Systematic Innovation

e-zine

Issue 39, June 2005

In this month's issue:

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.

Our guarantee to the subscriber is that the material featured in the e-zine will not be published elsewhere for a period of at least 6 months after a new issue is released.

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

TRIZ, Salt Curves And Innovation

(Thoughts On Being 'Too Lean')

During a recent Lean/TRIZ session in Denmark someone mentioned a recent Danish magazine article on Lean, and a comment that companies that had some kind of Lean initiative were seeing a negative impact on innovation. A typical initial reaction to this kind of pairing of Lean and innovation is that there ought not to be any correlation between the two. Indeed, if anything, any correlation ought to be a positive one; we need the innovation part in order to achieve the Lean part. Waste elimination is a good thing – a necessary thing in fact in today's highly competitive world – and we only eliminate waste by changing things. And we change things through creativity and innovation. So the two are positively correlated. Or so the theory goes.

But what if there is a link? Could Lean kill innovation? How might the two things be negatively as well as positively correlated?

In situations like this, where someone (in this case the magazine journalist) believes one thing, and someone else believes something else, the answer is most likely to come by examining how both could be right. A good way of formulating this kind of 'both right' problem is to look for a contradiction and then, from there, a 'third way' solution. If Lean *can* have a negative impact on innovation, we might formulate the contradiction 'we want Lean and we don't want Lean'. Having done this, we might then have a look at Edward DeBono's 'Salt Curve' theory to see if it has any relevance to the situation.

For those that don't know about it, the 'Salt Curve' analogy is about humans and salt: Human's like and need salt in order to survive. But, as we all know, too much salt is bad for us, and similarly, too little salt is also bad for us. Human physiology, in other words, dictates that there is an 'optimum' level of salt ingestion. We might describe this in the curve shown in Figure 1.

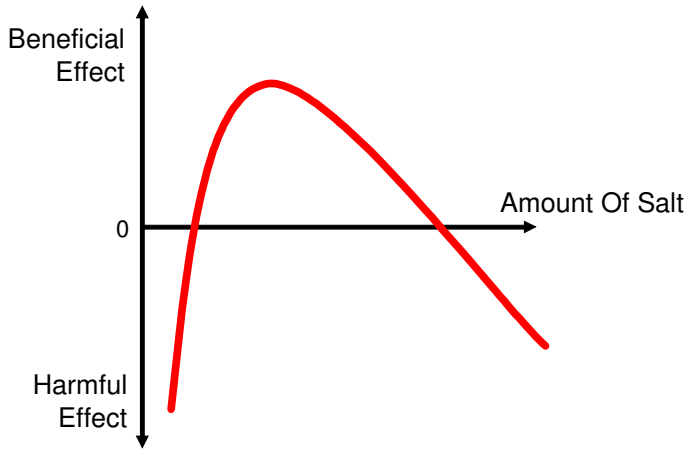


Figure 1: The Salt Curve

Applying the Salt Curve logic to Lean, and in particular waste elimination, we are forced to pose the question; 'is there such a thing as too lean'. Or perhaps 'is there such a thing as too much waste elimination?' Or, looking from a more zoomed-in perspective of the left-hand side of the Curve, 'do we ever reach a point where further reduction of waste

becomes harmful rather than beneficial?'

Such questions run counter to the prevailing 'common sense' of most management literature. That common sense dictates that all waste is a bad thing, and therefore must be eliminated. The Salt Curve, on the other hand, encourages us to ask beyond-common-sense questions.

One possible answer to the question comes from an earlier e-zine discussion about the Dodo. The Dodo is a now-extinct flightless bird (Figure 2). When its environment favoured Dodo's that did not fly, the wing became 'waste', and thus any bird that deployed its resources elsewhere (e.g. into more developed leg muscles for running) gained an evolutionary advantage. Three-quarters of a wing has little more functionality than no wing, and hence as evolutionary time went on, progressively more of the wasteful wing disappeared. The Dodo's evolutionary fight for survival favoured those birds with a wing-waste elimination Lean initiative. All is well in this world until the system changes. In the case of the Dodo, the system changed quite radically when humans decided that they were both a tasty meal and easy to catch. Net result extinction, since the bird was unable to respond quickly enough to the changing environment.

