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Systematic Innovation

e-zine

Issue 11, December 2002

In this month's issue:

Article – Who's IFR?

Article – Who Moved My Trees?

Humour – Gum Target

Patent of the Month – Syntactic Foam

Best of The Month – The Web Of Life

Investments – Nano-Scale Shape Memory Alloys

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.
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Who's IFR?

Introduction

Think of a room full of people anywhere, ask them all to spend a few moments defining their ideal car, shirt, music, or whatever, and the only sure guarantee at the end of the exercise is that there will be considerably more different answers than there are people present. The trouble is that everybody's idea of 'ideal' is different. When everyone has a potentially different definition of an ideal anything, it is likely to cause us a problem if we're in the business of supplying those anythings. Not least of which is the almost inevitable fact that our 'ideal' as a supplier is going to be different again – usually very different – from the 'ideals' defined by the customer.

Every Customer is Different

Everyone knows that every customer is different. Unfortunately, supplying a different thing to each individual one is very often inconsistent with the economics of mass-production. Consequently, in most fields, customers are given a choice between individuality or cost. Where organizations have sought to deliver both, we have 'mass customisation' (1). Otherwise, organizations usually attempt to satisfy the conflict by working out what 'most' customers want, and then set about supplying that. The conventional tool for establishing what 'most' is involves the normal curve. We have talked about this subject and the problems it causes in a previous newsletter (2). The biggest problem with supplying to the requirements of the normal curve is that customers a long way away from the 'average' are not given what they want.

There are basically two solutions to this type of situation. The first is to assume that the non-average, 'niche' customers will be served by someone else. The second – emerging – route involves tackling the conflicting customer requirements head on. If our market research tells us that 40% of the market wants red shirts and 60% want blue shirts, then that is what we will set about producing. We will either set up two production lines – a red one and a blue one, or (more likely) we will separate the production of red and blue in time so that we make blue shirts on Monday and Tuesday and red shirts for the rest of the week. Neither of these strategies is of much use to the poor old customer who might want a green shirt. But as soon as we start thinking about solving the problem of shirts that are 'red and blue' – i.e. are able to change their colour – then suddenly we no longer have to worry about different production lines or re-setting the machines twice a week, because we can produce the same shirts all the time, knowing that each was able to change its colour to suit the needs of the individual customer.

Fabrics that are 'red *and* blue' would solve this particular individualization problem. Shirts that were able to be size 15 *and* 17 would likewise solve the size contradiction. While these solution suggestions might sound a little bizarre (despite the fact that someone, somewhere has already solved both problems – on in the garment business), this type of contradiction-solving strategy offers far greater potential for solving 'every customer is different' problems. Why is Microsoft ubiquitous these days? (Partial) answer; because everyone can tailor the software to their own individual quirks and wishes.

Customer versus Supplier IFR

So, we can see that it may be possible to satisfy the differing needs of individual customers by solving physical contradictions of the 'read and blue', 'big and small' variety. What, then, about solving what is very often a bigger contradiction problem – the one between what the customers want and what the supplier is prepared to supply.

A good way of articulating this type of customer-supplier contradiction is to exaggerate it by thinking about their respective Ideal Final Result definitions. We sometimes use the lawnmower (British national pastime is mowing lawns – apologies to those readers that don't share this (bizarre) hobby) as a way of contrasting the different drivers of supplier and customer.

If you put yourself in the place of the lawnmower manufacturer for a moment and try to think of all of the things you would like to see featured in your new lawnmower design, you are likely to write an ideal final result specification that looks something like this:-

- (Main function) Cut grass efficiently – 100% cutting success
- Collect 100% of the grass cuttings (no mess)
- Silent operation
- Zero maintenance
- Fuel efficient
- Emissions compliant with legislation
- Nice to look at
- Compact
- Low weight
- Reliability – 100% (until the guarantee runs out, after which time, we'd like the customer to buy a new mower)
- Price – 'competitive'

Chances are if you are in any kind of industry job while you are reading this, you are working to very similar sorts of specifications on the products, processes or services you are responsible for.

