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In this month's issue:

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Beyond The Second TRIZ Hurdle

(Recovery After The Inevitable Fall)

Just as TRIZ struggles to build momentum in some areas, in others there are clear indications that some kind of critical mass of acceptance has been attained. For many of those associated with the second of these scenarios, it is probably timely to discuss an impending problem. We might think of that problem as a 'second TRIZ hurdle'. The first TRIZ hurdle being that which is required to be overcome when newcomers first see TRIZ: Present TRIZ badly to newcomers and their attitude is likely to be a negative one. As we all know, it is very easy to get this first contact wrong. Some in the community – Russians and others alike – appear to have mastered the art of creating this negative first impression. Some to the extent of virtually destroying interest in the method in whole nations. Looking at Figure 1, this first hurdle occurs right at the beginning of a time-line. Get it wrong and the resulting negative trajectory may result in a permanent scarring.

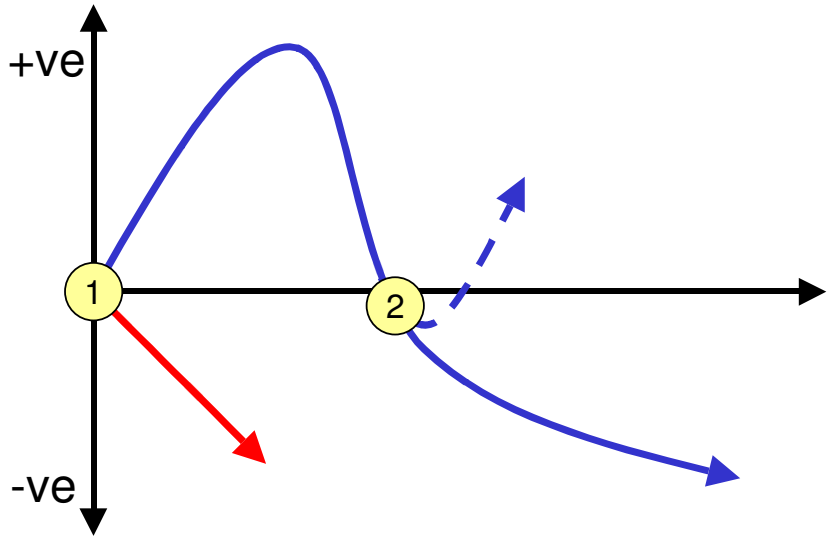


Figure 1: First And Second TRIZ Hurdles

Serious as this problem can still be, our focus in this article is on a second critical point. Point 2 on the figure relates to a person that has successfully climbed the initial TRIZ hurdle, and thus has a positive impression. The suggestion made in the figure is that no matter how positive that initial impression, at some point in the future, that upward trajectory is inevitably not only going to peak, but is going to dip down into the negative. There are various reasons why this phenomenon can occur. We will explore two of the major ones here. We will also examine strategies to help ensure that what happens after the second critical point is a return to the positive rather than a continuation of the negative.

The first reason for the dip into the negative impression zone is one that is likely to appear early on in someone's application of the method. This is a dip that occurs when a person realizes that generating a genuine solution to their problem is going to take some hard thinking. A typical scenario might progress something like this:

a) person is exposed to TRIZ and is turned on by the idea that here is a tool that offers the prospect of solving a particular problem they are working on. Often the method presents them with some new perspective on a problem that they

hadn't thought about before – such as recognizing for the first time that your problem is a contradiction – and on other occasions it may be a more general warm feeling that here is something that will help you out of a difficult bind.

b) The new problem perspective creates some kind of elated feeling, which then prompts a swift journey mapping their problem to a general problem (often here using the Matrix – which is one of the more intriguing tools for newcomers), and then getting to some 'generic solutions'. Because the human brain is much happier generating solutions than it is defining problems, and because the user is not very sure about the TRIZ abstraction process, there is usually some kind of uncertainty that begins to emerge here – 'have I done it right?'
c) Having seen the generic solutions generated by the method, one of two things now happens; a) because there is little familiarity with the generic solutions (e.g. Inventive Principles) there is a failure to generate any meaningful connections to their problem, or, b) again because of the way the brain works, there is a strong tendency to generate ideas from the generic solutions that are ones that you already generated previously, before you tried using TRIZ. This second phenomenon happens because the brain is a great connector, and will very quickly make short-jump connections over unfamiliar ones. So if you already thought of, say, segmenting your problem into parts, and the method delivers you Principle 1, 'Segmentation' as a solution direction, your first thought is going to be something like, 'huh, I already thought of that.' What TRIZ would like you to do in this situation is, of course, to see if there is *anything else* you could segment that you haven't already thought about, but that is not a natural way of thinking for most people, and so we end up with just the re-invention of our existing solution.
d) Net result in either of the above scenarios is that your earlier elation that here was going to be the answer to all of your woes, has resulted in either nothing or a re-invention of what you already had. And there goes the swing into 'TRIZ didn't work' territory.

The only real answer to this negative-trajectory scenario is to encourage newcomers to the method to practice the process on problems that are outside their domain, before they start working on the specific problems within their domain. This way they can make their mistakes, learn the process and get a grip of the ways in which the generic solutions need to be used on something where they can afford to make mistakes. In just about all of our in-house workshops, for example, we will adopt this approach for the Trends/Evolution Potential and (especially) the Contradiction Elimination tools.

The second major reason for the emergence of the second TRIZ hurdle is a more serious one, and one that is far less easy to overcome than the first. The second negative-impression trajectory happens when a user has been through the process in some form, has generated some generic solutions, and has then managed to turn them into an actual specific solution. So, if the user has solved their problem, how on earth can this lead to a negative impression of TRIZ? Actually, several reasons. Here are some of the more common ones:

1) 'this solution looks obvious' – while an 'obvious' solution is very often used in TRIZ as the very definition of a 'good' solution', the initial elation caused when that solution emerges is very quickly followed by a number of doubts; 'if I show my boss this solution, he will think its so obvious he'll wonder why it took me so long to solve it',
2) 'its all very well knowing that I need to move in direction x (for example, adding protrusions to a surface), but now I'm going to have to re-run all of my

optimization methods to find the precise solution' (or worse; 'my optimization tools don't allow for direction x to be modelled')

3) 'I still need some data' – this data is necessary to optimize the new conceptual solution produced by TRIZ. The worst case scenario here is that the new conceptual direction generated from TRIZ, makes a whole pile of previous experimental optimization data irrelevant. Our brains definitely don't like the idea of having done work that is now 'redundant'. This is a phenomenon otherwise known as 'spent cost' – the more time we have spent acquiring data to optimize something, the less enamoured we are with the idea of scrapping it. Or having to potentially start again with a bunch of new optimization experiments.
4) 'I don't know how to…' – if TRIZ presents a person outside their particular domain of expertise, then there is the dual threat of a) having to venture outside your comfort zone to learn a bunch of new stuff, b) having to potentially write-off a bunch of knowledge that has been gradually accumulated over a long time.
5) 'that's cheating' – almost as common as the 'its obvious' TRIZ solution, is the one where we think that the answer is a cheat. This scenario usually occurs when TRIZ shows us that we have been solving the wrong problem. Very often when we find a business solution to a technical problem (or vice versa), it usually comes with a feeling of disappointment.
6) 'someone already thought of it' – a common finding when we find ourselves looking on a patent database and realize that our beautiful new solution was actually thought about by someone five years ago.
7) 'I came up with the solution, not TRIZ' – perhaps the most serious one of all. After all, you did come up with the specific solution; all TRIZ could do was point you in the right direction

There is no simple remedy to any of these negative impression occurrences. The only general one is to recognize that at least one of them is inevitably going to turn up, and to remember that it is not TRIZ's fault that they did. Hopefully awareness of the problem is a substantial step along the road to making sure the dip into negative impression territory is a temporary one.