Figure 2: The Dodo

The same basic model can be seen to apply to organizations. A quick survey of companies that have gone out of business in recent times will reveal that a significant proportion have had some kind of Lean initiative in place at the time disaster struck. Perhaps, the Dodo analogy suggests, they eliminated so much 'waste' that they were unable to change when the world around them changed.

The main issue here seems to be how we define 'waste'. For the Dodo, the flightless wing was both 'waste' and 'potential escape route if the world changes'. For an organization, the question therefore becomes 'what elements of waste in today's definition, might turn out to be useful resources in a changed tomorrow?'

This is undoubtedly not an easy question, but perhaps examination of a second possible answer to the earlier 'do we ever reach a point where further reduction of waste becomes harmful rather than beneficial' question helps us to see a possible one.

In our TRIZ travels around the world, we see people in organizations pushed harder and harder to deliver results, to 'do more with less' and generally 'use their time efficiently'. All the fine words that any Lean initiative will tell people they need to be doing. In some

extreme cases we've been told that we are allowed no more than an hour to be briefed on a problem because the team is 'so busy'. In others we've heard that companies are 'too busy' to think about deploying TRIZ (or any other technique for that matter). The point here is that many people are now so Lean that they have no time to think anymore (or at least that is the way that they perceive the situation – and as we know, perception very often turns itself into reality).

It is surely true that no Lean-motivated manager intended that people made their work place so lean that they had no time to think any more. But nevertheless, it seems to have turned into the reality in many, many companies. The project team that gave us an hour to brief us on a problem surely knew in their hearts that such a short time was insufficient. But their time-sheets (measured to the nearest 0.1 hour of course) told them otherwise; told them that there was no project number for this briefing and that there was a pile of other things that the ERP system said they had to do this week.

Here we very definitely have a 'too lean' situation. It is perhaps an extreme one, but it is alas typical. Push people to too high a level of 'efficiency' and the strong likelihood is that their creative talents will be the first to suffer, the first thing to be squeezed out the work equation. And thus we have our negative correlation between Lean and innovation.

There is a wonderful paradox here. Best intentions conspiring to create dis-functional systems. No one ever says 'don't be creative'. Indeed the prevailing message from management is more likely to be 'apply creativity to eliminate waste'. But push that idea too far – over the hump of the Salt Curve – and the time for creativity becomes gradually squeezed down to nothing. This happens thanks to simple human psychology; creativity and stress don't mix.

Someone, somewhere already solved your Lean Salt Curve problem, of course. We can see specifics examples (at least theoretically) in companies like 3M where people are allowed to spend a certain proportion of their time doing whatever they like, or in Universities where academics earn sabbatical time. More generally, the Lean-versus-innovation conflict, if it has occurred in your organization, can be addressed using the Business Conflict Elimination Matrix tool. We might map a Lean manufacture versus innovation conflict as Production Cost versus Adaptability for example. Little point in doing that here, but very definitely a point in you doing it in your own specific situation.

Summary

'Lean' and 'innovation' don't have to be negatively correlated, but they often are because there is a tendency for managers to push systems too far.

Pushing too far in this case means going over the hump of a Salt Curve. Like S-curves, Salt Curves are everywhere. Unlike S-curves, they are not universal. They are common enough, however, that it is always worth considering whether there is a Salt Curve effect in whatever situation you might find yourself in.

The lesson of the Dodo tells us that there is such a thing as 'too Lean'. The truth of this statement becomes ever greater as the world becomes more and more turbulent; sooner rather than later, someone is going to disrupt your world and you're going to wish that some of that 'waste' you trimmed out of the system was still there to save you.

‘Everything Is The Field And The Field Is Everything’

(Albert Einstein quotation)

Everything evolves to a field. Nothing functions without a field.

Fields are everywhere around us. Some more obvious than others. There are several field checklists available in TRIZ to help us to make sure we have considered all of the field possibilities when working on a problem. These generic lists, however, are oftentimes insufficient if we have a very specific or specialized problem to solve. One such problem is the mosquito; subject of one of our more critical paper reviews last month. The aim of this article is to see how we might re-think the mosquito problem when we take a more detailed look at fields. The hope is that by doing this we not only get a clearer perspective on how a very cheap mosquito trap/repellant design may be achieved, but we also gain some useful new thoughts and strategies for solving other types of problem.