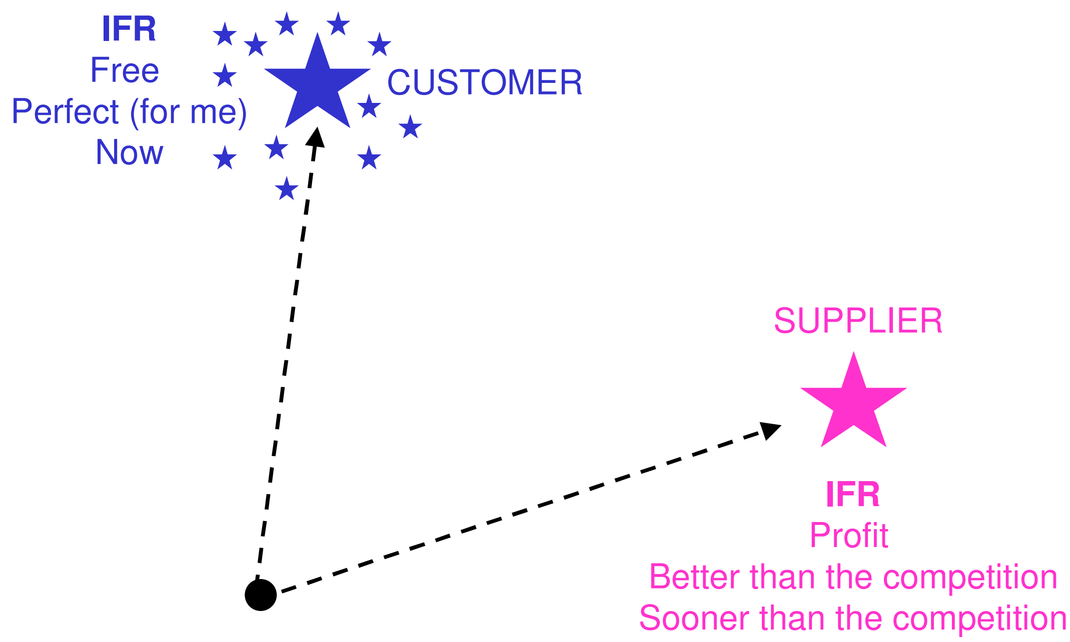
Now let's think about what the lawn-owner might define as their ideal final result:-

- a nice lawn

Hmm. Quite a difference. A difference, in fact, between the manufacturer selling a *solution,* and the customers buying a *function*.

But the point of this article is not to go over the solution versus function debate again (function wins every time, right?), but to elaborate a little on the conflict between those two ideal final result definitions.

The Ideal Final Result is often depicted as a 'guiding star' evolutionary end-point, something that offers us a direction for our innovation efforts. This conflict between customer and supplier suggests that rather than there being one guiding star, there are actually two – the customer guiding star (noting from the previous section, of course, that the customer guiding star might well actually be a whole constellation of stars – albeit they will be positioned close to one another if we define the ideal final result correctly), and the manufacturer guiding star:



The picture suggests that the two ideal final result definitions may be considerably different. The difference between the two is the fundamental tension that drives innovation (see our article on Conical Spirals – (3)). Historically the world has been dominated by suppliers, and customers have been faced with a 'take it or leave it' choice. Increasingly, however, it is likely that someone, somewhere will give the customers exactly what they want. Someone, in other words, will be prepared to challenge some of the contradictions between what the customer actually wants and how the supplier can supply it and still remain viable in a business sense. Historically, it has always been a newcomer who has been prepared to challenge these contradictions (4). Increasingly, forward thinking organizations are recognizing that they should pay considerable attention to the customer Ideal Final Result.

Hence the reason lawnmower manufacturers own the intellectual property on grass that grows to lawn-height and then stops growing so it doesn't need cutting. One day, they may do something with it.

References

1) Pine, B.J., 'Mass-Customization', Harvard Business School Press, 1995.
2) CREAX newsletter, 'Normal Curve Contrdictions', May 2002.
3) CREAX Newsletter, 'Conical Spirals', October 2002.
4) Utterback, J., 'Mastering The Dynamics Of Innovation', Harvard Business School Press, 1993

Who Moved My Trees?*

There are many parallels between business and nature. The way in which natural systems operate and evolve has much to teach us about the design and operation of business models. Successful transfer of ideas between the two fields demands the very TRIZ-like principles of abstraction and analogy. One such instance vividly struck us recently during participation in an ecological study of dormice.

