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Systematic Innovation

e-zine

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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.

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People Don't Like Change Because….
- Perception Mapping Hierarchies

In a world where change is the only constant, the lack of desire on the part of the majority of us to change can and often does become a big problem in many organizations. The problem of change, and more specifically the issue of getting people to buy into change is one that is prevalent across just about every type of industry in any part of the planet. As a consequence, we often find ourselves working to address this type of problem during a significant proportion of the management workshops we conduct. This article is aimed at drawing some general points from the specific work that we conducted in different companies, and – more importantly – allows us to explore a significant extension to the methods used to define the change problem and our responses to it.

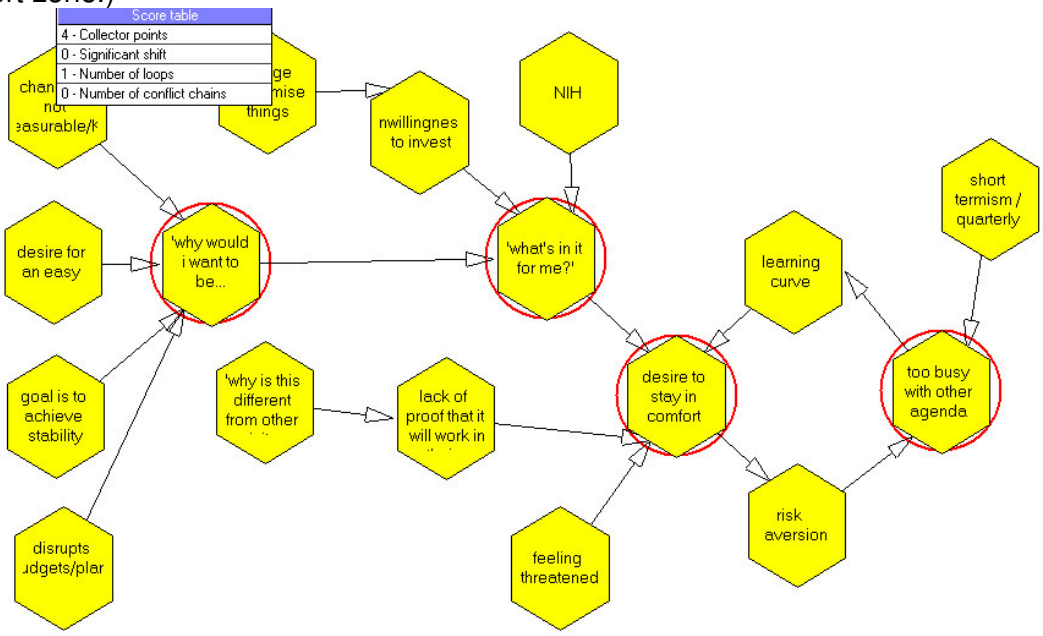
In highly complex problems like 'people don't like change because…' we usually recommend use of the Perception Mapping technique as a means of distilling some sense from all of the complexities present in the problem. The basic technique is described in detail in the new Hands-On Systematic Innovation for Business and Management book. Rather than repeat a description of the process here, we instead present a collection of the typical responses to the 'people don't like change because…' question and then perception map showing how we think these responses relate to one another. Firstly the typical responses:-

No.	Perception
1	Short-termism / Quarterly figures
2	Too busy with other agenda items
3	'What's in it for me?'
4	'Why is this thing any different from other initiatives?'
5	change is not measurable/KPI
6	risk aversion
7	lack of proof that it will work in their situation
8	feeling threatened
9	NIH
10	change de-optimises things
11	desire to stay inside comfort zone
12	disrupts budgets/plans
13	'why would I want to be disruptive?'
14	goal is to achieve stability
15	desire for an easy life
16	unwillingness to invest

And then the resulting perception map after we have answered the question 'which of the others does this one *lead to*?' for each of the perceptions in turn:

(Our experience in doing this kind of exercise with a large number of groups is that there is considerable variation in both the perceptions and the 'leads to' outcomes in different company cultures. We justify reproducing the map drawn here since it features one of the features common to almost every one of the maps drawn for this subject; the fact that the

main loop contains a perception relating to the desire of most people to stay inside their comfort zone.)