The Mosquito Problem

The mosquito problem requires some careful definition if we are to ensure a sensible solution emerges. At the highest level the function we require to achieve is stop disease carrying mosquitoes from biting humans and domestic animals. This definition in turn points us towards solution strategies operating at several different levels:

1) we put something on to skin that repels disease-carrying mosquitoes
2) we put something on to the skin that repels all mosquitoes
3) we put something in to the environment around the potential mosquito victim that repels disease-carrying mosquitoes
4) we put something in to the environment around the victim that repels all mosquitoes
5) we put something in to the environment that attracts disease-carrying mosquitoes away from humans and domestic animals
6) we put something in to the environment that attracts all mosquitoes away from humans and domestic animals
7) we put something in to the environment that attracts disease-carrying mosquitoes into some kind of trap
8) we put something in to the environment that attracts all mosquitoes into some kind of trap
9) we put something into the trap that ‘neutralises’ disease-carrying mosquitoes
10) we put something into the trap that kills disease-carrying mosquitoes
11) we put something into the trap that kills all mosquitoes

Clearly some of these definitions will be more difficult to achieve than others. Clearly also, some will be more expensive than others. In situations like this where we have a large number of possible solution routes and a constraint like ‘as cheap as possible’ (the constraint imposed by the authors in the paper we reviewed last month), there is a strong tendency to start rejecting possible routes early on in the process. Such strategies frequently carry the risk that we prematurely eliminate something that might turn out to be useful in the future. The risk is particularly high if it is a subject area where we allow our psychological inertia to influence our decisions. As an example of this, note that throughout the list of directions ‘mosquitoes’ and ‘disease-carrying mosquitoes’ have been seen as two different types of situation. Without knowing whether it is possible to distinguish between the two, it is foolhardy to eliminate either possibility. The point here – and also in general – is that it is far better to acquire some knowledge before we start filtering.

The Verb Is The Problem

The verb is the problem. If we look at the above list of possible solution directions through the lens of ‘verbs’, we find just three important words: attracts, repels and kills. We add a fourth verb ‘distinguish’ to this list if we wish to explore the difference between ‘disease-carrying’ and ‘all’ mosquitoes. So now we have four verbs relating to our problem. Now we need some knowledge to see how these verbs (functions) might be achieved.

One way of finding this knowledge might be to use a piece of semantic-software like Goldfire™. This would be expensive, of course, but because it has understood the importance of verbs, it is able to search for them quite efficiently. Since not everyone has the amount of investment capital necessary to purchase a Goldfire license, an alternative strategy is to conduct a manual search. Hopefully, if we are intelligent in the way we go about this search, we can get to pretty much the same end point in a relatively short space of time. In many ways too, the pain of manual searching can be a very positive thing since it makes it much more likely that we will think more carefully about what we search for.

A first useful piece of knowledge before we start interrogating things like patent databases is that we have seen a problem similar to this one, when we looked at badgers, bats and newts in a recent ecological study (Reference 1). The problem there was protection of those species by keeping them away from dangerous areas. In true ‘the verb is the problem’ fashion, the key to solving those problems was understanding what attracted and repelled those animals. With this idea in mind, we might head towards the patent database and start searching for ‘mosquito’-and-‘attract’, and then ‘mosquito’-and-‘repel’. If we are really smart, we might also think about verb synonyms. Fortunately, in the case of fairly specialized functions like ‘attract’ and ‘repel’ the number of synonyms is quite low.

Table 1 describes what we found out about attracting and repelling mosquitoes in a 15 minute search of the US and European patent database. A quick preliminary search on ‘mosquito’ reveals the existence of several hundred patents in this domain, so we know we have a solid basis for using this knowledge repository. As we did in the earlier Reference 1 work, we have classified the attraction and repulsion means in terms of the five basic senses. This kind of structure helps to ensure that all of the possible solution territory is covered, but also gives us additional search words (‘mosquito’-and-‘repel’-and-‘visual’ for example) that allow us to zoom-in on particular areas.