Beyond that, the best advice we can offer is to encourage users to do what TRIZ would always like us to do, but few of us are inclined to do, and that is go around the loop again. So, finding that someone already patented your brilliant new solution is inevitably disappointing, but it is also an opportunity to know design a better solution still (and a new patent). Another good reason for going around the loop, thinking about the boss-thinks-its-obvious problem is to not just present one idea, but a whole portfolio of ideas. For us, the key here is presenting not just that 'obvious' killer idea, but a comprehensive suite of surrounding solutions. Here the Evolution Potential tool is a great help; constructing an evolution potential radar plot of your new solution presents an excellent platform upon which to see where that solution will evolve in the future.

Final Thought - The Magic Three

Our focus in this article has been the 'second TRIZ hurdle'. Bad as it may sound, there is worse to come: There may be third and fourth hurdles after the second one discussed here. These hurdles are very similar in nature to the second one. Our experience suggests that if these hurdles can also be successfully negotiated, then a fifth one is very unlikely to appear. The whole thing will 'stick' as a positive thing in people's minds, in other words, if they can reach the magic three success stories.

Software (And Other) Design Patterns

(The Good, The Bad And The Innovative)

As interest in applying TRIZ to software problems grows and the number of case studies builds into something substantial, it becomes ever more apparent that one of the biggest problems in the software sector is that it is still much more like an art than a science. An awful lot of software gets developed by 'trial and error' methods. This is not to say that there are a lot of bad software engineers out there so much as to say that the whole industry is at an immature stage in its evolution. Just as much to blame for many of the software problems that we can see around us is the failure of customers to adequately specify what it is that they want. Software specification, in other words, is equally art-rather-than-science, and at a state where an awful lot is done by similar trial and error approaches. Trial and error 'methods' provide a vivid indication of systems in the early stages of their evolution – Figure 1.

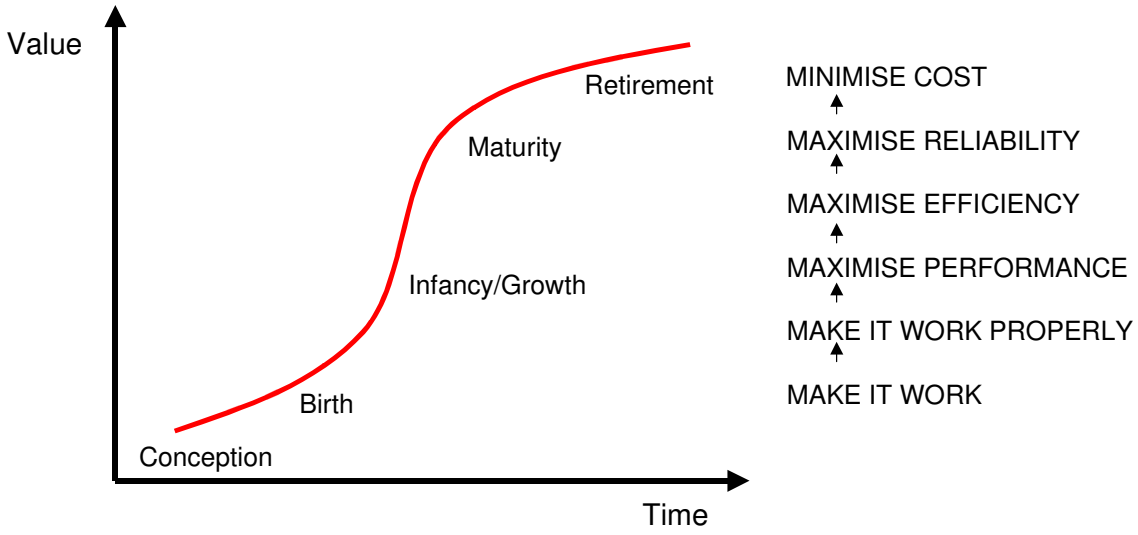


Figure 1: Shifts Of Emphasis During System Evolution

There is no difference in what we see happening now in the software industry as we could have seen at the equivalent early stages in the evolution of other industries.

Despite the large proportion of 'bad' software we see emerging from all of the trial and error development, there are very definite signs of the industry shifting from the 'make it work' evolution phase to the 'make it work properly' phase. One of the best signs that this shift is taking place is when we see attempts to identify and map best practices in a manner that allows those practices to be transferred to others. Software libraries can be seen in such a light. In these libraries we will find robust 'molecules' of code that are amenable to transfer from one application to another. Again in common with evolution in other industries, this kind of systemization or proceduralization very often begins at this sub-system level. It is very often then followed by increasing systematization at progressively higher levels. One of the best attempts at such a system-level 'make it work properly' advance is the work of the so-called 'Gang Of Four' (Reference 1 and 2). Here we see a team of software developers systematically setting out to distil the essence of what makes good software design. In many ways, the work that they have done is closely linked to that of TRIZ researchers; analyse large numbers of designs and identify best practice.

Rather than being influenced by TRIZ, however, the Gang Of Four were rather more influenced by yet someone else interested in the idea of studying lots of solutions and distilling best practice from them. Reference 1 goes to great lengths to draw parallels with the work of architect Christopher Alexander (Reference 3). Alexander's great contribution to architecture and the world is the identification of large numbers of what he called 'design patterns'. Essentially these are 'design strategies that work'. So, to take a typical example, a 'well-designed' room should have windows on two different aspects. Likewise, a 'well-designed' room should allow an occupier to sit adjacent to a window and be able to see the ground outside the window. In Reference 1, Shalloway takes the same 'design patterns' idea by presenting a series of software good practice strategies.

Shalloway presents 24 of these software design patterns. The Gang of Four segment the story slightly differently, and various other authors contributing to the subject add a few other variations, but essentially everyone seems to be slicing the same set of best practice software design strategies into slightly different forms (a bit like different variants of TRIZ?). While it is beyond the scope of this article to go into great detail about the 24 software design patterns (we will stick with Shalloway's slicing perspective as it is the one we find most practically useful), what we can do is examine them and see what connections there might be to tools and strategies to be found inside TRIZ. There are two reasons why we hope this might be useful:

1) we might find something that adds a level of richness to what is in TRIZ
2) we might find something in TRIZ that contributes to the richness and usefulness of the software design patterns.

Pretty quickly after we try and examine the first of these two aspects we begin to realize that 'design patterns' are not the same thing as 'inventive strategies' or 'trend jumps'. They help to define 'good practice' but not necessarily 'innovative practice'. This is perfectly understandable, of course, given the relative immaturity of the software industry, but it also begins to imply that TRIZ has got more to offer software design than the other way around.