At this point in the process, the perception map has identified which of the list of perceptions is more significant than others. According to the process, the important perceptions are the ones that form a closed loop, and/or act as collector points for several other perceptions (i.e. several other perceptions lead to a collector). Being both in a loop and a significant collector point, our map here has indicated that the 'desire to stay in comfort zone' perception is the most significant perception on the list.

At this point in the process, then, we have reached an interesting decision point. On one hand, we have created an opportunity to transition from a problem definition into a problem solving thinking mode. This is so because having started with a question about something we would like to improve (we want people to buy into change), the perception mapping tools has suggested that the main thing stopping us is that people like to remain inside their comfort zone. We have, in other words, formulated a conflict pair. We could, therefore, chose to map our conflict pair onto one of the Contradiction Matrix tools (in this case it would be the Business Conflict Matrix) and thus see ho other people have successfully challenged similar conflicts. If we chose to do this, we might end up with a situation like that shown below.

Initial Question
People don't buy into change because…

Perceptions
A
B
C
etc

Perception Map
Desire to stay inside comfort zone

Contradiction
Adaptability/Versatility versus Tension/Stress

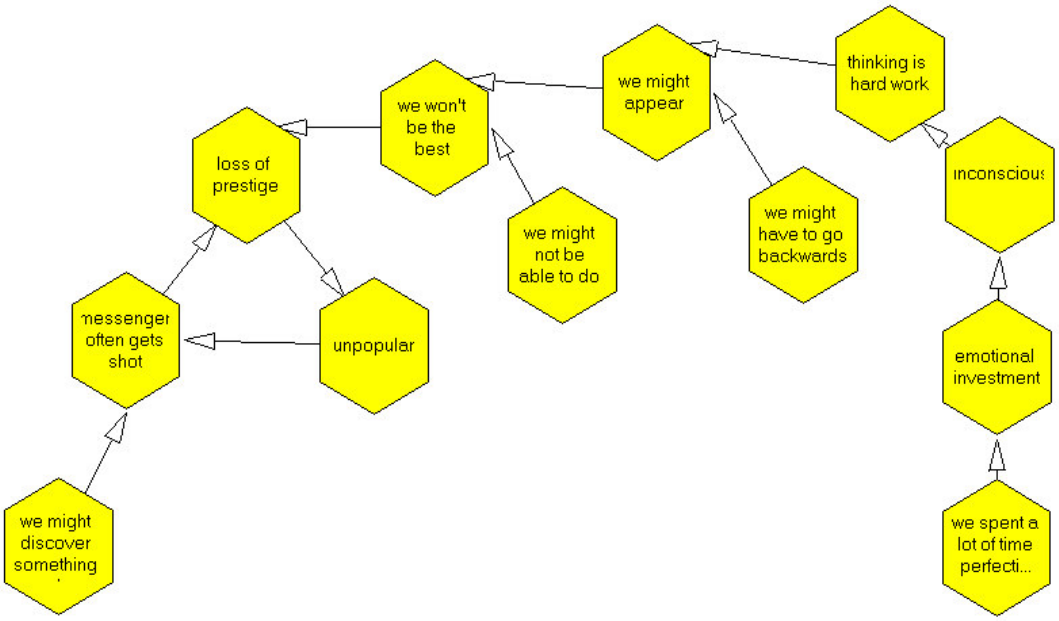
Matrix: 17, 40, 30, 3

solution generation

The figure here summarises the basic process we have been through. The transition to solution generation occurs by translating the specific conflict pair into the generic parameters of the Matrix. In this case, we have mapped ‘change’ as ‘adaptability/ versatility’ and ‘desire to stay in comfort zone’ as ‘tension/stress’. We could, of course, have picked other parameter matches. The key point being made here, however, is that the perception mapping tool has allowed us to make a transition from a long list of possible problems into a list of Inventive Principle suggestions that can help us to generate some solution concepts.