	ATTRACTS	REPELS
Visual	Contrasting colours Shiny colours Dark colours Movement	Strong sunlight
Auditory	Sound of other mosquitoes	Pregnant females repelled by sound of males
Kinesthetic	(Body) heat Standing water	Soapy water Excess heat
Olfactory	Human odour/pheromones Coryneform bacteria Carbon dioxide (range 90m!) Octenol Bacterial decomposition Yeast fermentation (methanethiols)	Soapy Water Isomenthone Linatool Geraniol Citral Citronellol 2-undecanone/2-tridecanone
Gustatory	Lactic acid Blood (pregnant female mosquitoes)	
Other		Bats/birds/dragonfly

Table 1: Mosquito Attractors And Repulsors From A 15 Minute Patent Search

A subsequent search on the word 'distinguish' (and synonyms – discriminate, etc) revealed no a priori means of distinguishing between disease-carrying and other mosquitoes. What did become apparent, however, was that it is only pregnant female mosquitoes that diet on blood. So while we don't have a means of distinguishing between disease-carrying and other mosquitoes, we do have a way of distinguishing between those that will bite and those that won't. (Important to note here is that, although the 15 minute search may be considered to be 'wasteful' in Goldfire terms, our reading has uncovered this and other facts that we would not otherwise have uncovered unless we had asked the specific question. The manual search strategy, in other words, can often uncover useful information that we only knew we wanted after we found it. The human brain has natural instincts that software does not yet possess.)

Remember here too that our primary purpose in this article is to describe a generic process. If we were really in the mosquito business, we might well wish to conduct these searches a little more rigorously. What has already become apparent, however, is that no inventor in the mosquito business has so far pulled together all of the information that we have acquired in just our 15 minute search.

The Verb Is The Field

Having found some of the things that attract and repel mosquitoes, we need to find means of creating the necessary conditions to deliver the desired functions. In TRIZ terms that means we need to identify appropriate fields. Specifically we need fields (or 'sources of energy') that deliver the desired verbs.

Let us look at a couple of examples of this field-verb connection for the mosquito problem. Carbon dioxide looks like an interesting first example. Mosquitoes have evolved over millions of years to be highly efficient prey-locators. The fact that they can detect the increase in CO_2 content in the exhaled breath of a human from 90m (actually, they may also be detecting other constituents of the breath at the same time) is quite some

testament to the power of that evolutionary drive.

So how to create carbon dioxide? To answer this question, we might chose again to conduct some kind of knowledge search. In this case the verb would be ‘create’ or ‘produce’, and we could go back to the patent database, or we could look at other knowledge repositories. We will in fact find many ways of creating CO_2.

Having understood the attracts/repels problem much better now, however, it is also timely for us to start thinking about our solution constraints. In this case, our primary aim is to achieve a very low cost solution. Hence we start looking for ways of looking for fields to deliver the desired functions, we might use cost related words as search qualifiers. Actually ‘cost’ works very well on its own since very few inventors are likely to talk about cost unless it is low-cost.

Again, rather than doing that here, we might further smarten our search by exploring whether we can combine several fields together. Thus, for example, we will quickly find that someone has a patent on a mosquito trap that uses a candle – a neat and relatively cheap way of achieving two mosquito attractors (CO_2 and heat) from one device. Strangely, no-one appears to have taken that a stage further by saying ‘why not have a candle containing octenol or lactic acid’, thereby adding additional mosquito attractants into the same basic device. This might form the basis of another patent. Or at least it might have if we hadn’t described it here.

One of the reasons we have described it here is because this solution direction attracts all mosquitoes, and, in the case of the CO_2, from quite some distance. We might question whether this is such a good strategy. It seems to have the ring of overkill about it (do we really want to attract every mosquito for miles around to one place?), and candles, while relatively cheap, are still not ‘free’. Nevertheless, it is a solution that we can store safely lest it becomes useful in other circumstances.

To achieve a ‘free’ solution, we are going to have to find a field that can be delivered for free. This doesn’t sound too easy, although again resource check-lists might offer some assistance. As might searches for existing resources. Having decided that the candle solution was ‘overkill’ however, we may wish to explore the possibility of looking at fields that might be associated with the ‘distinguish’ function. Here our knowledge search has already highlighted the fact that it is only pregnant females that feed on blood. This then begs the question, is there some way of repelling just those pregnant females? Our attractor/repulsor table quickly points out that pregnant females are repelled by the sound of male mosquitoes. Hmm. This sounds interesting. Maybe all I need to do to solve the mosquito-biting problem is repel pregnant females by imitating the sound of a male mosquito?