That being said, let us have a closer look at one or two of the design patterns in order to explore some of the potential parallels with TRIZ:

The Template Method Pattern

The Template Method is one of the design patterns associated with system behaviour. The Method is a recommended solution strategy for software problems where there is a procedure or set of steps to follow that is congruent at one level, but where individual steps may have different implementations at a lower level of detail. In more specific terms, let's say that we have a block of code with the following structure:

aaaaaaaa
bb bb bb bb bb
cccc cccc ccccc
d d d d d d d d
eee eee e eee eee

Now let's say that there are times when we require a similar block of code, but that this code has a slightly different form and functionality:

aaaaaaaa
xxxxxx xxxxxx
bb bb bb bb bb
CCCC CCCC CCCC
d d d d d d d d
yy yy yy yy
EEE EEE E EEE EEE

A very simple way of creating this second block of code, would be to simply copy and paste the initial block and make the necessary modifications. In this example, we have simply added a couple of new lines of code (xxxxx xxxxx, and yy yy yy yy) and edited the ‘c’ and ‘e’ lines. We might think that such a cut and paste strategy is not so bad an idea in this case. We have, however, introduced a certain amount of redundant code in that the ‘b’ and ‘d’ lines would now be present twice in our overall code. This in itself is not a problem. It becomes a problem though should a need to modify these lines arise in the future. If this happens, our cut and paste approach would mean we have to make the changes twice. This potentially increases our chances of introducing errors and, from a robustness perspective, is generally viewed to be undesirable.

The Template Method allows us to solve this redundancy problem by identifying and creating a single common template that allows both blocks of code to be present without any redundant or duplicated code. We can create such a solution by blocking the code as shown in Figure 2:

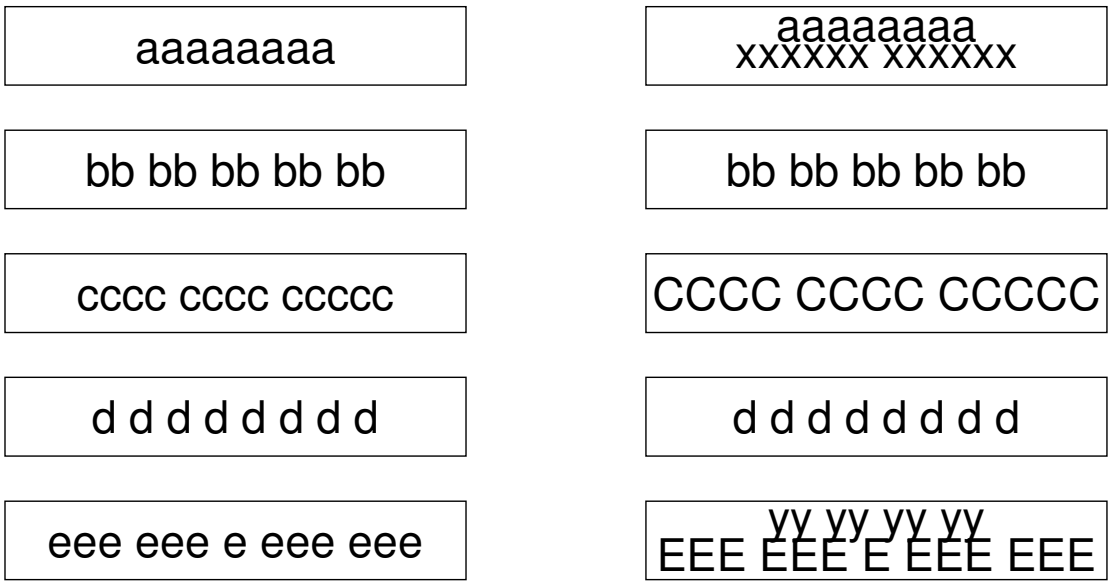


Figure 2: Different Code, Same Template

What has happened here is that, by re-structuring the code into smaller blocks, we are able to design a common template for both overall blocks. This then allows us to re-use the ‘b’ and ‘d’ code blocks in both left hand and right hand applications, so that nowhere are they duplicated. What we’ve basically achieved here is challenged an adaptability versus complexity conflict. The use of the Template method is effectively the same an application of Inventive Principles 2, Separation and (particularly) 7, Nested Doll. We’re still nowhere near what we might think of as an ‘ideal’ solution, but at least the design pattern has shifted to a more ideal one than before we started.

Other Patterns

If the above example looks like a fairly minor innovative jump, then many of the other Design Patterns are probably going to disappoint you. By way of example, we might look at a cluster of Patterns known as 'Decorator', 'Proxy' and 'Chain Of Responsibility' – Figure 3.

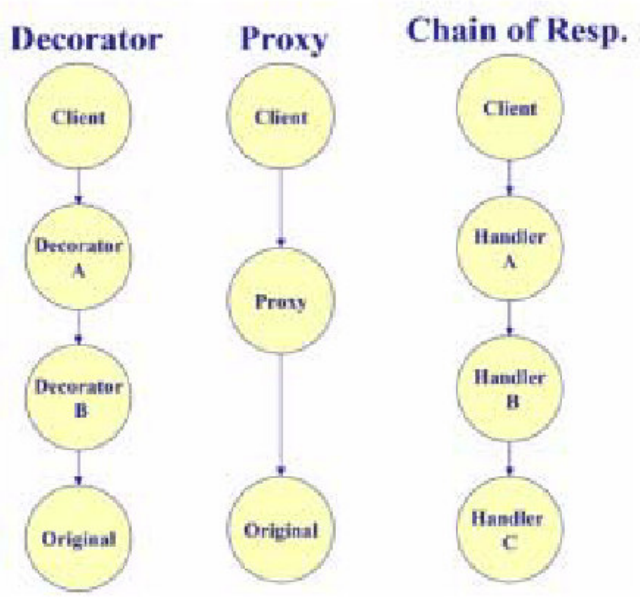


Figure 3: Decorator, Proxy and Chain Of Responsibility Design Patterns

The differences between these patterns in terms of the problems they solve is quite subtle. The same might be said for the basic strategy they incorporate to solve their respective problem, which in each case is essentially an application of Inventive Principle 24, Intermediary. In conventional engineering systems, the application of this Principle is usually indicative of a fairly low level innovation – far stronger solutions being the ones in which we are able to solve our problem without adding anything to the system. In software terms, it is far less of a negative to find ourselves adding a new block of code (so long as it doesn't feature any redundancy!), and so it can be an effective inventive strategy. Especially for systems still in the early stages of their overall evolution trajectory.

A more detailed analysis of the other software Design Patterns reveals that they too feature what we might view as the 'less innovative' of the TRIZ Inventive Principles. Here then lies both problem and opportunity. The Design Patterns are a problem because many of them – like the above decorator, proxy and chain of responsibility patterns – look to possess very little in terms of innovation; yes they are examples of good practice, but this is not the same as a breakthrough software design solution. Taken together, the 24 Design Patterns seem to cluster around just 4 or 5 of the Inventive Principles found in TRIZ. All 5 of them too are consistent with Principles that are most commonly used when systems are at the start of their evolution.

