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Systematic Innovation

e-zine

Issue 18, July 2003

In this month's issue:

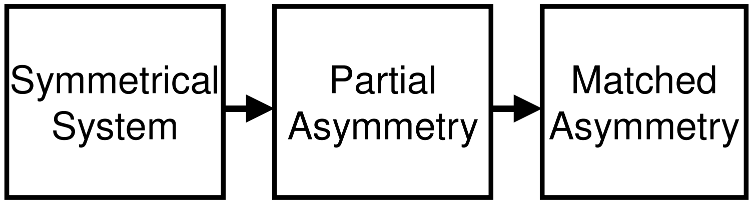
The Systematic Innovation e-zine is a monthly, subscription only, publication. Each month will feature articles and features aimed at advancing the state of the art in TRIZ and related problem solving methodologies.

Our guarantee to the subscriber is that the material featured in the e-zine will not be published elsewhere for a period of at least 6 months after a new issue is released.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

Finding The External Asymmetry

Asymmetry plays a significant solution generation role within systematic innovation – being both an Inventive Principle and subject of one of the more recent trends of evolution:-



Asymmetry tends to be an available resource in many systems. This is because many manufacturing systems and indeed many design practices assume that symmetrical things are easier to produce. The down-side of this assumption is that a lot of the advantages that asymmetry can offer to a system are not used.

On the other side of the coin, however, the Asymmetry idea is not simply about 'increasing the asymmetry' in or around the system. The trend of evolution version of the Asymmetry solution route attempts to introduce the idea that asymmetry is only of use when there is an 'external asymmetry' for the system to match to. Understanding these concepts of external asymmetry and 'matched asymmetry' are the two objectives of this article.

External Asymmetry

Human ergonomics offer good examples of 'external asymmetries'. The hand, for example, is a highly asymmetrical external feature as far as things like gloves and grips on things like cameras, keyboards and controls are concerned. In this area we can see how very many systems have sought to exploit more and more of the benefits associated with matching to the geometry of the hand:-

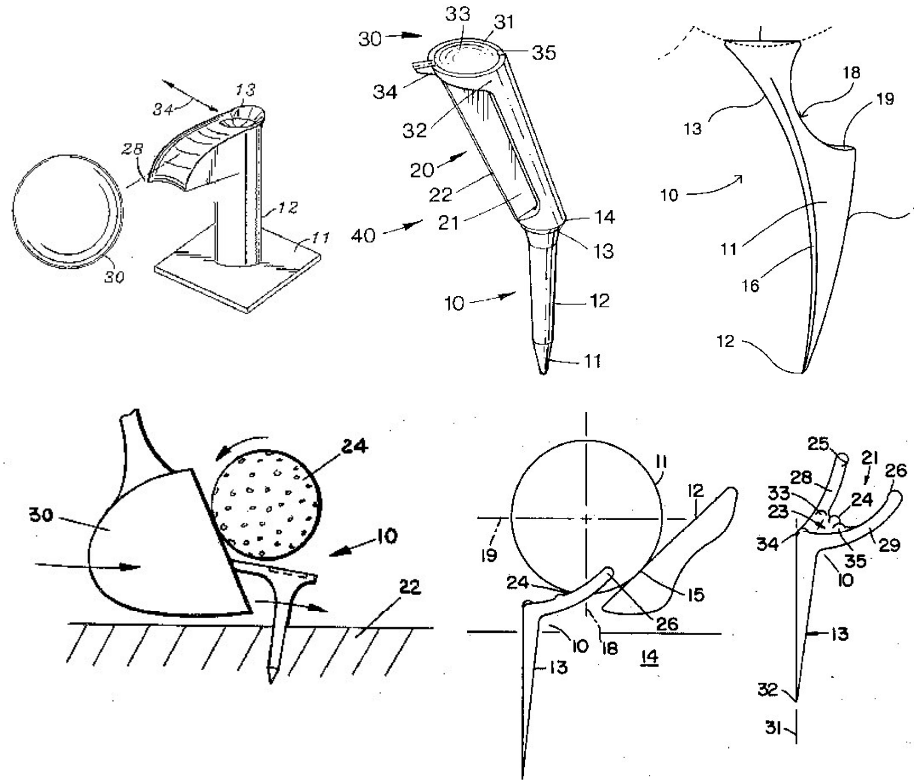
  

In the case of the above oven gloves, the evolution from left to right illustrates have increasingly matching the system to the asymmetries of the hand offers the user increasing dexterity when it comes to manipulating hot items.

