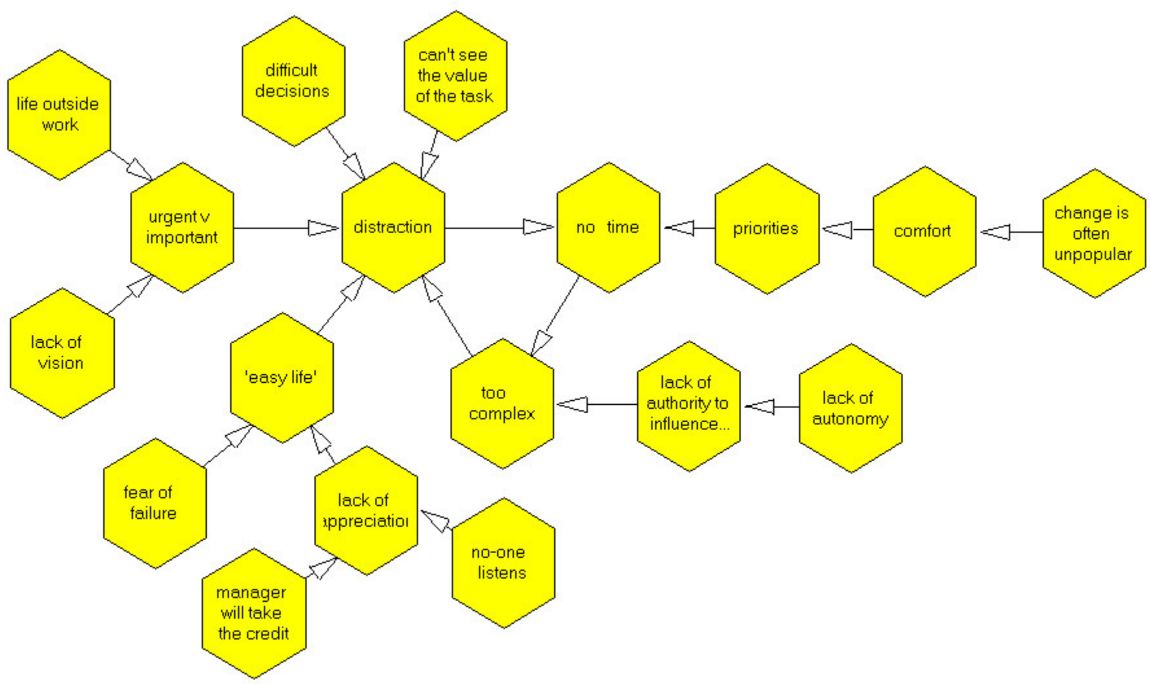

Figure 2: Perception Map For Generalised 'Motivation' Problem

The perception map indicates the presence of one self-re-enforcing loop in which our susceptibility to distraction leads to a lack of time; the lack of time then leads to our feeling of being overwhelmed by complexity; which in turn leads back to our susceptibility to