This in turn, then, suggests that there is considerable potential for TRIZ to deliver some genuine software design breakthrough solutions as and when some software engineers start to find ways of using some of the other Inventive Principles. Now we have found ourselves a potentially very significant innovation opportunity. One that we hope the forthcoming TRIZ-For-Software book will start to make systematically possible. Watch this space is all we can say to that thought.

References

1) Shalloway, A., Trott, J.R., 'Design Patterns Explained: A New Perspective On Object-Oriented Design', 2nd Edition, Addison-Wesley Software Patterns Series, 2004.
2) Gamma, E., Helm, R., Johnson, R., Vissides, J., 'Design Patterns : Elements Of Reusable Object-Oriented Software', Addison-Wesley, 1995.
3) Alexander, C., Ishikawa, S., Silverstein, M., 'A Pattern Language: Towns, Buildings, Construction', Oxford University Press, Center for Environmental Structure Series, 1978.

Not So Funny – Bad Design Part 36 – 'Emergency Reception'

Part way through one of our recent travel marathons, we had occasion to stay in an off-airport transit hotel in London. We arrived at the hotel at around 11pm, and had to check-out for another flight at 8am the following morning. For the sake of efficiency we settled all of the bill for the stay upon arrival. So far so good.

In the morning, we woke up and realized that we didn't know the times of the shuttle buses to take us back to the airport. So we set about ringing the hotel reception desk to find out. Hmm. Problem. We can't find a number written on the phone for the reception desk. So we look around the room for the usual guest information directory. There isn't one. There is a breakfast order form, but it doesn't look like there is any other documentation. Never has been; never will be. We pick up the phone and dial a few obvious combinations of numbers – 0, 9, 100 – none of which have any effect. So then we pick the phone up and turn it upside down; nothing. Then we look harder at the top surface, looking at every detail this time. That's when we discover the 'Emergency Reception' button.

Now what to do? What does this button mean? With the symbol next to it, it definitely looks more like an 'emergency' button than a reception button. We're not sure if ringing up to find out the time of the shuttle bus counts as an emergency. Maybe we should just go down a few minutes early and wait in the lobby. We don't want to cause any undue fuss, after all, and maybe dialing this number goes straight through to the emergency services. So we look again for another number to dial. Restaurant appears like the next most likely option. Maybe they will know about the shuttle bus times? A couple of minutes later and we're now certain that the 'emergency reception' is our only bet. Surely the hotel wants us to be able to contact the reception desk? Maybe ringing the number doesn't immediately alert the London emergency services, maybe it goes to the reception desk first and they decide. We're still not sure that asking for the shuttle bus times on this number will go down well, but now we've dithered for so long that we might have well gone down to the lobby early anyway.

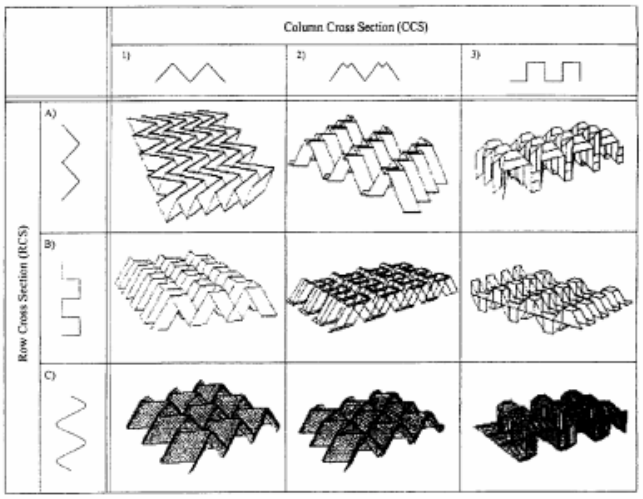
Tentatively, we pick up the handset and press the emergency reception button. The number rings. Rings some more. And then some more. Thirty seconds go by. The phone keeps ringing. Sixty seconds. No answer. We finish packing. Still no answer. Hello? Now we're thinking, what if this was an emergency? Now what would we do? Still no answer.

We put the phone down, and start again. This time we press the restaurant button. "Ah, hello, restaurant? uhm, do you happen to know the times of the shuttle bus?"
"Every fifteen minutes, sir. I can just see one going."
"Thanks, err, do you happen to know the number for reception?"
Pause.
"Press the button marked reception, sir."
"OK, thanks. Err. Do you happen to know if there've been any emergencies in the hotel recently?"
"Sir?"
"Never mind. Thanks for your help."

Patent of the Month – Folded Sheet Structures

Patent of the month this month comes from a mathematician at Rutgers University in New Jersey, which might just be a first on two counts. The invention offers a lifeline to assist in a long known manufacture problem. Professor Daniel Kling's invention 'Patterning technology for folded sheet structures' was granted as patent number US6,935,997 on August 30 2005. The following comes from the abstract of the patent:

"The present invention supplies practical procedures, functions or techniques for folding tessellations. Several tessellation crease pattern techniques, and the three-dimensional folded configuration are given. Additionally several new forming processes, including mathematical methods for describing the material flow are disclosed doubly-periodic folding of materials that name the doubly-periodic folded (DPF) surface, including vertices, edges, and facets, at any stage of the folding. This information is necessary for designing tooling and forming equipment, for analyzing strength and deflections of the DPFs under a variety of conditions, for modeling the physical properties of DPF laminations and composite structures, for understanding the acoustic or other wave absorption/diffusion/reflection characteristics, and for analyzing and optimizing the structure of DPFs in any other physical situation. Fundamental methods and procedures for designing and generating DPF materials include ways for defining the tessellation crease patterns, the folding process, and the three-dimensional folded configuration. The ways are mathematically sound in that they can be extended to a theorem/proof format."



One of the reasons we are so interested in this patent is that it bears a direct relation to one of our product inventions – the folding sheet – which has been stalled for over a year now because we can't find a printer/manufacturer with the capability to fold the thing in the required way. This has been one of those scenarios where the factor preventing successful commercialization is manufacturability. In actual fact, we have had on our minds for the last few months that the real piece of intellectual property we need is not so much the end product, but the process that allows the end product to be manufactured economically. Now it seems that Professor Kling has gone a long way to achieving that goal. Again from the invention disclosure:

The use of rollers to form patterned structures by embossing, stamping, or crushing sheet materials is well established. The use of rollers to fold sheet material into DPFs and other folded networks is new. It is surprising that a pre-gathered sheet material, such as a sine-wave corrugation, may be manipulated in three-space under the influence of rollers into a folded tessellation structure. The fact that fluted material will convert into faceted material under a folding operation that does not significantly stretch the material inside rollers is completely non-obvious, and extremely valuable for mass production.