The key question when trying to locate external asymmetries is '*is there a genuine and repeatable asymmetry for my system to match to?*' In the case of the oven glove, the repeatable asymmetry is that every human hand (disabilities excepted) has certain common features – four fingers, an opposing thumb, a left and a right – that a designer can safely try and match the system to.

In the case of pens and other writing implements, the ‘genuine and repeatable asymmetry’ is not present since a proportion of the population is left-handed who would find it difficult to use implements designed solely for right-handed use. This is why most writing implements are largely symmetrical (or rather why there are a number of specialist ‘left-handed’ pens on the market to compensate for the fact that several sectors of the pen industry have assumed that they should bias their designs to suit the 85-90% of the population that are unfortunately right-handed).

Finding genuine asymmetries is often not as easy as it first appears. The figure below, for example, illustrates a number of granted golf-tee patents where the inventor has assumed that there is a benefit to be obtained by introducing asymmetries into the tee design:-

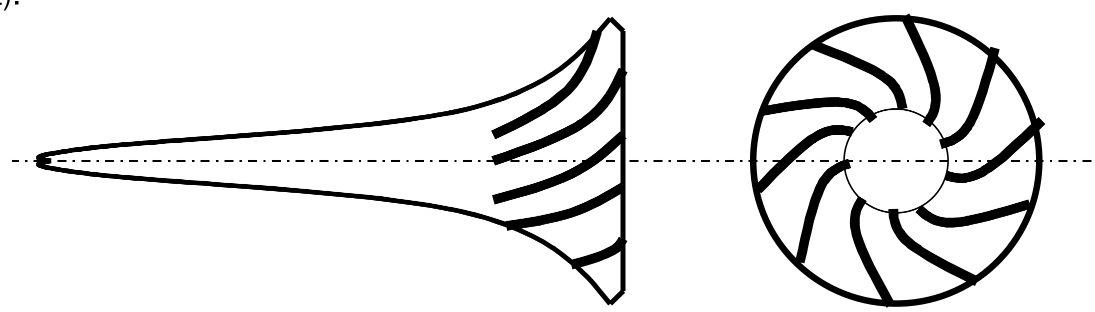


What is the problem with all of these designs? Answer they have assumed that an external asymmetry exists, when in actual fact it doesn’t. During normal use of a golf-tee, the golfer picks up the tee between two fingers, picks up the ball with all of the fingers, manipulates the ball so that it sits in the cup of the tee, then uses the palm of the hand to press on the ball so that it in turn drives the tee into the ground. At no stage during this operation does the golfer have to worry about the orientation of the tee. All of the above designs, on the other hand, require a conscious effort by the golfer to align the tee to achieve the required position. The reason none of these tees has succeeded on the market is because they have all served to make life more complicated for the golfer – the process of spiking a tee into the ground being transformed from an operation that requires no conscious effort to one that, in the case of several of the designs, requires significant effort.

In last month’s article on constrained evolution – where we also examined the golf-tee – we decided that one of the constraints on the design was that it should not be any more complicated for the golfer to use. When we then examine the Asymmetry trend we need to take due account of this fact. None of the above designs meet our constraint. This does not mean that Asymmetry cannot be used, however, merely that the above inventors have failed to use it effectively. All of them have identified and tried to exploit the presence of a certain amount of asymmetry – for example the golf-club will hit the ball from one direction and hence have tried to use the direction of the club to encourage the tee to stay in the ground after the shot has been completed (i.e. they have tried to eliminate the 'lost tee' problem).

They have found one external asymmetry (golf-club direction), but have failed to record the absence of another (the way the user holds and places the tee).

A smart design would recognize that there is a need here for 'asymmetry and no-asymmetry'; we want to take advantage of the golf club direction, but don't want to complicate life for the golfer. It is a physical contradiction. A smart design would take advantage of the genuine asymmetry and have no adverse impact on the areas where there is no asymmetry. The physical contradiction resolution strategies can help us to resolve this problem. The design shown below, for example, has used the 'transition to the sub-system' strategy to produce a design which is symmetrical and asymmetrical – it is symmetrical as far as the golfer is concerned and is thus used in a manner identical to a 'normal' tee, but it is also asymmetrical as far as the club-head is concerned – the idea being that as the club head strikes the tee, it will deflect and rotate (if we're smart, at the same time also driving the tee further into, rather than out of the ground – so we don't lose it).



In summary, the Asymmetry solution triggers contained in systematic innovation can help us to generate some very elegant solutions. The key to effective use is to identify the presence of external asymmetries. No external asymmetry means no benefit in introducing asymmetry within a system. External asymmetries often exist. The great asymmetry skills involve first finding them, and then identifying ways of isolating them from things that are not asymmetrical.