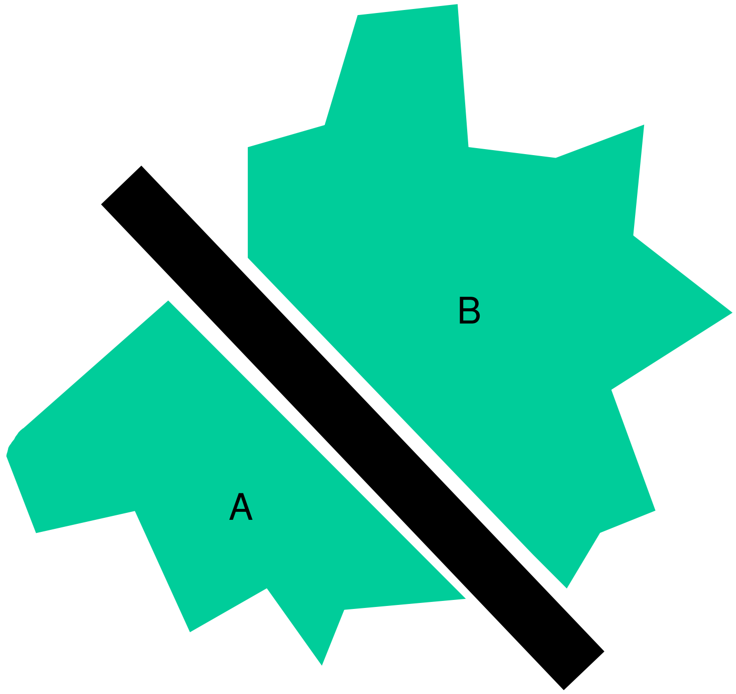
A Dormouse

The dormouse is an endangered species in the UK. The ecological study involved estimating the number of dormice present in a certain area, and then determining a plan to ensure their future viability.

Natural systems can be classified in a variety of different ways. One general distinction that can be drawn between different species involves a split into 'specialists' and 'generalists'. A generalist species – for example humans – learns to survive and thrive by living in a variety of habitats and by eating a variety of different foods. A 'specialist' on the other hand has evolved in a certain, more specific direction to take advantage of an evolutionary niche. The panda evolved to take advantage of a (once) plentiful supply of bamboo – a foodstuff that not many other animals could digest, the koala bear has done the same thing with eucalyptus leaves, and the dormouse has found an evolutionary niche by becoming a tree-dweller. By moving off the ground, the dormouse became less vulnerable to location and attack by predators. It also moved closer to its primary food source – nuts. Dormice live in trees and eat the products of trees. Specifically, they like eating the nuts of hazel trees.

The evolution of the dormouse away from the ground and up into the trees has taken pace to the extent that the manner in which the animal moves from place to place involves the use of trees that are close to one another. Hence dormice live in woods.

Modern man has caused the dormouse a few problems. Not least of these problems is the fact that we tend to cut trees down for either timber or access. The study we were involved in was examining a wood that had actually become segmented into several smaller woods through the cutting of several roads, houses and access routes:



Insertion of an access road splits one wood (AB) into two woods A and B

When this sort of segmentation happens, dormice in one sector of the wood become cut-off from other sectors, because there is no longer an off-ground path between them. When the dormouse population gets segmented like this, it becomes increasingly difficult for them to sustain a viable population. This segmentation phenomenon is in fact so great it represents one of the primary reasons why the dormouse is on the endangered species list.

Business Analogy

The management plan devised to help protect and preserve the dormice involves stricter control over which trees can be cut down and where, and, in some cases the creation of off-ground structures connecting different clusters of trees. These structures include things like hedges, planting of new trees, and, in some cases, the tying of links between trees that no longer overlap with one another. All of these strategies require the intervention of man to undo the damage that mankind has done.

In business, it is not always possible to rely on this kind of external assistance. This despite the distinct possibility that someone or something will come along and cut down the trees we rely upon.

The key to understanding the business analogy of the dormouse situation is recognizing the split distinction between generalists and specialists. Specialists ('niche players', 'core products', and platform technology' to name but three often used terms) are very common in a business context. Like the dormouse, in order to compete in the world it is necessary to be better than enough other people in order to survive. Specialisation is a very common strategy for achieving this kind of distinction. Thus a company that specializes in the production of left-handed scissors is likely to find a certain niche advantage over a general scissor manufacturer. Generalists in business, on the other hand are very much rarer. The exceptions are those companies that have realized that in a volatile and rapidly evolving world, the only constant is change. The generalists are the companies that have begun to recognize the importance of flexibility and adaptability, and the fact although they may be making scissors today, tomorrow it may be necessary for them to be making laser cutters.