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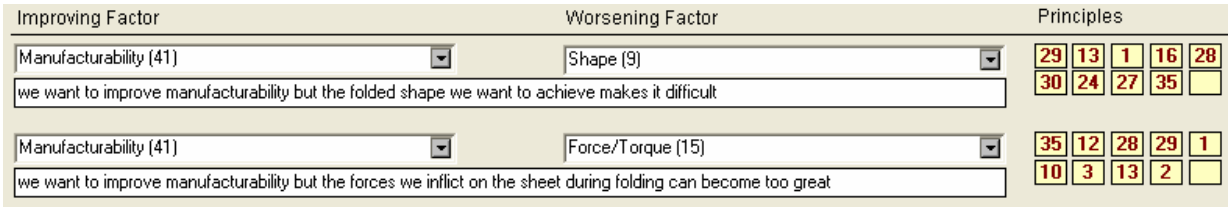
So what are the inventive steps made in achieving the invention? Well, looking at the Claims will probably not assist the lay-reader since they relate to three independent fold algorithms. Novel as these procedures are, the key to the manufacturability problem is where the real inventive leap has taken place. And a fine piece of 'psychological inertia' removal it represents too. Here again is the relevant text from the invention disclosure:

Our process, called the Novel Crease forming Process, applies both to edge creases and vertex creases. In common situations it first appears cumbersome, or even absurd, and this non-obviousness had previously inhibited its invention.. …. By usual standards our process starts by 'mis-folding' the sheet and then rolling the bend or crease into final location. The material is softly curved or temporarily creased in a position not directly centered on its final location. The curve or crease is then caused to migrate until it reaches its desired final location. While it is migrating, typically the fold radius and or included fold angle are tightened in preparation of instating the crease at its final location.

So, in other words, the solution to the manufacture problem comes by splitting the manufacture operation into two stages – the first where the sheet is 'mis-folded'; the second where the position of this fold is shifted to where it needs to be for the final shape. The big idea here, of course, is one of those classic problems where it is not possible to go directly from beginning to end, and we have to instead go via a third intermediate position.

It is interesting to map this solution onto the Contradiction Matrix. We might do that by looking up a pair of conflicts, both relating to our desire to improve manufacturability. The two things preventing us from achieving this improvement are, firstly the shape of the structure we are looking to form, and secondly the forces that we inflict on the sheet to be folded. Here is what we then get:



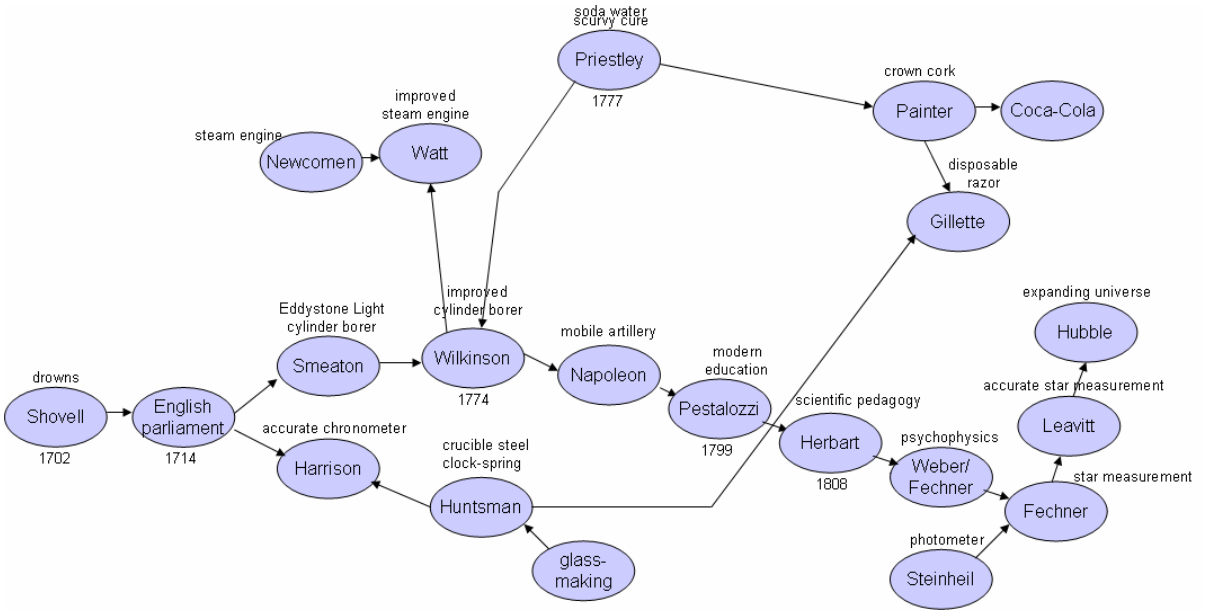
Amazing to us (in retrospect, obviously) is that now we know the answer – thanks to Professor Kling's invention – seeing Principles 13 ('The Other Way Around'), 1 ('Segmentation'), 16 ('Slightly More, Slightly Less'), 24 ('Intermediary') and, 10 ('Prior-Action') in the list of suggestions from the Matrix makes us wonder how on earth we didn't make the invention ourselves. This is an important issue, and one that is a common complaint from newcomers to the method; 'sure it looks obvious in retrospect, but how come you couldn't do it looking forwards?' Two answers are worth mentioning and noting for future reference on not just this but every problem:

1) the transition from generic solution to specific solution requires some domain knowledge. In this case it was knowledge of tessellation mathematics that prevented us from doing anything with the Principles.
2) Very often the final solution will have to emerge (as it did here) from a combination of different ideas. The key idea in US6,935,997 seems to be about making a temporary (Principle 10) 'wrong' fold (Principle 13) and then using the wrong fold to transition (Principle 24) to the 'right' position (Principle 1). If nothing else, what we are being told here is to generate as many ideas as possible and not eliminate any of them. It would have been very easy to dismiss the idea of 'fold it wrong' as nonsense. Taken by itself, of course, it would not have been useful, but combined with something else, it becomes the key to the solution.

Best of the Month – The Pinball Effect

Okay, we admit it, we're a little slow off the mark with this one. The Pinball Effect by James Burke was first published in 1996. Actually, it seems that it is currently out of print, which meant that we were forced to delve into the second-hand market to find a copy. In our defence, we have been aware of the book for some time, but have previously been put off by some of the publisher's blurb printed on the cover of the book. Take, for example, the following: 'how did the first bottle cap lead to Bowie knives and lighthouses and cannon and schoolrooms and the expanding universe?' While this sets off the theme of the book very well – the idea that apparently innocuous and minor inventions often lead to profound global shifts – when you know that Bowie knives, lighthouses and cannons all pre-date the first bottle cap by over a century, it is difficult to see how the invention of the bottle cap 'lead to' the others. Well, of course, once we delve into the book we see that the author never makes this 'leads to' connection. Rather what he does is to make some extremely well thought out connections between a staggeringly broad array of different discoveries and inventions.