Constraint Management
Transforming The Solvable Into The Unsolvable

How we take account of the constraints associated with a problem is often one of the more difficult areas of TRIZ to grasp. Constraints can be both technical ('the solution must not cost more than x' or 'the solution must fit inside space y') and organizational ('we must have a solution in place by next week'). The purpose of this article is to examine constraint management strategies and to show how we can use systematic innovation techniques to demonstrate that there are situations when it is possible to demonstrate that the constraints imposed on a situation can make it 'impossible' to solve. Impossible is a very strong word to use, of course. It is unlikely that we could ever definitively prove that something is truly impossible or not. We can, however, demonstrate techniques that can convincingly argue the case for un-solvability to others. Very often, the ability to convincingly demonstrate that something is **not** possible is an important role of systematic innovation.

Let us begin the discussion by making the somewhat sweeping assumption that given enough time, skill and effort, *all problems are solvable*. Figure 1 attempts to draw this by suggesting that it is possible to define an area within which the solution to a problem must lie. Very often, we will not know what this area looks like or in fact even be able to describe its boundaries. Fortunately that is not the point of the discussion.

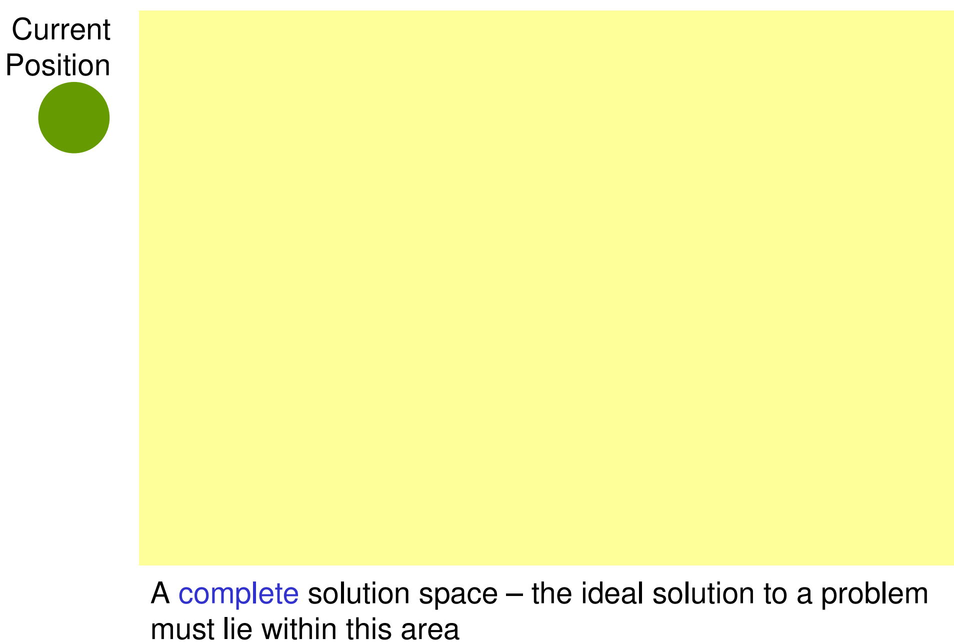


Figure 1: 2-Dimensional Representation of a Complete Solution Space

We approach the point when we start including the constraints associated with the problem onto the solution space. In the first instance, we might include the technical constraints – weights we cannot exceed, minimum efficiencies, emissions targets, etc – and then we might add in the business constraints. When we are thinking about business constraints we are generally thinking about time, cost, risk and quality type issues. We see both technical and business constraints plotted on to the total solution space of Figure 1 in Figure 2 below:

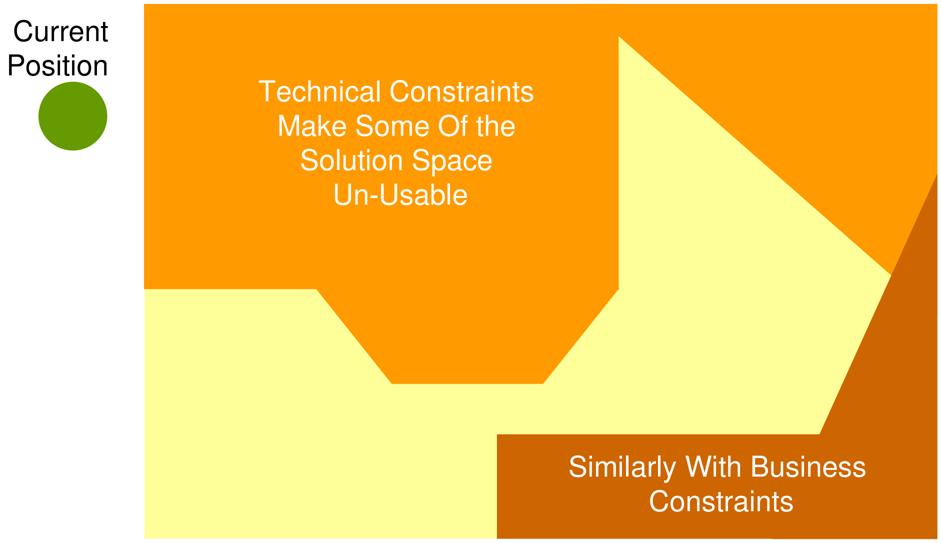


Figure 2: Complete Solution Space Plus Constraints

The net result of the inclusion of these two families of constraints is to reduce the available space where we can look for solutions to our given problem – Figure 3.

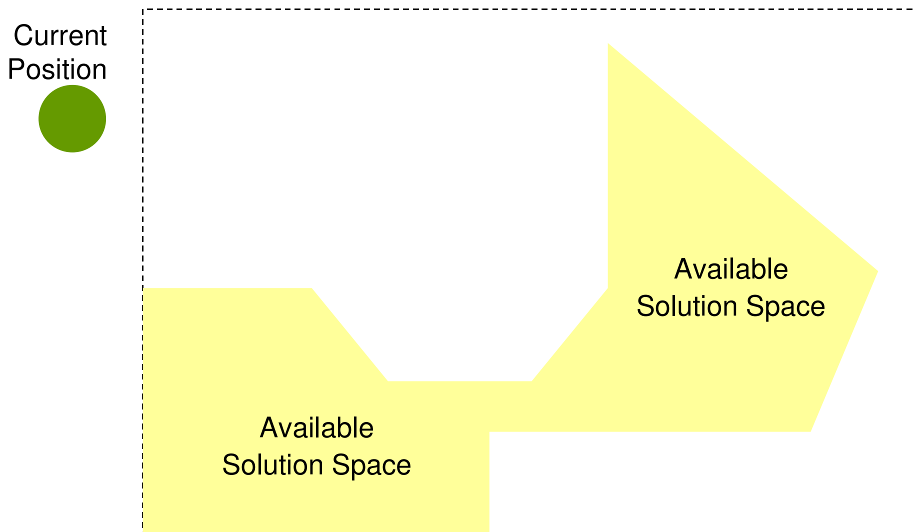
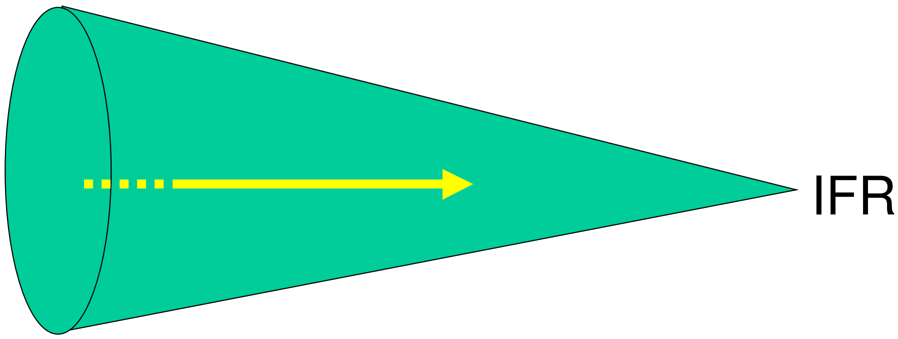


Figure 3: Resulting 'Available' Solution Space

Reference 1 offered a realistic example of what this process might look like in reality. In that case, the 'total solution space' was represented by an evolutionary potential radar plot, and the constraints were represented by removal from the plot of those spokes (trends) that did not fit the constraints we imposed.

One of the main functions of TRIZ is to provide solution ideas that are sign-posts towards more ideal systems; the suggestions offered by the trends, Inventive Principles and Inventive Standards are distilled from directions that other problem solvers have found to be successful. In terms of the solution space described in Figure 1, TRIZ is pointing us towards the places within the space where the 'good' (i.e. 'more ideal') solutions lay. We usually represent this idea using the image of a cone, the tip of which represents the Ideal

Final Result solution. The main idea behind the cone idea is that the evolution towards more ideal states is actually convergent – the number of possibilities decreasing – as we



get closer and closer to the ideal final result end-point. The area inside the cone can similarly be used to represent a solution space.

Figure 4: Successful Evolution As A Convergent Process

If we then combine this convergent evolution idea with the previous solution space map, we might get something like the picture illustrated in Figure 5.