Again I need some knowledge (what noise do male mosquitoes make?) and again I will need a field. Specifically in this case I need a cheap (free!) field that makes a sound like a male mosquito. Even better – just to make sure, and to allow me to write the strongest patent application – I might also think about whether this field might also be able to be combined with other (free) mosquito repelling means. Something that sounds like a male mosquito, and emits the smell of isomenthone perhaps.

We’re obviously not interested in specific answers here, but needless to say, there is a very neat, free (existing resource) way of doing what we want to do. This is one solution we might actually want to patent. In which case you can read the invention disclosure on

the patent database some time soon. Or you can try and work it out for yourself. Either way, the main points of this article remain:

- think about the *verbs* in your problem definitions
- use the *verbs as the basis for searches* of knowledge databases
- make the connection between verbs and fields (‘*the verb is the field*’)
- explore *combinations of fields* when looking for the strongest solution

Reference

1) Stuart, F., Mann, D.L., Hills, D., ‘Is TRIZ Useful For Generating Ecological Mitigation Solutions?’, TRIZ Journal, April 2004.

Humour – Convenience

Anyone that hasn't tried Google Images yet, ought to give it a try. A great way of finding pictures to illustrate something that you are searching for. Or mostly. Here's one of the first images that appeared when we recently did a search for images to illustrate the concept of 'convenience':

Not quite the thing we had in mind for illustrating the new customer purchase focus trend, but an interesting use of Inventive Principle 5 nevertheless.

More seriously, avid image searchers will probably already be familiar with two other great graphic locator sites, but for those that are not, please check out either or both of:

http://creative.gettyimages.com/source/home/homeCreative.aspx

and

http://pro.corbis.com/default.aspx

The days of graphic-less Powerpoint presentations may be numbered.

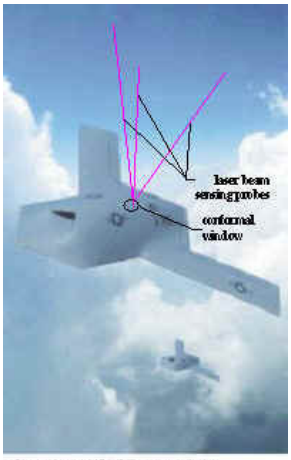
Patent of the Month

A difficult choice this month, having found a fairly big cluster of interesting patents. Honourable mentions need to go to US6,891,623 and US6,891,958, either one of which you might care to check out if either nano-lithography or asymmetric digital water-marking sound like your bag.

Our bag points us in the direction of US6,894,768, which appears to offer a winning combination of making a real impact to a long-standing aerospace problem, and also making a nice TRIZ analysis.

The patent focuses on the problem of measuring the behaviour of an aircraft in flight:

United States Patent 6,894,768.
May 17, 2005
Optical air data systems and methods
Abstract
Systems and methods for sensing air outside a moving aircraft are presented. In one embodiment, a system includes a laser for generating laser energy. The system also includes one or more transceivers for projecting the laser energy as laser radiation to the air. Subsequently, each transceiver receives laser energy as it is backscattered from the air. A computer processes signals from the transceivers to distinguish molecular scattered laser radiation from aerosol scattered laser radiation and determines one or more air parameters based on the scattered laser radiation. Such air parameters may include air speed, air pressure, air temperature and aircraft orientation angle, such as yaw, angle of attack and sideslip.
Inventors: Caldwell; Loren M. (Ft. Collins, CO); O'Brien; Martin J. (Pine, CO); Weimer; Carl S. (Littleton, CO); Nelson; Loren D. (Evergreen, CO) Assignee: Ophir Corporation (Littleton, CO)



Operational USAF/Boeing UCAV

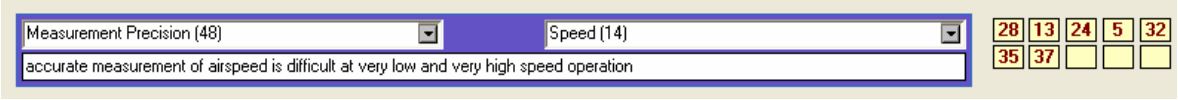
One of the nice things about the invention disclosure is that it allows us to explore and analyse two successive generations of measurement systems.