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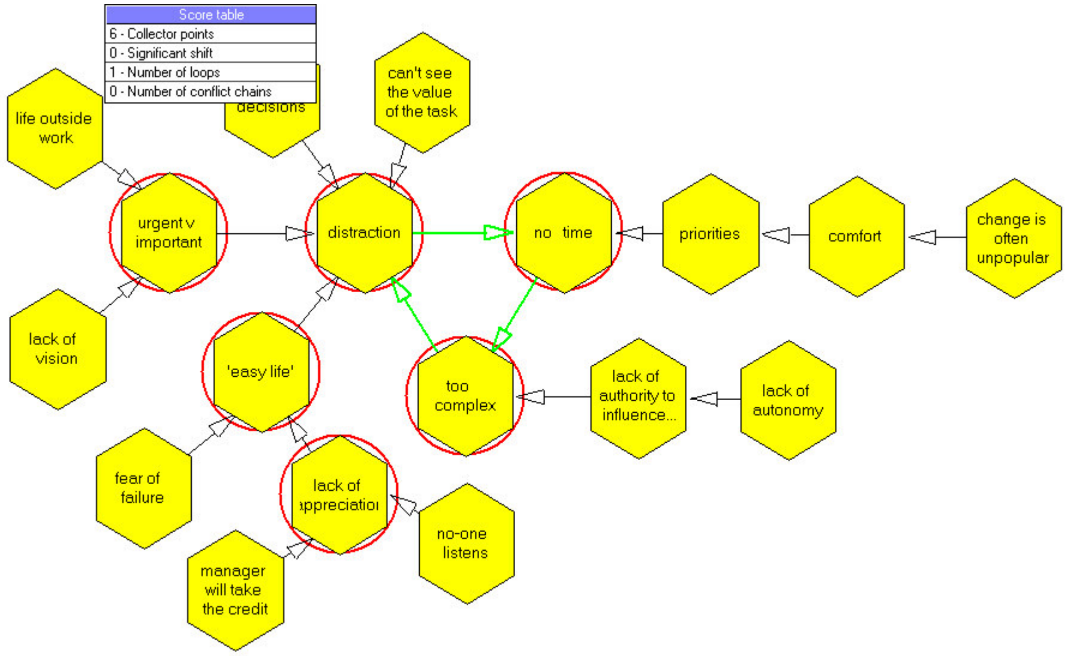
distractions. According to the technique, out of all of the listed perceptions, these are the ones that are the most important and thus the ones that we should chose to focus our



problem solving activities on – Figure 3.

Figure 3: Perception Map For Generalised 'Motivation' Problem Showing Important Perceptions As Determined By Presence of Loops and Collectors

Since the 'susceptibility to distraction' has also been identified as a strong collector for other perceptions (eight of the other perceptions lead directly or indirectly to this one), it would further suggest that this is the perception from the ones in the loop that is the most important one. We might thus formulate a new problem along the lines of 'how might we stop ourselves from being susceptible to distractions?'

Asking this type of question very often leads to definition of contradictions. In this case, for example, we might see a conflict between the desire to avoid susceptibility to distraction and (for example) the need to allow times when the brain can re-charge itself. As soon as we have identified these kinds of contradiction, of course, we open ourselves up to the use of the Inventive Principles as a means of generating no-compromise solutions – e.g. I can use Principle 1, Segmentation to deliberately create times of the day when I should focus on the important stuff, and other times when we might allow the brain to wander, or I can use Principle 5, Merging, to give me the idea of joining several requirements into one piece of work in order that that completing that one piece gives me several useful outputs.

An important thing to recognise as the perception mapping activity proceeds is that the process is seeking to make systematic sense of the complexities rather than filtering things out. This is particularly important when using the process in a group setting in which everyone would like to see their contribution being recognised. The perception map offers a means of inter-relating complex information in situations that may otherwise be highly emotionally charged.

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TRIZ and Six Sigma
1) Working The Right Project

A well known joke in the Deming community from a time before 'Six Sigma' was anything other than a term concerned with standard deviations in a statistical process control setting concerns the continuous improvement process. The Plan-Do-Study-Act (PDSA) improvement cycle was initially devised by W. E. Deming in a form like that shown in Figure 1.

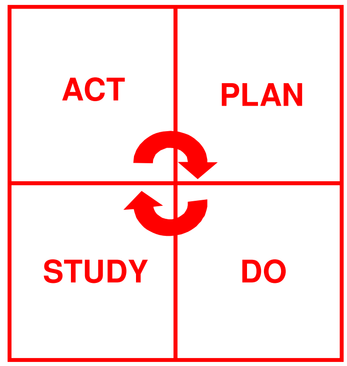

Figure 1: The Plan-Do-Study-Act Continuous Improvement Cycle

What is less well known about the picture is that the relative area of each of the boxes was also important. Specifically, the area was supposed to give an indication of the amount of time each activity required. Unfortunately, if we draw what actually happens in most organizations, the time distribution looks something more like the picture illustrated in Figure 2.