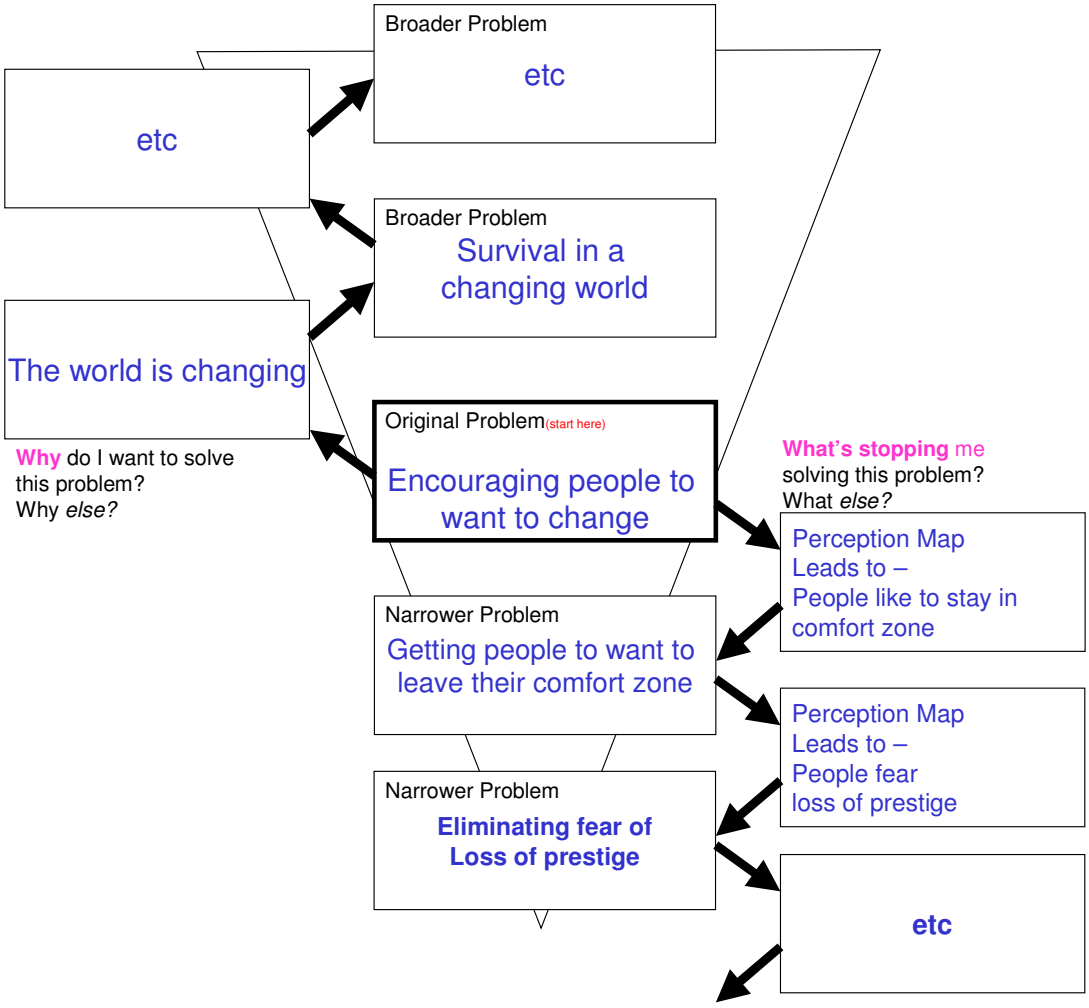
This transition to solution generation is then one side of the decision point. The alternative would be to explore the output of the perception mapping exercise in more detail, and use what we have found to delve into looking at the problem at a more detailed level. A very effective way of doing this is to conduct a new perception mapping analysis switching the significant output of the first analysis (in this case the perception that people like to stay inside their comfort zone) to become the start point for a new analysis. If we did this, our new start question would become something like ‘people like to stay inside their comfort zone because…’ In which case, we might end up with a new perception map looking like the following:

No.	Perception
1	we might appear stupid
2	we might discover something we don't like
3	we might not be able to do it
4	we spent a lot of time perfecting this
5	we won't be the best anymore
6	we might have to go backwards
7	unpopular
8	messenger often gets shot
9	loss of prestige
10	emotional investment
11	unconscious competence
12	thinking is hard work