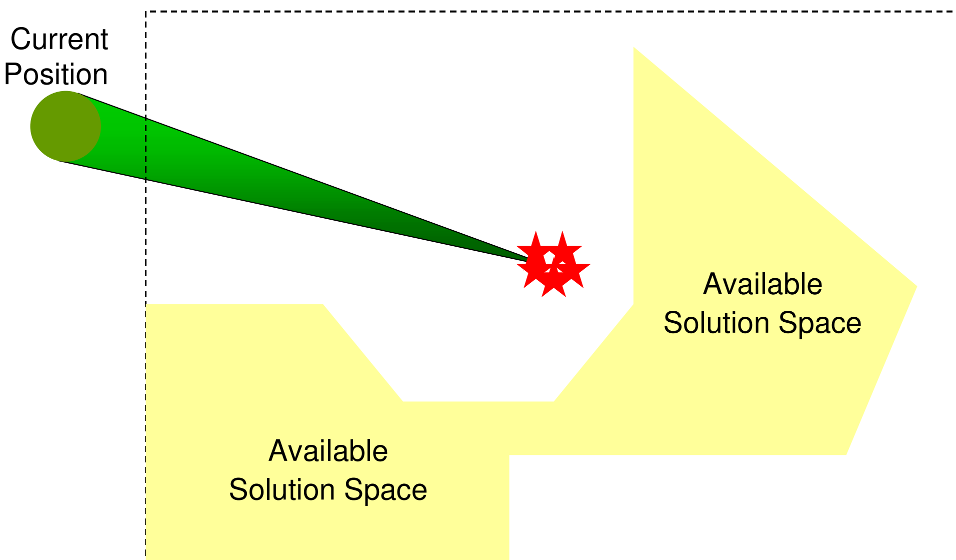


Figure 5: Ideal Solution Direction Inconsistent With Available Solution Space

In this case, we see that there is no common area between the solutions that lie in the direction of the ideal final result and the solution space that matches the problem constraints. We have, in other words, reached a situation in which our constraints have resulted in there being no possible solution to the problem. At least not a solution that lies in the direction of 'more ideal' than the current position.

This situation leaves three possibilities:-

a) we accept a solution that is less ideal than the current one
b) we admit defeat
c) we use the information to justify challenging the constraints in order to increase or shift the available solution space until it matches the more ideal evolution direction

Option c) is usually the most effective strategy. If we are smart and comprehensive in the way we use TRIZ, it will provide us with all the evidence we need to go back to the owners of the constraints in order to challenge them. We think this is a valuable function that the method offers.

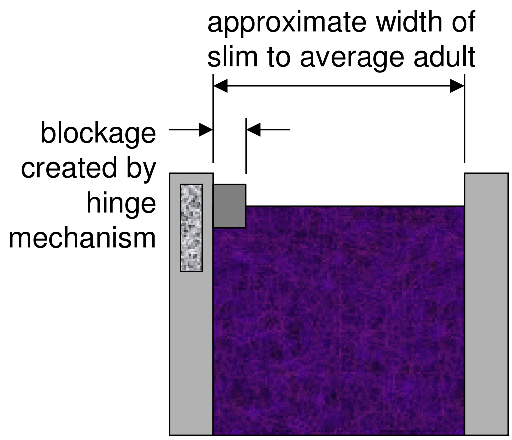
References

1) ‘Trends and Constrained Evolution’, Newsletter, June 2003.

Not So Funny – Bad Design Solutions of the World Part 237 – The Airline Seat

Thirteen hours on a plane is a long time. To try and help alleviate the boredom, the British Airways' Boeing 747-400 Series fleet are fitted with individual TV screens. In the case of the exit rows on the aircraft, the TV screens fold out from under the seat so that they can be safely stowed during take-off and landing. The design of the hinge mechanism for these TV screens obviously presented the designers with a number of challenges. Not least of these challenges was a conflict between the size of hinge required and the space available on or around the seat to locate it.

In some ways, we could argue that the designer used TRIZ Inventive Principle 17 – Another Dimension – when he (conceivably it could also be a she, although we doubt it) decided to position the hinge as shown in the figure below.



There are, of course, valid uses of the Principle and invalid ones. In this case, the designer appeared to forget that someone might actually want to sit in the seat (main useful function perhaps?). Or rather that the person sitting in the seat might have two legs, including one on the left. Perhaps the designer was a monopod and therefore didn't realize that his design would create a problem for anyone else? Who knows.