What Burke actually says about bottle-caps and Bowie knives can be summarised in the following picture:

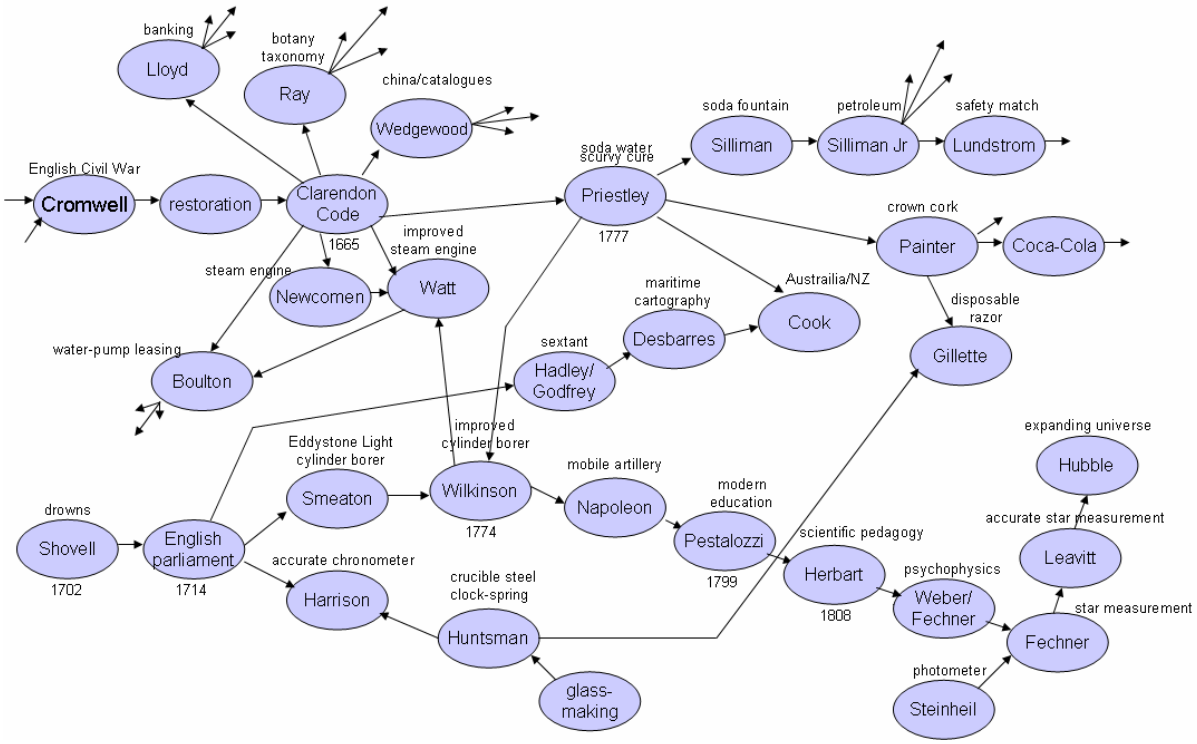


Perhaps the publisher never understood the flow of Burke's discussion, but what this particular chapter of the book shows is how the drowning of a high-ranking English dignitary – Sir Cloudesley Shovell – in 1702 did actually lead, over 200 years later, to Hubble's discovery that the universe was expanding. This is a perhaps even more implausible connection than the incorrect one used on the jacket of the book. What the chapter and the above figure also show is that Joseph Priestley's invention of soda water ultimately lead to the disposable razor.

The drowning-to-expanding-universe story works something like this: Sir Cloudesley Shovell mis-navigates his booty-laden fleet of ships into rocks of the Scilly Isles south of England. This loss prompts the petitioning of parliament to do something to improve protection of shipping around Britain. In true British government fashion, sure enough, shipping legislation appears 12 years later that spurs the invention of the Eddystone lighthouse and accurate chronometers. John Smeaton, the designer of the Eddystone light, also created the first cylinder-boring machine. Smeaton's design was soon used as the basis of an improved design by John Wilkinson (who, note, is connected to Joseph

Priestley via marriage to his sister). Wilkinson's design, in addition to allowing James Watt to transform Newcomen's first steam engine into one with sufficient efficiency to make it commercially practical, also transformed the manufacture of cannon's to the extent that they could be made light enough to become mobile. Napoleon proceeded to exploit this rapid-reaction force, horse-drawn artillery to conquer of large parts of Europe at the end of the 18th century. In Napoleon's march through the canton of Unterwalden in Switzerland in 1799, there was much loss of life and, consequently, the creation of large numbers of orphaned children. Failed agriculturalist Johann Heinrich Pestalozzi, lacking the usual schooling resources, was inspired to take on the responsibility for educating the orphans. In so doing, he effectively invented modern schooling methods. Pestalozzi's methods inspired close friend Johann Friedrich Herbart, who, upon taking over Immanuel Kant's chair of philosophy post at Königsberg University, developed the first scientific pedagogy. Herbart later moved to the University of Göttingen, where he met and began working with Ernst Weber and Weber's pupil, Gustav Theodor Fechner. Weber and Fechner developed what we know today as psycho-physics. Renaissance man Fechner also went on to take advantage of Carl Steinheil's photometer, and establish a means of measuring the distance of stars through their luminosity. Fechner's method was then used by Harvard-based Henrietta Leavitt. Leavitt's contribution to the story is that she was able to model the cyclic variation in star luminosity, and thus increase the accuracy by which stellar distances could be measured. Inside the next twenty years, Edwin Hubble would then further build on Leavitt's findings, ultimately proving that the universe was expanding.

Now, while you might consider one or two of these links a little tenuous, and while you might also be thinking, 'ah yes, but surely we can link almost anything to anything else using this kind of connection strategy', both points turn out to be the biggest joy and the biggest point of the book. Taken as a whole, then, The Pinball Effect takes the reader on a fascinating journey that manages to not only connect a whole series of things to other things, but then goes on to cross-link them to form an enormous web of links. The book does this by including no less than 447 'gateways'. Each of these 'gateways' allow the reader to jump from one point on the web to another at a point somewhere else in the book. Thus, by following some of the links from the Shovelly-Hubble chapter, we can expand the earlier model to one that looks like this:



And now the story gets to become rally interesting. You will need to read the book for yourself to see the full glory of the web (although, alas, Burke does the whole job in writing rather than in pictures).

For those that aren't going to go to the trouble of scouring their local second-hand bookstore for a copy, it is worth noting some of the big ideas that emerge from reading the book. First, of course, is the amazing level of connectedness of everything. The big one for us, however, was seeing the modern world as we know it emerging from such trivial and apparently unconnected events. And so the whole Industrial Revolution emerges as a result of the Clarendon Code of 1665. The Clarendon Code was an Act of Parliament that, after the restoration of the English monarchy following Oliver Cromwell and the English Civil War, prevented so-called 'dissenters' from taking positions in the church or academia. As a consequence of this Code, all those smart people who would otherwise have passed into these professions were forced into commerce and the trades. Net result; Priestley, Newcomen, Watt, Boulton, and just about all of the father's of the industrial age. We see the same thing with the Act of Parliament produced after Shovelly's drowning, suggesting that when the minor shifts happen at a governmental level, then the downstream results can be very non-linear indeed.

More on this kind of highly non-linear effect (albeit at an organizational rather than governmental level) in a fuure article. Meanwhile, here is a book that we heartily recommend from just about every angle. Well worth the search.

Conference Report – 1st TRIZ Symposium, Japan

We were extremely happy to accept an invitation to present a keynote address at this, the first Japanese TRIZ Symposium, held in Shuzenji during the period 1-3 September. You will find our presentation 'TRIZ: Critical SWOT' in both Japanese and English versions at Toru Nakagawa's excellent TRIZ Home Page In Japan. You will also no doubt find a review of the conference there too in the coming days. Meanwhile, from our perspective, the Symposium was review-worthy from several angles.