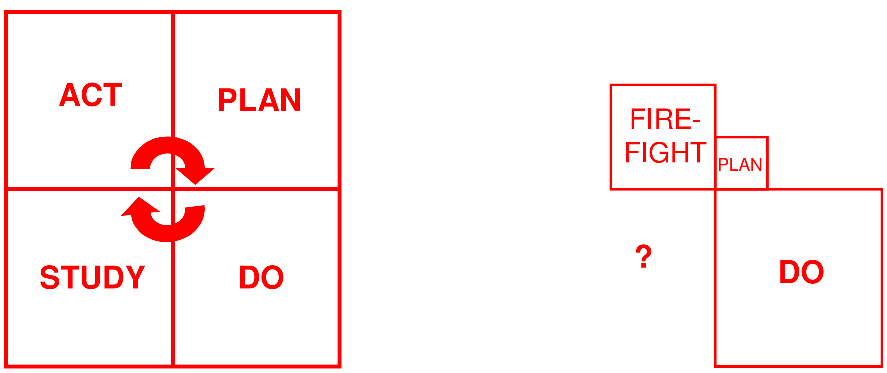

Figure 2: PDSA Cycle – The Intention and The Reality

The figure highlights some of the inherent traits of the human brain and the way in which organizations function. Most notably, both our brain and our boss are happiest when they are actually 'doing' something. If you're doing something then you appear busy, feel busy and are (apparently) making progress. Even if it turns out that you are doing the wrong thing, to most people it is better to look and feel busy than to give the impression that you are not making progress. Planning on the other hand does not tend to give a feeling that progress is being made. As a consequence – according to Deming at least – we tend not to do enough of it. The consequence of that, as we frequently find further downstream, is that we have spent a lot of our 'doing' time doing the wrong thing, and hence we have to

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spend time fire-fighting. Fire-fighting – or 'solving problems that should never have occurred' in more accurate terms – carries the additional paradox that when we are fire-fighting we also look and feel busy.

Now, no-one with an even slightly realistic view of the world is going to suggest that anyone is going to spend less time 'doing' and spend more time 'planning' what we are going to do. Unwiring several million years of human evolution is not a task to be taken on lightly. Fortunately, we can avoid having to take on this challenge by making an alternative suggestion. That suggestion is this; might it be possible to make a more effective job of doing the planning activity than we currently do. So, we don't spend any more time than we would normally spend doing the planning part, but rather spend the same amount of time doing it better.

Exactly the same idea applies in the Define-Measure-Analyse-Improve-Control (DMAIC) improvement methodology framework found in Six Sigma; where our brains will frequently tell us that the M, A, I and C parts look and feel busier than the D part of the process.

A common phenomenon in the application of Six Sigma is the focus on reduction in variation (perhaps there is something in the name that causes this piece of psychological inertia? Hmm.). Variation reduction is, of course, important. Hmm again. Okay, usually it is – I'm probably not too disappointed if the number of fries in my portion achieves 6σ reliability, but I'm probably very, very worried if I think the person who designed the engine that carries me over the Atlantic was thinking in terms less than 8, 9 or maybe even 10 sigma.

The point here is that the 'Define' part of the DMAIC process should be the thing that guides what level of sigma do we actually require. Or rather, does the customer require. Even more important than this is the idea – thinking about the normal curve illustrated in Figure 3, below – that it is not just about variation reduction, but also making sure we have identified the right mean value.

Figure 3: Defining The Problem and the Normal Curve

Six Sigma, of course, encourages us to think (hard) about customers and what customers want. This means that, hopefully, we stand at least a fair chance that we will pick the 'right' mean. This is a good thing. It could, however, be a much better thing if we begin to integrate some TRIZ thinking into this Six Sigma philosophy.

We will mention two elements of this kind of TRIZ/Six-Sigma integration thinking in this article:-

1) The first concerns 'function'. Six Sigma will tell us to take into account the wishes of the customer. Unfortunately, customers are often not very good at telling us what they want, and so we have to do things to help elicit the information we need for them. Six Sigma makes no great connection to

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'function' since very few customers are explicitly thinking about function either. What TRIZ will tell us, on the other hand, is that whether they can tell us about it or not, those customers are buying functions from us. So, a very good first step in ensuring we are delivering the 'right' solution – and therefore are working on the 'right' Six Sigma project – is making sure we have understood the function of the thing or service we are working on, and whether our current way of doing things is delivering that function in the most appropriate way.