What we can surmise with a high degree of confidence is that the designer did not really think about what he was producing. Or care. We would like to suggest to Boeing or their seat suppliers that their designers should be forced to spend their day at work sitting in the monstrosities that they produce. Maybe then they might work out the difference between an acceptable design solution and one that is some way beyond the borders of incompetent.

After thirteen hours of personal experience sitting in this particular design, we heartily recommend that Boeing and its seat suppliers contemplate hiring only those designers with an IQ greater than 20 in the future.

We will feature more examples from our catalogue of incompetence in future months. Airport designers, logistics and customer relations personnel might like to start bracing themselves!

Patent of the Month

A very nice patent relating to high intensity light sources was granted to the University of Strathclyde in Scotland. US6,573663 was granted on June 3. From the invention disclosure:-

It is an object of the present invention to provide a new and improved form of high intensity light source which utilises an electric discharge to generate light.

According to a first aspect of a present invention there is provided a high intensity light source comprising:

a solid dielectric sheet having a front and a back surface;

a conducting medium in contact with at least a portion of said back surface of the dielectric sheet, said conducting medium being electrically connected in use to a fixed potential;

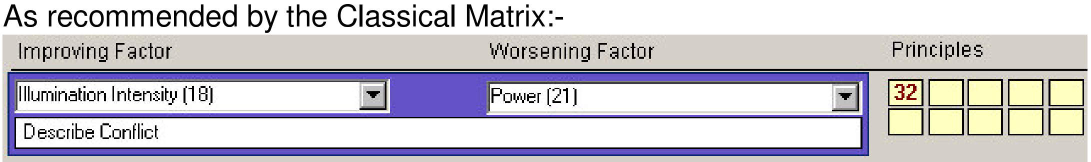
means for establishing electric charge of a first polarity which is electrostatically bound to said front surface of the dielectric sheet at a potential which is different to said fixed potential; and

selectively-operable means coupled to said front surface of the dielectric sheet for applying a rapid potential change to at least a localised region of said front surface so as to cause the charge built-up on the dielectric sheet to form an electric discharge with the consequential emission of light.

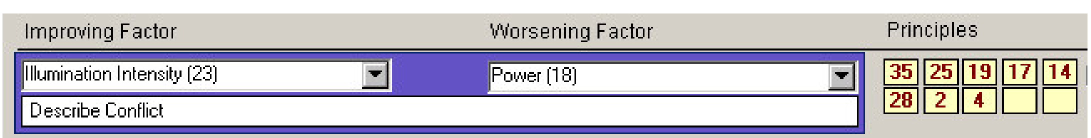
High intensity light sources are increasingly used in laser applications (e.g. dye lasers), UV light sources (sterilisation and polymer curing), and in the generation of ozone for sterilization and bleaching.

Elegance of the invention aside, what is interesting (and heartening to us) is that the methods used by the inventors to solve the illumination intensity versus power contradictions present in the state of the art fit extremely well to the recommendations found in the new Contradiction Matrix published this month.

As recommended by the Classical Matrix:-



As recommended by Matrix 2003:-



As used by the inventors:-

Principle 35 – Parameter Changes – use of dielectric
Principle 19 – Periodic Action – pulse generator
Principle 17 – Another Dimension – the two sides of the dielectric being different from each other (also, therefore, using Principle 4, Asymmetry)

All in all, very re-assuring to us, since the Matrix 2003 book went to press before this patent was granted.

Best of the Month

The best of the month award this month goes to our old ‘friends’ at the Anti-TRIZ-Journal Journal. Their cutting reviews of the monthly content of TRIZ Journal often sacrifice credibility for the sake of a cheap laugh. They do the same again this month with the Michael Slocum article – making a naïve initial assumption in order to set up a series of cheap shots at an article that was both thought provoking and deserving of something better. On the other hand, the reviews of three other articles – the plough case study, the bus-seat case study and the article about SARS in Singapore – hit the nail right on the head. These reviews are both pointedly accurate and funny.

Anyone seeing TRIZ for the first time this month via a visit to TRIZ Journal will have observed three articles that have virtually nothing to contribute to the greater learning of anyone. Using TRIZ in reverse to justify an already existing result (like the bus seat case study - where probably anyone that has ever driven a post-1980 car will already sat on the solution suggested by the authors) is both pointless and damaging. Even worse was the SARS case study. Here we see a bunch of authors who really should know better picking an emotive title (so, heaven help us, everyone is likely to open it up and have a look) and then adopting a logic so foolishly twisted that it almost defies belief;

a) no-one in Singapore used TRIZ to manage the threat caused by SARS
b) oh, look, the strategies they did use corresponded to some of the ones that TRIZ would have made
c) therefore, TRIZ helped.