The background description begins with a description of what is still the dominant air data system (ADS) measurement method:

The prior art ADS has limitations. With respect to the Pitot tube, for example, if aircraft velocity is too low, the pressure transducer may lack requisite sensitivity to provide meaningful telemetry data, such that transducer signal noise or error may be greater than meaningful differences in pressure measurement. Alternatively, if the velocity is very high (e.g., supersonic), certain assumptions, such as those regarding incompressibility of air flow in Bernoulli's equation, are violated and the measurement is incorrect. Accordingly, Bernoulli's equation must be altered to

compensate for various breached assumptions. This compensation process must continue in rapidly changing conditions of altitude and air density. It is, therefore, desirable to improve accuracy and operability of the ADS.

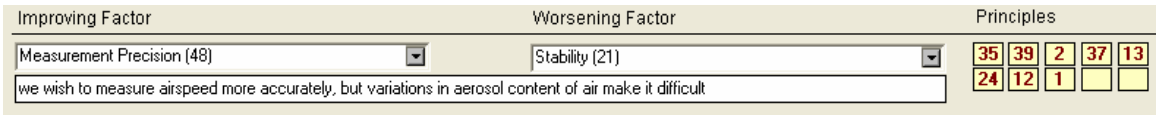
This description allows us to extract an important contradiction between the desire to make an accurate measurement and the problems that occur at the extreme ends of the speed envelope. We might this contradiction as follows:



Although, of course, TRIZ wasn't used to generate the solution that was able to solve this problem, what we can see here is that Principle 28 gives us a very definite pointer away from a mechanical measurement system and towards one utilizing some kind of field. The next generation ADS indeed turns out to make use of a field – an optical one as it turns out from the US6,894768 disclosure description. And lo the optical air data system (OADS) appears as a new generation measurement method. The disclosure then moves the story to the current invention:

However, the prior art OADS relies on scattered light that is unpredictable because of varying aerosol distributions. For example, aerosol distribution varies significantly with altitude and cloud content. In addition, some regions of the atmosphere contain too few aerosols to enable reliable air data measurements. Thus, aerosol-based optical air data systems cannot determine the air speed at all altitudes frequented by modern aircraft.

Again we find a system that has hit a limiting contradiction. This time the desire to make accurate measurements is compromised by variations in the properties of the atmosphere under different conditions. We might map this new contradiction as follows:



And now here are the key inventive steps made by the inventors as described in Claim 1 of the disclosure:

1. A method for remotely sensing air outside a moving aircraft, comprising:
projecting laser radiation from the aircraft into the air to induce scattered radiation that has a molecular scattered radiation component and an aerosol scattered radiation component;
detecting scattered laser radiation;
distinguishing the molecular scattered laser radiation component from the aerosol scattered radiation component; and
determining one or more air parameters based on the scattered radiation, the air parameters selected from the group of air speed of the aircraft, pressure outside the aircraft, temperature outside the aircraft and aircraft orientation angle.

As with all of our 'patent of the month' features, there is never any implication that an inventor actually used TRIZ to derive their invention. Our intention always is to see how well the strategies used by actual inventors match to those that the method says other people have used. Viewed in this light, we may again see that the strategies used by the inventors match incredibly well to those suggested in the 2003 version of the Contradiction Matrix: the key inventive steps involving both Segmentation (Principle 1) of aerosol and molecular components of the air, and then using the Relative Change between them

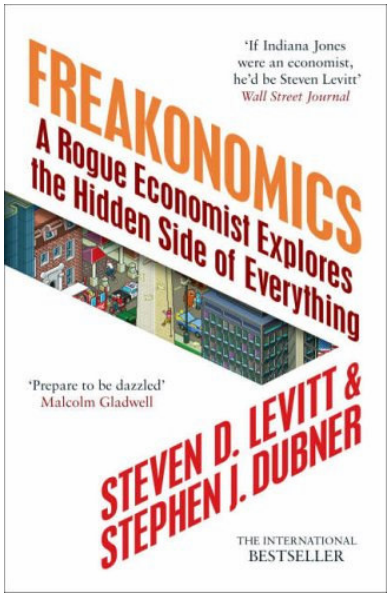
(Principle 37) as the means of obtaining the necessary measurements.

What is also interesting about the invention is that the new measurement capability makes possible a series of measurements that were not previously possible to make. As such the laser system described in the invention also allows us to contribute new entries into the knowledge database section marked ‘measure pressure’ and ‘measure temperature’.