2) Many of the tools of Six Sigma are concerned with 'optimisation'. We have already mentioned the importance of ensuring we are optimizing on the 'right' thing, but there is an even more important point that emerges when we start to bring the TRIZ ideas on contradiction and contradiction elimination into play. Figure 4 presents a hypothetical example of how we might typically use a normal curve to help determine the 'optimum' value of an element of the thing we are designing. This could be 'average' shoe-size, or age of a customer, or operating temperature, or whatever else might be important. As a part of constructing this normal curve we will acquire a bunch of data (which can be very time consuming of course – but not to worry, because, hey, at least we will look and feel busy while we are doing it). Then what do we do? We effectively eliminate anything which lies outside our 6σ range. This is what 'common sense' tells us to do. No problem. Except that we might just have thrown away some very important data. If we think about 'contradictions' then all of the stuff we discard is very definitely important. What about if we could produce a solution that achieved not just the 'average' value, but also achieved the values at the extreme ends? Every thing we say is outside our scope is an either/or decision – you can either have the mean or the extreme. Well, of course, we have selected the mean to include the majority of situations and so why should it matter? It matters because if we can achieve the mean AND the extremes then we have solved a contradiction.

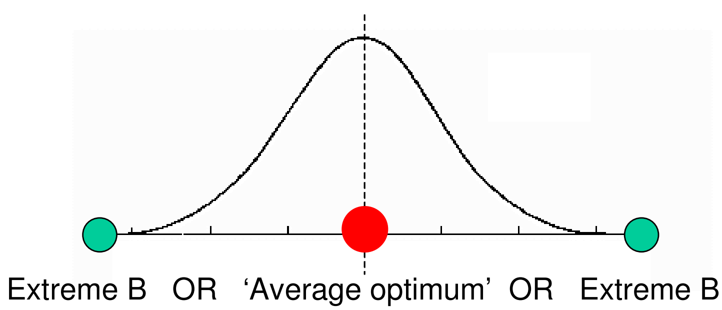

Figure 4: Every Rejection of Extreme Values is a Lost Contradiction Resolution Opportunity

Let's take a trivial example; let's say I'm trying to design a computer keyboard, and I'm trying to work out the best ('optimum') configuration. One of the things I might look at is the age of the customer that is going to use the keyboard. This is likely to lead me to an average customer age of (say) 25 years. Likely as not, anyone younger than 3, or older than 65 is likely then to be off our design radar screen. Net consequence? Old people and young children are usually disadvantaged when they try and use our keyboard. Probably the marketing department will have done some analysis that shows that neither of these customer types is going to bring us any significant revenue, so, hey, who cares?

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How about if we re-think this problem from the perspective of resolving the contradictions present? What about if the keyboard was usable by 2 year-olds *and* the twenty-something hot-shot *and* grandma? Sounds dumb? Let's take the thinking a step further and see:

Grandma is likely to type slowly and uncertainly due to a likely unfamiliarity with the computer. On the other hand, she has probably used a keyboard before and knows what key is where. So she is a user we could classify as 'slow but intelligent'. The two-year-old on the other hand is likely to be slow and not so intelligent –as likely to hit the keyboard with a fist as with a carefully placed finger in fact. What if the keyboard was able to recognize the difference between these two users? Hmm. Maybe, if I could do this, I would also have a design that could discriminate between a twenty-something able to type with two fingers versus a twenty-something who types with all ten? Or whether a user is relaxed or frustrated (e.g. through the force of key-presses)? Or if the user is dyslexic? The point being that thinking about the extremes of the normal curve gets us to define contradictions that, if we can solve them, make the plotting of the curve completely irrelevant.

Anytime we find ourselves plotting normal curves and trying to find an 'optimum' anything – both things that Six Sigma will encourage us to do – we are missing a potentially very important opportunity to define a better (compromise-eliminating) solution. At the very least, this should be worth a thought during that brief initial planning activity.

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Humour

More on Jokes and Inventive Principles; this month an example of Principle 11:-

A feature for a future version of the Innovation Suite?
You ask for it; we program it.