Err? Sorry guys but this logic does not work. TRIZ didn’t help. A ‘real’ SARS case-study would have generated some genuinely useful solutions that did not already exist, not reproduced what everyone with half an ounce of common sense had already thought of.

If anyone was setting out to destroy the reputation of TRIZ, they could learn a lot from the authors of the SARS article. Or maybe this was the authors’ intention all along? We wonder. We really, really wonder.

Find the Anti-TRIZ-Journal Journal at http://www3.sympatico.ca/karasik/.

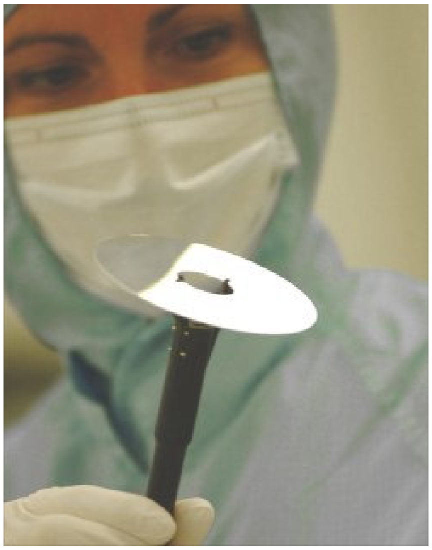
Investments – NanoMagnetics

Our recommendation this month comes via a timely reminder in this month's Eureka magazine of the company NanoMagnetics in Bristol, UK. We first met people from the company a couple of years at a government-run awards ceremony. We were very interested in their technology at the time, but recent developments seem to make the potential even greater than we first imagined.

NanoMagnetics is a private speciality chemicals company that designs and manufacturers an advanced magnetic material, DataInk™, for the computer hard disk industry. Both the means to produce DataInk™ and its use as a medium for information storage are broadly protected by international patents. Unique in the market, DataInk™ can effectively replace the magnetic material used in today's hard disks, while providing the manufacturing industry a predictably progressing technology roadmap to storage densities 100 times greater than that possible with conventional technology.

NanoMagnetics was formed by scientist Eric Mayes, formally a researcher at Lawrence Livermore National Laboratory who moved to the United Kingdom in 1996 to complete his PhD in chemistry at the University of Bath, and Nick Tyler, a former investment banker with Merrill Lynch and financier with Credit Suisse First Boston. After filing a patent on their technology in 1996, the two founded the company in 1997 and began development work within modest facilities. In February 1999, the company was awarded a "Smart Award" from the government and immediately set up a laboratory within the partnering Department of Physics at the University of Bristol.

Demonstrating successful progress and strengthened patent protection, NanoMagnetics secured £6.7m from UBS Capital Ventures, Formula Ventures, Interregnum, Bank Atlantic Financial Ventures alongside the original syndicate. NanoMagnetics has recently grown to 15 full time employees working in a new 10,000 square foot research and development facility on the outskirts of Bristol. The facility contains both Class 100 (165 m^2 or 1780 ft^2) and Class 100,000 (140 m^2 or 1510 ft^2) cleanrooms, as well as sufficient analytical (including TEM, SEM, AFM/MFM, XRD, XRF, VSM, AGFM) and production (substrate cleaning, polishing, finishing and lubricating) equipment for a wide range of developments.



The company's technology offers the potential for a considerable increase in thestorage density of computer storage systems. Hard disk drives currently store information at densities up to 70 billion bits (or gigabits) per square inch, with data stored as microscopic magnetic patterns arranged in circumferential tracks on a media. At extreme magnification, individual bits of data are revealed to be composed from grains of different sizes and shapes. The density at which information can be stored is restricted by how cleanly these patterns can be represented. Current production technology is limited by coarse granularity as well as the presence of some very small grains which spontaneously lose their memory – the superparamagnetic effect. These limitations will likely only allow for a possible tripling of storage capacity in the future. To significantly extend storage capacity, data patterns would ideally be recorded on orderly and uniform grains.

NanoMagnetics grows tiny magnetic grains within hollow protein spheres called "apoferritin", which are 10,000 times smaller than the diameter of human hair. The resulting nanoparticles are limited in size by the inner cavity of the spheres, producing highly uniform material which we call DataInk™. Importantly, DataInk™ is produced using mild and inexpensive chemical techniques.

The resulting particles can pack closely, like oranges on a grocery shelf. Films of DataInk™ are baked (or "annealed") to optimize their magnetic performance, and to also carbonize the protein spheres. What remains is an ordered assembly of uniform, magnetic grains. This type of media is ideal to expand the storage capacity of hard disk drives, as it is able to support smaller and smaller patterns. Using individual grains to represent bits of data, this protein-derived media could ultimately extend densities to between 5,000 and 10,000 Gbits/in^2.