The danger highlighted by the dormouse story is that the specialists often end up at the end of an evolutionary cul-de-sac from which they are unable to escape. In some instances, the cul-de-sac may be appear to be a fairly safe one – there will always be a certain percentage of the population that is left-handed for example – in the case of the dormouse it was the evolutionary reliance on the fact that there would always be lots of inter-connected trees. On the other hand, when someone comes along and cuts the trees down, or invents a laser-based paper cutter that works just as well for left-handed or right-handed people, our nice safe cul-de-sac, suddenly becomes a trap.

** with apologies to Spencer Johnson, author of well known business parable book 'Who Moved My Cheese?' – a book that has many parallels to the dormouse story, not least of which is the overall message that it is not a good idea to become too reliant on one source of food, or one way of doing things.*

Humour

A practical(ish) application of resources forms our humour recommendation this month. www.gumtarget.com is the place to visit for novel ways of encouraging people to dispose of their used chewing gum in a non contaminating way.

As quoted from the site:-

GumTarget is the environmentally friendly alternative to dropping your gum where it isn't wanted.
GumTarget is the fun and convenient alternative to carelessly discarded chewing gum.
GumTarget gives chewers somewhere to easily dispose of their gum when there is no bin close to hand.
GumTarget is a fun place to deface and rewarding to use. Who would you want to stick your gum on? Would you like to voice your opinion on a topic that you feel passionate about? From sport to music and entertainment, GumTarget gives you that opportunity to stick it where it counts whilst keeping gum off the streets and making our environment a cleaner place to live in.

Purchasers are able to design their own gumtarget posters. Lots of opportunities for imaginative thought here. It could bring a whole new dimension to encouraging people to vote at election time. It would also be more reliable than the Florida voting system. Probably.

Patent of the Month

United States Patent	**6,476,087**
De Toffol	**November 5, 2002**

Method of manufacturing syntactic foam

Abstract

A method of manufacturing syntactic foam is disclosed which includes the steps of combining a polymer, microspheres and a solvent to form a slurry. At least a portion of the solvent is removed through a porous wick, and conditions are applied which substantially solidify the polymer.

Inventors: **De Toffol; Roberto** (55 Athena Avenue, St. Ives, New South Wales, 2075, AU)

Patent of the month this month is a manufacture-focused patent in the field of syntactic foams. Any good invention needs three principle attributes if it is to become a commercial success:-

1) it needs to offer a good solution to a problem
2) there needs to be a viable means of production
3) there needs to be a market demand

In other words, IDEA, MEANS and DEMAND.

In terms of syntactic foams, the patent describes the following:-

Syntactic foams are composite materials whose resinous matrix is embedded with preformed particles such as glass or ceramic microspheres. Syntactic foams distinguish themselves from other foams by the fact that hollow or solid spheres of a predetermined size and packing composition are used to control the density of the foam.

Syntactic foams have been used for purposes which require a low density packing material such as undersea/marine equipment for deep-ocean current-metering, anti-submarine warfare, sandwich composites, the aerospace industry and the automotive industry.

Examples of syntactic foams in the prior art include for example U.S. Pat. No. 5,120,769 which discloses syntactic foams having an insoluble matrix, and U.S. Pat. No. 3,832,426 which discloses foam having an insoluble matrix and carbon microspheres. Syntactic foams having a soluble polymer matrix are disclosed in U.S. Pat. No. 5,432,205.

Thus, the idea and demand exist thanks to the abilities of this class of foams to generate very consistent (or locally controllable) properties. Foams, in any event, fit very elegantly into the TRIZ trends towards increased use of empty space within structures. With regard to the third essential element, MEANS, the invention disclosure describes the following:-

Difficulties have been experienced, however, in producing syntactic foams that have a density which is comparable to conventional foams. Typical densities of syntactic foams *vary between 0.3 and 0.5 g/cm.sup.3, whilst conventional foams typically vary between 0.01 and 0.1 g/cm.sup.3. The density of syntactic foams has generally been restricted by the limited porosity of the foams. Porosity is a measure of the total void volume of the syntactic foam, and constitutes the sum of the void volume of the microspheres and the interstitial void volume. Using current methods of syntactic foam manufacture, the void volume provided by the microspheres is greater than the void volume provided by the interstitial spaces. Thus, the density of syntactic foams have been limited by the void volume of the microspheres. As such, the application of syntactic foams have been limited.*

In other words, the reason we haven't all heard about syntactic foams because of a difficulty associated with achieving suitably low density. This problem has in turn been limited by the volume of the microspheres being used.