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Conference Review – ETRIA Conference, Aachen, November 2003

The third annual ETRIA TRIZ conference was hosted by the Fraunhofer Institute in Aachen, Germany from the 12th to the 14th of November. The conference was attended by around 80 delegates (including 34 authors) from another highly international audience. The nominal theme of the conference was the application of TRIZ in the automotive sector. Around half a dozen papers were concentrated on this theme, and a similar proportion of delegates were from the automotive sector.

The conference format returned to the single-track structure used during the first conference. This because of the frequent frustration experienced by delegates that they wanted to have the opportunity to experience all of the papers. Three days was probably too long for the conference in this instance. In keeping with the idea that someone, somewhere has already solved your problem, other conferences resolve this issue by scheduling shorter presentations and then having a session at the end of the conference in which the presentations voted 'best' by the audience are invited back to give a longer version. This also tends to encourage delegates to stay to the end of the event – like previous occasions, the numbers attending the conference tailed away quite markedly during the third day.

New content at the conference was fairly infrequent, although there were nice contributions from Gaetano Cascini and the PAT-Analyzer software (thanks to Gaetano for using some of the CREAX 'patent of the month' examples as his case studies!), Michael Slocum and Markus Grawatsch. Ellen Domb's paper on the application of TRIZ to the generation of actual products (shock, horror!) was also much appreciated.

The greatest level of controversy probably came from Michael Slocum's statement that TRIZ was more likely to succeed if it rode the wave of popularity currently being experienced by Six Sigma. While the idea that TRIZ could be subsumed inside something else was probably too much to bear for some present, the concept must have some validity. At the very least because TRIZ has an awful lot to offer the Six Sigma community.

The conference inevitably brought about one or two frustrations (previously published cases, papers on the theme of 'I don't know anything about TRIZ, but…', and an automotive case study that had failed to start from the idea that 'someone, somewhere has already solved your problem' and as a consequence managed to re-invent a wheel that the aerospace industry invented two decades ago. Or at least got a part of the way there – since the automotive solution produced seems to be two generations behind where aerospace is today). It is great, of course, that people are actually using TRIZ, but publishing of inferior or outdated solutions ultimately does the TRIZ community no favours.

Nevertheless, this comment should not detract from the overall positives of the conference. Another very friendly, very open atmosphere and another good step towards consolidating the position of the conference in the TRIZ calendar. See you all in Italy (hopefully!) in the last quarter of 2004.

Readers interested in finding out more about the conference – and how they can get a copy of the presentation materials – should visit either the ETRIA website or see Professor Toru Nakagawa's always enjoyable Home Page in Japan.

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Patent of the Month

Strictly speaking, probably not the most profoundly important invention ever created, but nevertheless our patent of the month this month does make a useful comment about finding gaps in the evolution of system. The patent is US6,662,025, which was granted to NEC on 9 December. The subject is mobile phones. More specifically, the use of mobile phones to send SMS messages. As you might imagine, mobile phones are big business and consequently there is an awful lot of intellectual property being generated in the arena. So much so, in fact, that it is difficult to find the gaps that might have been left by competitors.

US6,662,025 describes and adaptive user interface. From the abstract:

"A mobile phone with adaptive interface is disclosed. The frequency distribution table stores frequency occurrences of each character in messages entered into or received by the mobile phone. When entering text messages, a controller displays the character of the character group on a display in an order based on the frequency distribution stored in the frequency distribution table, whenever input means is operated."

So basically, whereas the existing state of the art in text messaging forces the user to press the '7' key four times in order to write an 's' (or 5 times for a '7'), the NEC inventors have very simply introduced a (continuously updated) algorithm that calculates which of the characters contained on each of the keys of the phone is used more than other ones and then re-prioritises the sequence accordingly.

Thus if I send and receive a lot of messages containing the letter 's', then it will climb to the top of the priority list on the '7' key so that it will appear after one key press rather than requiring the conventional four.

The main learning point from this very simple invention is the TRIZ trend direction towards adaptation in systems. The inventors in this case have identified the sequence of letters on the phone keypad as a fixed thing, but the point is that literally ANYTHING that is currently stationary or fixed or constant could deliver a useful functional advantage by becoming adaptive.