Since 1999, NanoMagnetics has sustained a 1700% annual increase in density. At this rate, they will overtake industry's anticipated densities by the end of this year. Leveraging on our compelling progress, NanoMagnetics will aim to qualify DataInk™-enhanced media, then partner with one or more hard disk manufacturers for the next generation of drives. NanoMagnetics' phenomenal series of milestones and their dates are as follows:

- August 1999 – 75 bpi or 0.002 Gbits/in^2
- August 2001 – 0.7 Gbit/in^2
- December 2001 – 2.2 Gbit/in^2
- June 2002 – 6.0 Gbit/in^2
- August 2002 – 12.1 Gbit/in^2

The Company is currently preparing to scale up the manufacture of DataInk™ and is working with a number of key industry players.

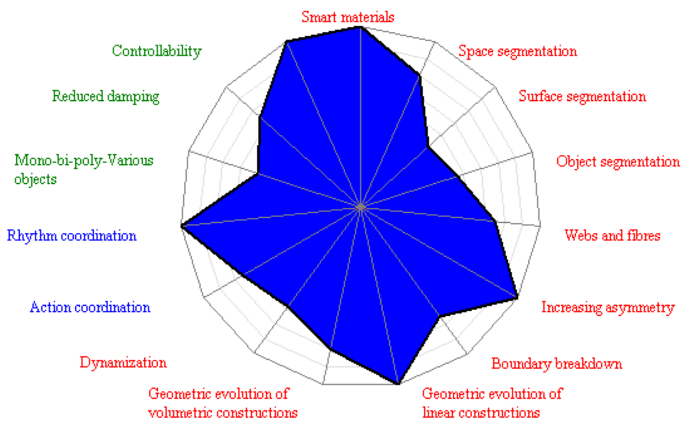
In addition to its commercialization of DataInk™, a small portion of the company's activities remain focused on the continual development of its broadly protected, international patent portfolio. NanoMagnetics has intellectual property in the areas of magnetic information storage, microwave shielding, magnetic fluids (ferrofluids), MRI contrast agents for medical imaging, and nanoscale semiconductors.

Check them out at www.nanomagnetics.com

TRIZ and Biology - Killer Whale

Killer whales have large amounts of blubber. Blubber, essentially fat, is an essential and complex survival material. Far from being undesirable, as for humans, good blubber is a valuable commodity in the world of marine mammals.

Blubber is a layer of fatty tissue between the skin and the muscle and in some whales can be over two feet thick in some places. Like any other body structure, blubber is not a simple chemical compound or structure but a complex tissue. It is composed of a number of different substances including connective tissue fibres and fat cells. This complex structure makes blubber a remarkably advanced material. The following Evolutionary Potential radar plot of blubber displays a high degree of evolution across a number of different trends.



For marine mammals blubber provides a number of different functions including insulation, energy storage, buoyancy and improving shape and locomotion. What we are (most) interested in here is a feature that was brought to our attention by killer whales.

The killer whale's large coating of blubber provides them with effective insulation from the cold of the open ocean. The thicker the layer of blubber the better the insulation, and consequently the more energy efficient the whale will be when moving at low speeds. When moving at higher speeds however, the whale actually needs to effectively dissipate much of the heat it is generating and it also requires a more streamlined shape to reduce drag from the water.

A contradiction is present:
The blubber needs to be thick to provide good insulation and energy storage **when** moving slowly
But the blubber must be thin to allow heat loss and reduce drag **when** moving fast.

It can be seen that the contradiction can be separated in time as we want the two different conditions at different times. Inputting the contradiction into the Innovation Suite and selecting separate in time we find that the very first principle suggested is the very same that nature has employed: Dynamization.*

The connective tissue fibres of the blubber are made of collagen and they have the effect of making the blubber both stiff and tough, but also flexible. The blubber of the killer whale automatically adapts to the change in speed of the whale to give it a more streamlined shape when moving at high speeds.

In addition, if we think also about separating the blubber contradiction in space – i.e. the whale wishes to dissipate more from some areas than others – we can observe that the layer is not distributed uniformly over the whale's body allowing for effective "thermal windows" to be created along with the change in shape. In this instance, Principle 3, Local Quality has also been utilized.

* The contradiction can also be separated on condition i.e. *if* the whale is swimming slowly the layer must be thick, *if* the whale is swimming fast the layer must be thin – once again the first solution suggested bears a high degree to nature's solution: Parameter change – Change concentration or consistency, change the degree of flexibility