The invention solves the contradiction by:-

Accordingly, in a first aspect of the invention, there is provided a method of forming a syntactic foam including the steps of:

a) combining a polymer, microspheres and a solvent to form a slurry;

b) thereafter removing at least a portion of the solvent through a porous wick; and

c) applying conditions which substantially solidify the polymer.

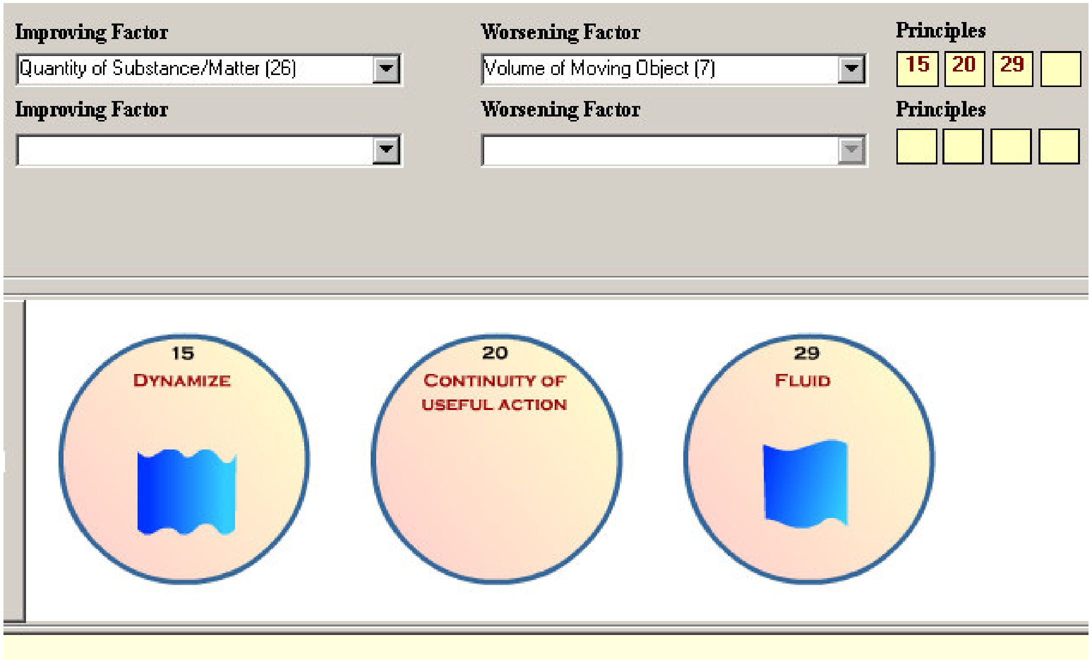
The applicant has found that by manufacturing syntactic foams in accordance with the method of the invention, it is possible to provide adequate coating of the microspheres to form the syntactic foam using a high microsphere mass fraction. This occurs primarily by the solvent reducing the viscosity of the polymer thereby allowing less polymer to be used to coat the microspheres and by causing at least a portion of the solvent to be removed from the composition. The applicant has found that using this method the porosity of the interstitial void volume of the syntactic foams can be greater than the void volume of the microspheres. This enables syntactic foam densities of less than 0.15 g/cm.sup.3 to be produced. Further, the technique is simple and is ideally suited for mass production and easily applicable for manufacturing large items.

In a preferred form, the method further includes the steps of combining the polymer and the microspheres to form a paste, and thereafter adding the solvent to the paste to form the slurry and mixing the slurry to achieve dispersion of the microspheres prior to removal of the solvent. Even more preferred is that a final portion of microspheres necessary to maintain the desired mass fraction is added alternatively with the solvent. This helps to maintain a consistency which allows easy pouring.

In a preferred aspect of the invention, the solvent is removed from the slurry while the slurry is in a mould such that the syntactic foam forms a desired physical conformation upon removal of the solvent. In an especially preferred aspect of the invention, the syntactic foam is made by a method in which the mould is the porous wick for removal of the solvent. The porous wick itself may be made from any material that is capable of soaking up or removing the solvent. The most preferred porous wick is made of plaster. Alternatively, the porous wick may be made of clay, ceramic, cement, concrete, finely *perforated plastic or metallic sheets with absorbent backing, fine metallic mesh/gauze with absorbent backing, rigid porous foams or sponge-like material.*

An advantage of this arrangement is that the removal of the solvent through the mould walls does not cause any major disturbance of the distribution of the microspheres. As such, the resulting syntactic foam is able to maintain an even density and tactile strength.