We often talk about the 'relentless search for resources' when we are using TRIZ. Relentless really does mean exactly that. As is amply demonstrated by the NEC patent finding even the most obviously 'fixed' thing and making it adaptive can result in a useful piece of intellectual property.

One of the nicest things about the evolution from constant to adaptive is that – again as in this patent – it can cost virtually nothing to deploy. The NEC solution costs no more than a small amount of programming, and some additional memory requirement in the handset.

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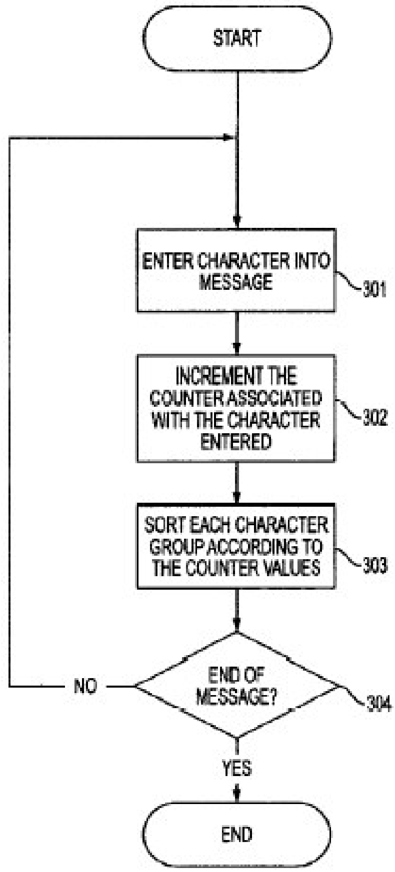

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Best of the Month

No specific TRIZ recommendations again this month. Instead we look to the Design Museum in London and its Conran Foundation Collection. The Foundation recruits a designer each year to identify (and purchase) designs worthy of 'immortality'. The designer selected to chose the immortal designs for the new exhibition opening on 17 January is Thomas Heatherwick.

What is very interesting to see in the 1000 or so selections made by Hardwick is that they all have a very strong link to the TRIZ theme of resolving contradictions and our previous suggestion that 'Design for Wow' emerges when conflicts and contradictions are eliminated. A couple of simple, but choice examples from the selections are the magnetic paint available for sale in the US – an excellent solution for all of those MagNotes users out there that want a big place to display the magnetic hexagons, but don't want to have to buy a big magnetic board'; paint the walls with a magnetic paint. We want some!

Or how about the combined sick-bag/photo envelope used by Virgin Blue airline in Australia. A neat transformation of an object (the sick-bag) that spends 99.9% of its life being used to do nothing into something that can do something useful on almost every flight. Especially for a holiday carrier!

Those that can't get to the Design Museum in person might like to check out their website at www.designmuseum.org).

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Investments – Renishaw

UK-based high-precision measurement specialist Renishaw is a company with a very impressive record of innovation. The company recently announced the introduction of what appears to be another disruptive advance in the state of the art in machine tool measurement systems.

The new RM60 radio probe transmission system - the world's first machine tool probe to use frequency hopping spread spectrum (FHSS) radio transmission - offers the benefits of rapid part set-up and part verification on a wide range of machines.

From the Renishaw website (http://www.renishaw.com/client/publicity/UKEnglish/PUB-6062.html) :

The RMP60 probe and the new RMI receiver have been developed following considerable experience of supplying a range of approved fixed-channel radio transmission products, such as the MP16 and MP18 probe systems. Renishaw is now adopting FHSS technology for its next generation of radio transmission systems due to the considerable advantages to system users.

Spread spectrum transmissions give more robust communication than single channel transmissions by distributing their signals across a wider frequency range. The RMP60 radio probe system operates in a band defined for industrial products, between 2.402 and 2.481 GHz. The system utilises frequency hopping, where a signal is transmitted using a coded pattern of different frequencies identified to the radio transmitter and receiver. Renishaw's innovative use of this technology enables reliable real-time probe signals to be transmitted in an industrial environment.