What this map then tells us is that the most significant factor determining our desire to stay inside our comfort zone is the possibility that we may lose prestige (i.e. this perception is both in a loop and acts as a significant collector point). We now have another opportunity to make a transition from problem definition to solution generation. Actually we have several – we can, for example, take our original desire to encourage people to want to change and say that 'loss of prestige' is the thing stopping us, or that we want to get people out of their comfort zone and again say that loss of prestige is the thing stopping us. Either way, we have an opportunity to define a conflict pair (or pairs), and then see, through the Matrix, how other people have successfully challenged such conflicts.

Alternatively, we also have the opportunity to delve even deeper into the problem by exploring the loss of prestige problem in more detail. And so here is the point of the article; problems operate on many levels, and if they involve people are inevitably highly complex. The process of combining Perception Mapping and Conflict finding is an excellent means of obtaining a coherent understanding of problem situations. In essence the process we are seeing here is conceptually identical to the Why-What's Stopping Analysis psychological inertia tool. The figure below summarises what we have been doing, and hence the process that you may care to follow in your own problem situations:



Business Principle 36 – 'Paradigm Shift'

Inventive Principle 36 is known as 'Phase Transition' in the technical version of TRIZ. In the business version of the systematic innovation toolkit, although the meaning has stayed the same, the name has been changed to 'Paradigm Shift'. According to the Principles definitions in the new Hands-On Systematic Innovation business book (Reference 1), Principle 36 means:-

"*Use phenomena occurring during disruptive shifts in an economy. (Awareness of macro-scale business phenomena)"*

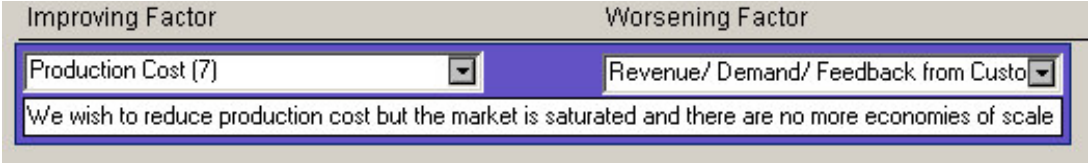
It is undoubtedly nevertheless one of the more abstract and therefore difficult to use of the Principles. It is also a Principle that is rarely made use of in a business context since very few organizations are at a stage in their evolution where they are able to lift their heads from the detail of what they are currently doing to see how the macro-scale changes around them may affect their future business success. This also helps to explain why it features relatively infrequently in even the new version of the Business Conflict Matrix; there are simply insufficient examples to justify including it.

That is not to say that the Principles is un-important of course. Making a positive use of the Principle can in fact result in some effective win-win solutions. We recently came across a good illustration when we were re-reading ''Thinking Beyond Lean' (Reference 2) recently. At the time we did not fully appreciate the example described in the text. Or rather we did not fully appreciate the connection to Principle 36.

The Thinking Beyond Lean book is essentially a diagnosis of the global automotive industry as it shifted and evolved through the 1980s and 1990s. One of the main themes of the book involves a discussion of the evolution of the organization structures of the biggest car companies as market conditions took their various twists and turns. As suggested by the title, the highly competitive nature of the whole industry has meant that throughout the evolution, in order to remain competitive, companies have had to set up structures that are as lean as possible.

Because the industry is so competitive, 'being lean' was a business essential. The Toyota Production System probably started the so-called lean-revolution; and when one company does something successful, the others are going to have to follow suit fairly quickly. By the end of the 1970s, Toyota and other companies had done a pretty good job of cutting away all of the waste present during the process of developing a new vehicle. In systematic innovation terms, they were approaching a significant limiting contradiction; there was continuing pressure to reduce production costs, all the fat had been cut away, and the market was saturated and there were no more economies of scale left to be had.