Check out the actual product being developed by patent assignees Ophir at www.ophir.com/senseAir.htm.

Best of the Month – Freakonomics

The number of mentally stimulating texts by economists can probably be counted on the fingers of one foot. Here is an exception to the general rule. 'Freakonomics – A Rogue Economist Explores The Hidden Side Of Everything' by Steven Levitt and Stephen Dubner is an excellent read for anyone with an interest in the bizarre workings of complex systems.



Although the book professes to have no unifying them to hold it all together, it actually has a very important one; the prevailing 'common-sense' view of the world (in this case the economists common sense view) is usually wrong. This idea in itself not novel – several authors have written on the subject – but it is novel in the context of economics.

Each of the six long chapters of the book examines and challenges a different aspect of the 'common sense' problem. So Chapter 1 for example is about 'who benefits' and how incentives can cause enormous and unexpected effects on the things we are trying to measure. Thus, to pick out one of the main examples from the chapter, if teachers are measured on how many students advance to the next grade, then guess what, statistics show that more students pass than without the incentive in place. Great. Or is it. Turns out that more students pass irrespective of whether they actually learned anything or not. The point being that an apparently innocuous value definition like how we decide to measure something, can deliver serious and profound downstream effects that we had no idea were going to be connected to the incentive we put in place.

This tiny-things-grow-into-monsters idea crops up again in later chapters spanning a range from mis-information in the media, to the 15-years-later effect of abortion law on crime rates, to the effects that the naming of an infant at birth will have on his or her future career prospects. A running thread concerning the often crucial difference between correlation and causation (if A and B are correlated, A may cause B, B may cause A, or both A and B may be caused by something completely different).

A fascinating read throughout. You may never think of economists in the same light ever again.

Conference Report – Kreaturk, Istanbul

The 7th Kreaturk conference was held at the Princes Hotel in the business district of Istanbul on the 27th and 28th of May. The conference was designed to present a broad menu of different 'creativity' tools, techniques and ideas to a primarily Turkish audience. The basic format was three parallel sessions of around an hour duration each, with five time-slots during each day. A total of seventeen different presenters filled the various slots with one or two presentations each:

TRIZ was discussed in both of Darrell Mann's sessions (one on business applications and one on 'how to get people buying in to change') and another two by good friend Andre DeZanger. SIT was also represented in the form of Sandra Minnee from the Netherlands. Not sure if it is appropriate to call it 'the other end of the spectrum', but if TRIZ counts as 'structured creativity', then the 'unstructured' end was covered by such sessions as 'The Labyrinth Experience', 'Symbolism and Aesthetics' and 'Once Upon A Time On A Dark Night'.

As often seems to be the case at ‘creativity’ conferences, the atmosphere was extremely friendly throughout, and highly conducive to learning. All that was required was an open mind. Not always easy (e.g. everybody being told to stretch and become a tree at one early session), but maybe that was just for us engineer types? Still, we soldiered on through and, also unusually for conferences these days, managed to come away with a couple of pages of fresh thoughts and things to try out in future TRIZ sessions. Nothing earth shattering, but definitely worth the time and effort. If only for the invention of Viagra Patches and methods for their deployment!

Many thanks to the conference organizers for their beyond-the-call-of-duty efforts and attention to detail. An enjoyable experience that we would be honoured to repeat again in future years.

Investments – Nano Coatings

Fresh from the recent Hannover Fair, the German 'Institute of New Materials' presented a number of technologies worthy of further attention. Heavily prominent is the word 'nano'. Not such a great surprise these days given the trends in materials science, but nevertheless some novel manufacture techniques and applications on show. The ones that sparked our interest the most were a new nano-coat 'light management foil' – designed to make displays appear brighter from certain angles thanks to the use of nano surface segmentation (!), and a capability to make flexible CDs:

> CDs can only be read by hair fine lasers if their microstructures have been worked into the material with walls as vertical as possible. Therefore, the rate of manufacture, even in the case of mass production, is severely limited and correspondingly costly. The INM has developed a new type of material with which CDs can now be printed like pages of a book in rotation printing many times faster with speeds of up to 30 meters per minute. This creates flexible CDs stamped on plastic film, which can be played on any CD drive by means of an adaptor and opens up completely new fields of application for the versatile data carrier.
>
> The clever material is a so-called Nanomer®, consisting of silane functioning as methacrylate and contains ceramic nanoparticles made of zirconium oxide. It possesses the astonishing property such that microstructures embossed extremely fast by a roller into the still semi-liquid (thixotrope) layer remain standing as if frozen into place and can be hardened in a subsequent facility by means of UV light. The INM has applied worldwide for the patent on the new type of nanotechnology for optical microstructures. Using this technology, the Bertelsmann subsidiary Topac in cooperation with the INM has developed the first production technology and the first CD products with market maturity.