Looked at from a high altitude helicopter, there was an interesting shift at the conference from the correpsonding Invention Machine User Group/TRIZ conference held at the same time last year. In 2004, one of the main questions on the lips of the delegates was 'will TRIZ take off in Japan?' At the conference this year the mood was very much one of 'TRIZ is past a critical point and *will* take off in Japan'. Certainly the increased number of delegates provided evidence of this mood-shift (there were over 100 people attending the event), but then probably more significant was the number of companies presenting real case study evidence of their TRIZ activities.

In all just over 20 papers and posters were presented. The large majority of these were delivered in Japanese, logically since all bar 4 of the delegates were from Japan. Exceptions were myself, Valery Krasnoslobodtsev and Richard Langevin from the Altshuller Institute and Ik-Cheol Kim from South Korea. Fortunately for non-Japanese speakers, you will find English translations of all of the paper abstracts at the TRIZ Home Page in Japan.

The highlights from our perspective were the Hitachi paper comparing the original and new Matrix 2003 tools and the 'vendor' session. The former was good (okay, we're biased) as for the first time it presented a very definitely independent analysis of Matrix 2003. As unbiased as we try to be when we write about it, there is always likely to be the doubt in people's minds concerning our objectivity. The Hitachi paper highlighted the fact that Matrix 2003 gave significantly better results than the original. It did sufficiently better in fact to warrant the purchase and distribution of 300 copies of the book within the company. Sales of the Japanese edition book are currently out-pacing those in the rest of the world

by a factor of nearly three-to-one in fact. More evidence, we think, that TRIZ in Japan has certainly climbed over some kind of acceptance hurdle.

The vendor session was interesting if only for the fact that I've never seen an equivalent thing happen anywhere else, either inside TRIZ or in any other domain. This session was an opportunity for the four main TRIZ-providers in Japan to stand up, one after the other, and describe to the delegates what their organization was about, and what made them unique. Visions of trying to get the same thing going in the English speaking TRIZ community creates painful images of a lot of acrimony, lies and deceipt, but, at Shuzenji it was quite the opposite. Whether this is because the provider community in Japan has successfully shifted into the 'grow the pie, don't argue over scraps' state, or whether it is because everything seems so polite everywhere in Japan is difficult for an outsider to appreciate. All that I can say is that it was an extremely well thought out and executed part of the programme that I believe the audience really appreciated and seemed to get genuine value from. Indeed, a questionnaire session at the end of the vendor presentations was returned to, reviewed and presented in front of all during the last session of the conference. The major themes emerging from this analysis were (in descending order of importance as voted by the delegates), TRIZ software, TRIZ-for-software, TRIZ for Business and then integration with other methods.

Higher on the agenda than in other TRIZ events running this year (5 full conferences in all) was USIT; with a keynote from Professor Nakagawa and then two additional case study papers. USIT appears to be gaining a significant foothold in the Japanese market in certain quarters. Quite clearly it doesn't work for a whole host of different problem scenarios, but for those that it does, the feeling from users was that they liked the relatively shallow learning curve. It will remain to be seen whether the spread of USIT is because of its genuine capabilities, or the fact that, with Professor Nakagawa at the helm, it is one of the few options open to organizations wishing to bring in outside trainers. We can only watch and wait to see what happens in the longer term.

Finally, it is worth mentioning the tremendous spirit present throughout the conference; great discussions in all of the breaks and after-hours activities (most informal discussions were still going on until well into the night). It was truly a joy to be present and to be allowed to take part despite all of the language difficulties. Talking to the conference organizers it seems like there will be an attempt at the 2006 conference to encourage greater attendance and participation from overseas. Assuming it will be possible to have translation of materials into English, then I would say it was an event fully worthy of your time and energy.

Many thanks to the organizers for their hospitality and for translating my contribution into Japanese. Much appreciated and long remembered. See you next year.

Investments – Nanofabrication: next generation chip manufacture?

A new nanotechnology tool that will dramatically cut the cost of leading-edge nano research at the sub-50nm scale has been developed by EU researchers. It could lead to Next Generation Lithography (NGL) technology. The commercially available first generation tool is low cost compared to sub-50nm alternatives. For example, electron beam lithography costs €2m per machine, whereas the Soft Ultraviolet (UV) Imprint machine developed by the IST-programme funded SOUVENIR project costs in its basic version well below €200,000. It will initially be used to produce novel and experimental nanotech devices in universities and research institutes. Later generations, however, are expected to be used for small manufacturing runs. Further generations still could cause a fundamental shift in the semiconductor and nanotechnology industries. "In principle, this new technique has the potential to be used for mass manufacture by the semiconductor industry. One approach we use can already form patterns down to the 10nm scale," says Dr Markus Bender, researcher at German company, Applied Micro- and Optoelectronics (AMO), and coordinator of the SOUVENIR project.

The semiconductor industry's holy grail
This is a big deal. Next Generation Lithography (NGL) is the holy grail of the semiconductor industry. It will allow rapid, large-scale manufacture of modern microchips at a sub-50nm scale. Industry giant Intel has spent 15 years and millions of dollars looking for it. A small team of dedicated researchers in Europe may have found the solution in three years at a cost of €2,300,000.

It will take a few years more research to know whether SOUVENIR's work will lead to viable NGL, but even with its first generation tool the SOUVENIR team have already generated remarkable results and a new product on the brink of commercialisation.

Photolithography works by casting light through a mask to produce a pattern on a chemically-coated substrate. The light changes the chemical structure of the substrate. Depending on the type of photolithography, either the lit or shadowed chemical is washed away in the next step. In either case the result is a pattern etched into the substrate.

With nanolithography the patterns are invisible to the naked eye and the vast majority of the world's microscopes. The result is the tiny circuits in semiconductor chips.

The SOUVENIR project developed a new technique to create those patterns, one that is low cost and, comparatively, low tech. In a first step the substrate was coated with a low viscosity, UV-curable resist. The resist is simply a UV-sensitive chemical layered onto the substrate. They then used a soft polymer mould, called an elastomer, pressed against the resist-coated substrate, called imprinting, followed by the UV photopolymerisation, or curing, of the resist.
This costs less than other photolithographic techniques. Because the mould is pressed

against the resist, the system does not require the extremely expensive 'deep' UV light sources used in the semiconductor industry. These light sources can only work properly in a vacuum. Finally, the elastomer mould is considerably cheaper than those used in microchip manufacture. The result is a low-cost pattern process at the sub-50nm scale.

However, the low cost comes at a price. Currently, the system is too slow and unproven to replace the current industrial photolithography processes. What's more, the elastomer moulds used in the SOUVENIR process at the moment need further improvements for high-resolution alignment processes, essential for mass manufacturing semiconductors.

But ultimately it has the potential to become the next generation lithography. Thanks to research completed by the German government's Federal Ministry of Education and Research (BMBF), it is possible to use the same imprinting technique using a hard mould, based on quartz, which does have the required precision for semiconductor manufacture.

"There are still problems with that particular technique," says Dr Bender, "the quartz approach only works with a substrate of one square inch, but we can use the elastomer mould on a six inch wafer." Furthermore, while quartz could address the precision issues the technique is currently too slow for large-scale semiconductor companies.