Looking at the contradiction being solved by the invention:-



it appears clear that both Principles 15D ('increase the amount of free motion') and 29 are being used by the inventor.

All in all, a very simple patent (we think it features the 'it's obvious' element so often found in good solutions), consistent with the recommendations of the TRIZ Contradiction Matrix, and focused on generating the missing element ('MEANS') in enabling syntactic foams to become more widely used.

Best of the Month

Best read of the month this month comes via Fritjof Capra's classic text 'The Web Of Life'. This is a book that we've just finished reading for the second time this year (we left our first copy of the book at TRIZCON earlier in the year) in preparation for an article on the TRIZ complexity trend in next month's TRIZ Journal. As well as links to this trend, there are many other connections to the findings uncovered by TRIZ research. We recommend it highly to anyone with a desire to achieve a more systemic or holistic thinking framework.

Within the world of TRIZ, November saw the second TRIZ Future conference, which this year took place in Strasbourg. Just over 40 papers were presented, more than a handful with a significant contribution to make to the furtherance of TRIZ. The CREAX team managed to sit in on all of the papers presented during the conference. Our main recommendation goes with 'Tools for generating and selecting concepts on the basis of trends of engineering systems evolution' by Niokolay Shpakovsky, Peter Chuksin and (wonderfully presented by) Elena Novitskaya. A delightful combination of elegant thinking and Flash animation. Other honourable mentions should also be given to Johan Tiesnitsch, Toru Nakagawa, Bohuslav Busov, the WOIS team and to Joe Miller and Ellen Domb for the insights contained in their paper on function analysis techniques. All in all, our main recommendation is that, if you haven't already done so, you obtain a copy of the proceedings.

Incidentally, in case anyone is wondering why our best-of list features none of the papers featuring authors based in the former USSR, one of the worrying aspects of the conference for us was the failure of many of the Russian authors to adopt one of the key TRIZ principles – 'someone, somewhere already solved your problem'. Too many times, there was a discussion of a problem or an apparent 'advance' in the TRIZ methodology that turned out to be a re-invention of something that already existed. We know it must be difficult to access materials written in languages other than your own, but if a 'Russian' version of TRIZ is going to truly succeed in the West, it must recognize that methods like the Theory of Constraints, Neuro-Linguistic Programming and Root Cause Analysis are well-established and that TRIZ must seek to take advantage of the benefits they offer, not to try and invent an inferior version in isolation. The purists may dislike this view, but frankly very few people worry about the purity of TRIZ; at least not when they are faced with the need to generate real solutions to real problem or opportunity situations.

Investments – Nano-Scale Shape Memory Alloys

Anyone that has been following some of our big areas of interest over recent months will have noticed our like of shape memory alloys and nano-technologies. It was our great pleasure, therefore, to find a solution that brings the two things together. Not that we were surprised, of course, since all of the TRIZ trends would point us in the direction of the two things coming together at some stage. The key to when the two would come together was always going to be finding the right application. That seems to be emerging as a computer data storage one. Specifically, the increasing requirements to store more data in smaller spaces, and to access more and more data in shorter and shorter timescales.

Anson Medical – a technology company spun out of Brunel University – has been developing a system using single-crystal layers of (nickel-titanium) shape memory alloys to significantly enhance data transfer rates. Rates two orders of magnitude greater than the current state of the art have been projected for the technology. Two orders of magnitude is difficult to turn your back on.

The technology itself involves temporary heating (using a 2nm diameter electron beam) of areas of the shape memory alloy crystals. The temperature change causes very small areas to change their shape through the transformation from body-centred cubic to orthorhombic crystal structure. The resulting pattern of changed and unchanged crystal-size dots can then be read by a lower power beam.

Subsequent warming of the area containing the SMA crystals allows them all to ‘remember’ their original shapes – thus erasing the data ready for re-writing.

There is not much text available in the public domain on this technology at this time. Anyone interested would probably be best starting at the Anson Medical website (www.ansonmedical.com) -which, although not featuring much about the technology, does contain some nice medical applications of SMAs.