Sample of Flexible CD storage Material

Of course, flexible storage media was with us in the dark days of floppy discs. Increasing memory capacity required a shift to immobile structures like the CD. Now it looks like we have the prospect of CD-like storage capabilities in something which is now flexible again. This shift in the capacity-flexibility conflict has come about by shifting the problem to the nano scale.

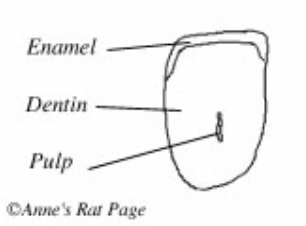
Check out the Institute of New Materials website at:
http://www.inm-gmbh.de/htdocs/home/frame_en.htm

Biology – Rat Incisors

Rats are notorious for their gnawing abilities, seemingly able to wreak havoc on any structure that gets in their way. How they manage to achieve and maintain such abilities is the subject of our biology feature this month.

Rats are monophyodont, which means that they have one set of teeth during their lifetime. Rats have only two types of teeth in their mouth -- molars and incisors. Our focus here is on their incredible incisors.

The morphology of the rat incisor was long ago described by a biologist as "a shape...with almost geometric precision...of a segment of a spiral." The incisors of a rat are very different from those of other mammals, and this difference is what makes the rat such a good gnawer. The pulp cavity for the incisors remains open and no roots are developed; as a result, the rat's incisors grow continuously. There are two sets of incisors: one upper and one lower. They are covered by enamel only on the external facing surface; the interior surface of the tooth is dentin – see the cross-sectional view in the figure below:



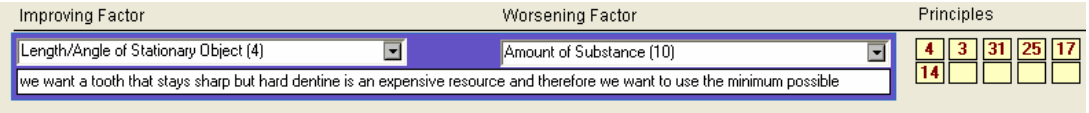
Enamel is the one of the hardest known natural materials. Rat enamel is harder than most - specifically, measured on the Mohs hardness scale, the rat's lower incisors rank 5.5 compared to 5 for a human incisor and 10 for a diamond. Dentin on the other hand is somewhat softer (around 4 on the Mohs hardness scale). This asymmetrical structure of the rat incisor, with the tooth being harder on one side than the other, is the main reason for the incredible gnawing ability.

The back and forth movement of the jaws during gnawing rapidly wears away the softer dentin on the interior surface of the incisor more so than the hard enamel on the external-facing side. As a result, a sharp, bevel-shaped edge is continually formed and reformed.

The incisors grow at a rate of about 5 inches a year, and are continuously worn away, to be completely replaced every 40 to 50 days. The bite load of a rat is up to an amazing 10 pounds.

From a TRIZ perspective, the contradiction being challenged in the incisor design is that

between the desire for a tooth that stays sharp, while at the same time makes the most efficient possible use of available resources. Enamel in particular is an expensive material to produce, and so anything that can be done to minimize the amount needed to perform the required gnawing function is a benefit. Below you can see how we have mapped this conflict pair onto the 2003 version of the Matrix:



The match between the recommendations from the Matrix and the strategies present in the rat is almost uncanny – with definite links to Principles 4 – Asymmetry, 3 – Local Quality, 25 – Self-Service (where the top and bottom incisors work to sharpen each other), 17 – Another Dimension ('B. If an object contains or moves in a plane, consider use of dimensions or movement outside the current plane' – beveled edge) and 14- Curvature (if allowed to grow without restraint, the rat's incisors would grow in a spiral with an angle of 86º).

It seems, in other words, that human inventors have uncovered exactly the same success strategies for this length-versus-amount-of-material as the rat has evolved.