But Dr Bender believes that with a commitment to research these hurdles could be overcome. "This is the first generation of the tool we developed and, with work, we can in principle get much better, faster and more scalable results," says Dr Bender. If he is right it could provide a viable alternative to the costly high-tech approach taken by Intel for Next Generation Lithography. The highly specialised light sources, mirrors and ultra-high vacuum used in Intel's Extreme Ultraviolet Light (EUVL) technique impose almost unconquerable and enormously expensive scaling constraints. After years and millions of dollars there is still no commercially viable EUVL system available.

"I think there's the same potential with our technique as with the EUVL. UV imprinting is still an under-investigated area, and if it wasn't for the EU this research wouldn't get funded. Companies are not researching this field," says Dr Bender. "We are working in close cooperation with an Austrian company, Electronic Vision Group (EVG) to develop tools for the two approaches. I think next year we'll have a step and repeat tool for 300mm wafers on the market," says Dr Bender. This first generation tool is designed for small volume production, for example for chemical sensors and in biotechnology applications at small companies and research centres. Right now, small companies can't afford their own tools for sub-50nm nanotech devices. But ultimately, this research could change how the semiconductor industry works. "This is a totally new technique and we've got to prove that we can reliably reproduce the results. That's what we'll be doing now," says Dr Bender.

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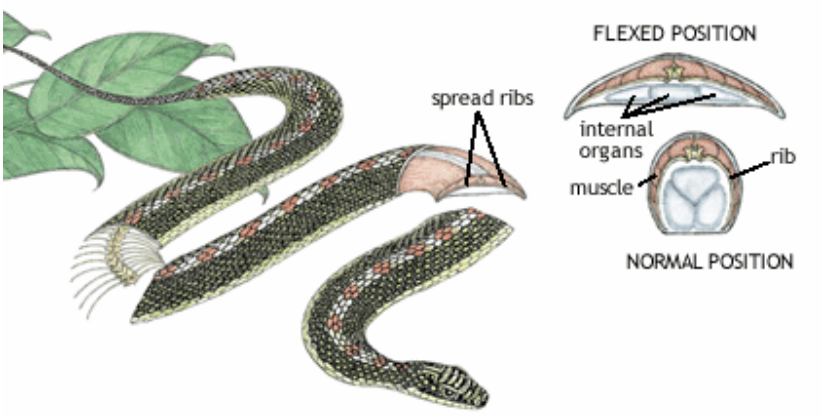
Biology – Flying Snakes

Do snakes 'fly'? It has been known for some time that certain species of snake are able to 'parachute' – i.e. they are able to drop from elevated positions onto, say, ground-based prey. Recent observations of the paradise tree snake (*Chrysopelea paradise*) have demonstrated that rather than simply 'parachuting' this snake is able to actively control its descent in such a way that it can truly be classified as a 'glider'. Some tests have demonstrated that for every 1m of descent, the snake is able to travel over 4m horizontally. With this capability, the tree snake is far better able to attack not only ground-based, but other airborne prey such as birds.

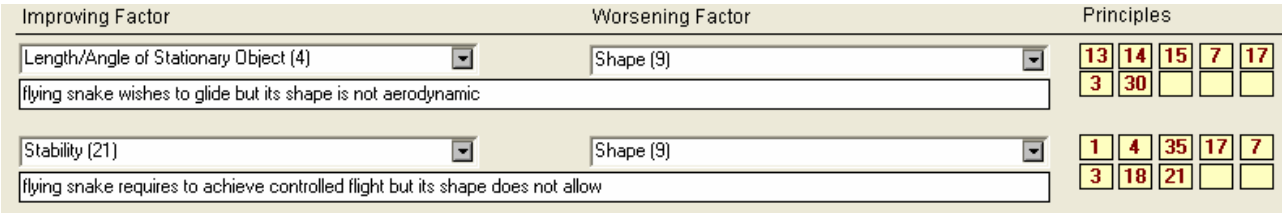
The means by which the tree snake is able to perform such a feat demonstrate an amazing series of evolutionary advances. The excellent web resource found at http://www.flyingsnake.org/ reveals the following:

1) When the tree snake is preparing to jump, it dangles like the letter **J** from a branch. It then flings itself upward and away from the branch, only to begin falling at a very steep angle.
2) After falling less than ten feet, the two-foot-long snake assumes a tight zig-zagged **S** shape and begins to wiggle and undulate (with much the same motion as if it were crawling across the ground). This action is thought to increase stability and control during the descent.
3) One of the most important factors in the snake's midair shift from free fall to glide is a dramatic increase in the width of the animal's body. Like most other snakes, a flying snake is roughly circular in cross section. But while a member of *Chrysopelea* is falling after launch, it flares its ribs so far outward that its belly becomes concave. With its body molded into a highly flattened **C**, the area of the snake's ventral silhouette-that is, its silhouette when seen from below-nearly doubles:



This flattening of the snake cross-section shape essentially turns the animal into an airfoil. Together with the snake's tight **S**-bends (which aerodynamicists believe make its entire body act like a highly slotted wing) produce more lift than the snake would otherwise be able to achieve.

Examined through the lens of contradictions, the flying snake has basically solved two important problems; firstly it has been able to achieve 'gliding' – the ability to translate horizontally as it falls from a tree – and secondly it has been able to do this in such a way that it is able to control its trajectory. We can map both of these problems onto the Contradiction Matrix as follows:



Looking then at the solutions adopted by the paradise tree snake, we can observe the following close matches to the recommendations made by the Matrix:

a) change of cross-sectional shape – Principles 15, Dynamics and 17, Another Dimension, and 4 Asymmetry (air-foil shape)
b) wiggling s-shape motion – Principle 15 again, plus Principle 14, Curvature, plus Principle 18
c) making use of air-flow through the tight curves – Principle 3, Local Quality.

You can find more about the flying snake at another excellent website:

http://biomechanics.bio.uci.edu/_html/nh_biomech/flyingsnake/flyingsnake.htm

No doubt we will be examining several of the other examples featured at this site in future articles.

News

Several readers have asked us to include information and updates surrounding our work and activities in general. While it is not one of the intended objectives of the e-zine, we are happy to include news as and when it might be useful to our readership.

Here is a quick summary of what is happening this month in and around Systematic Innovation:

In-House Workshops
It is nice to be able to report that we have several new clients asking us to conduct multiple in-house training workshops. The bad news is that these are tending to fill our diary up for some time ahead. The good news is that we have a bunch of companies making a serious commitment to making TRIZ happen inside their organisation.

Multi-Media Super Corridor
We are very happy to announce that we have now received official confirmation that our software development organisation in Kuala Lumpur has attained MSC status. Congratulations to the team in KL for passing a rigorous series of business and technical qualification criteria.

Focused TRIZ Workshops
A further step along our intention to offer more public workshops in which TRIZ is adapted to the user (rather than, as is usually the case, the other way around), we are happy to announce two new two-day workshops, one for the automotive industry and one for the ICT sector. Both workshops will initially run in SE Asia. We will be looking to repeat the workshops in other parts of the world during 2006.

(Finally, a big apology for the late arrival of your e-zine this month. The delay is one of the sad outcomes of a catastrophic hardware failure during a recent trip, and a consequent inability to access the content of the September issue. Important lesson: no point in having an ‘international warranty’ on a laptop if the countries you are visiting do not stock parts for your model. Anyway, we hope that the late arrival does not spoil your enjoyment of the e-zine.)