Radio probe systems allow for great flexibility in the positioning and orientation of the receiver, particularly where line-of-sight restrictions make optical transmission systems impractical. The RMI is a combined antenna and interface so no separate enclosure is required to be mounted in the control cabinet. Conduit routings are therefore simplified for faster installation, making the RMP60 highly suitable for retrofitting to existing machines.

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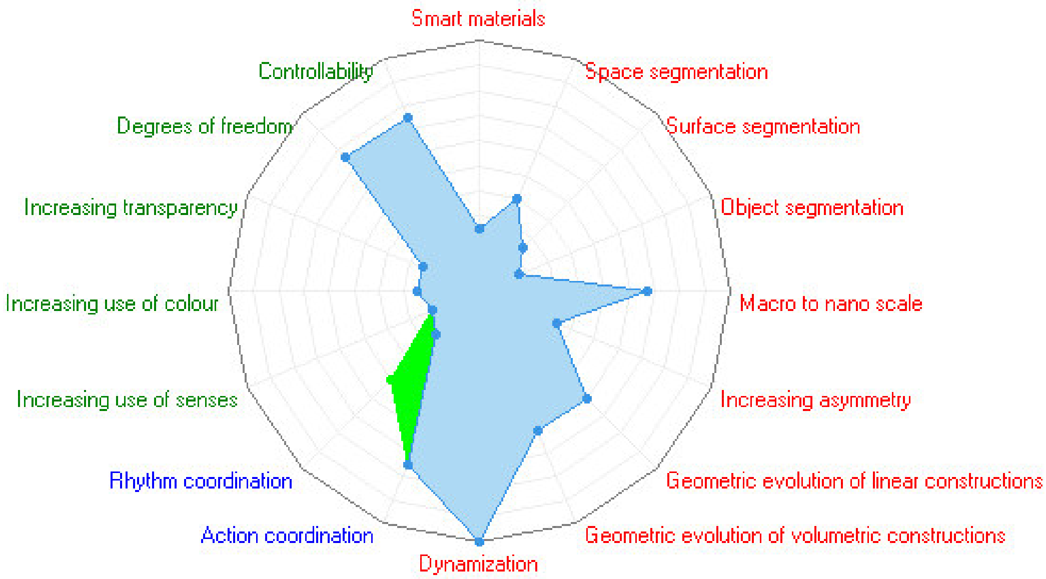
Of interest from the TRIZ perspective is the trend jump made by the FHSS system. A summary-level evolution potential plot of the probe system reveals jumps along the rhythm co-ordination trend:



The plot also shows that there is still considerable untapped potential in the system; implying that there are still many opportunities to evolve the product range as customer demands change.

Check out other Renishaw capabilities at www.renishaw.com.

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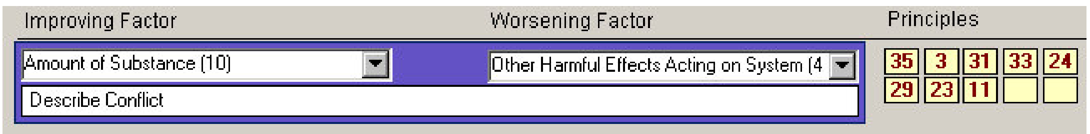
Biology – Holly Leaves

In the wake of our memories of a Happy Christmas at home in the UK, this month we examine the leaves of the Holly tree (Ilex aquifolium). Holly has to solve a problem. On the one hand, it does not want to be eaten by animals, and on the other, it would like to get the maximum use out of all of the resources that it deploys – in this case, extracting maximum energy from the sun and minimizing the amount of structure it has to assemble to protect itself. Clearly, the tree attempts to solve the avoiding-consumption problem by having leaves containing sharp spikes. The spikey leaf design, however, requires use of additional resource to create the tough spikes, and is less than optimum from a sunlight capture perspective.

We might think of this problem as a conflict between maximization of resources and prevention of consumption by predators. A good match for this conflict in the new Matrix is as follows:-



The solution adopted by the tree involves the second of the recommendations made by the Matrix; Principle 3, Local Quality. And so, at the lower portions of the tree we will find leaves that are very spiked, while higher up – where animals are unable to reach – the leaves are often considerably less spiked and thus make more efficient use of the available resources.

Holly Leaves From Bottom and Top of a Typical Tree

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