In terms of the Business Conflict Matrix, the important conflict may be seen as that between Production Cost and Market Demand:



The Matrix recommends five different Inventive Principles that other industries have deployed when challenging this big conflict:-

7 Nested Doll – e.g. nest some external feature inside your product that makes your offer more valuable to a customer (or, nest yourself inside a bigger system)

13 The Other Way Around – e.g. shift from a downward spiral price-cutting war and re-design the business model and possibly the product offering to enable higher prices to be obtained

1 Segmentation – segment the market into different price sectors, geographical regions, market niches, etc

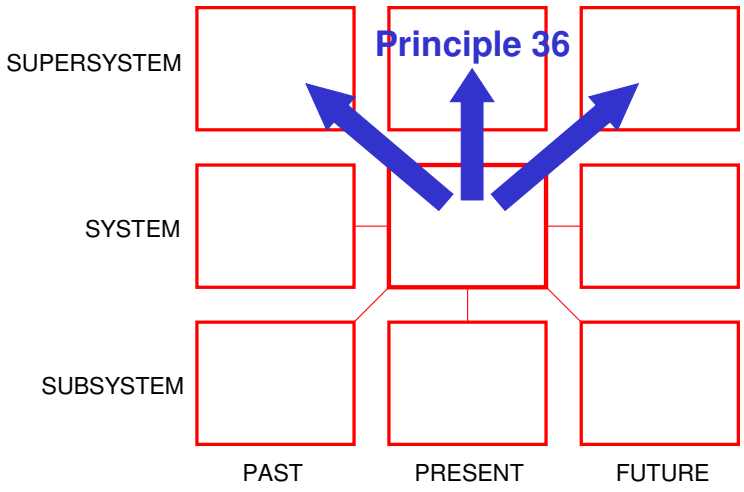
24 Intermediary – possibly similar to Principle 7 in this case, but perhaps causes us to focus more on the channels by which the market is approached.

25 Self-Service – e.g. find other sources of waste to be eliminated, or add forms of self-organisation into the business, or the way that it presents itself to the market.

Several of these suggestions could have got us to the strategy used by Toyota and the rest of the industry, which was to look to commonalise parts across different models (and in some cases different companies) in order to reduce the development burden.

What none of these Principles does, but Principle 36 specifically does, is focus our attention on the bigger picture. In many ways, TRIZ tries to be self-correcting. The important 9-Windows concept is a way of saying that the human brain will always tend to focus on one perspective of a problem – system, present. When we see Principles like number 3, Local Quality, for example, the method is telling us to go and look for the answer to our problem down in the sub-system. Likewise, Principle 10, Preliminary Action, is encouraging us to go and look in the 'past' window.

Principle 36 is trying to do exactly the same thing for us (in the business application context at least) by suggesting to us that we explicitly go and look for solutions to our problem in the 'super-system':



In the car industry situation where individual car production has been optimized, the use of Principle 36 would explicitly force us to look upwards to find solutions at a higher hierarchical level. This is in fact the main point of the Principle.

It is not the only point, however, since the Principles description also asks us to look out for macro-scale business phenomena and disruptive shifts. In the car industry case, the

macro-scale shift was the conflict between desires to reduce costs (and therefore prices to the customer) coupled with the knowledge that the market was becoming increasingly driven by customers wanting products more and more tailored to their individual needs. A classic mass-customization problem in fact. One that the industry has subsequently solved by segmenting vehicle design into 'platforms' and 'interiors/exteriors'. The platform is the foundation of the vehicle; the part that costs the most to develop, but also the part that the customer doesn't see and has very little direct interest in. The interior/exterior, on the other hand, is all the stuff that the customer sees, and tends also to be the less expensive to develop part of the vehicle. The net result of this segmentation is shown in the figure below:

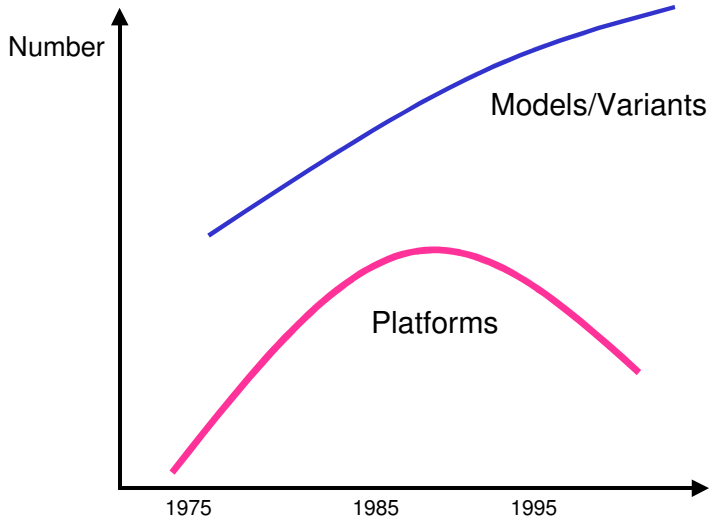


Figure 1: Typical Variation In Number of Models And Platforms Offered By Automotive Companies

Number of platforms being developed has reduced significantly – to the point where one platform may be re-used across 10 or 20 different models – while the number of models has continued to rise to meet (still rising) customization requirements.

The point of all of the Inventive Principles, not just 36, is to help direct us to our own solutions, rather than to re-invent what has already been invented. The car industry example of macro-scale phenomena, and shifting focus further up the industry hierarchy is a good example of Principle 36 being used. The big idea now is that we are able to use the same Principle to help us to generate solutions in our own specific problem situations.

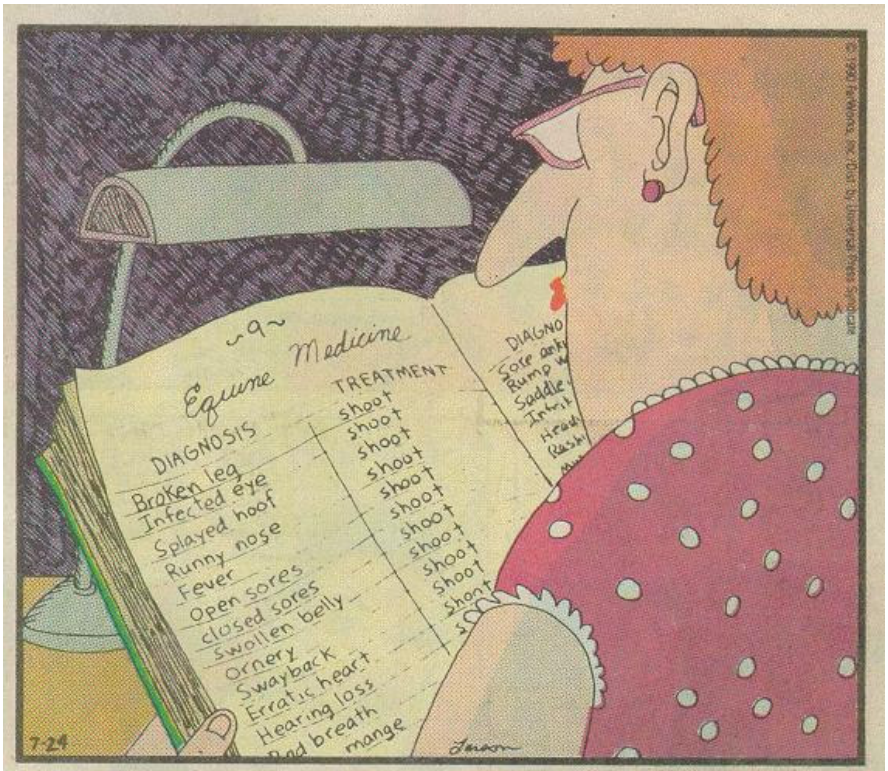
References

1) Mann, D.L., 'Hands-On Systematic Innovation for Business and Management', CREAX Press, May 2004
2) Cusumano, M.A., Nobeoka, K., 'Thinking Beyond Lean: How Multi-Project Management Is Transforming Product Development At Toyota And Other Companies', Free Press, New York, 1998.

Humour – Another Inventive Principle

We still can't get Gary Larson's publishers to see the advantages of publishing a book of 40 Inventive Principles illustrated by Mr Larson's cartoons – the fact, for example, that he uses just about all of the 40 Principles makes him unique among the world's cartoonists.

Here is another of Mr Larson's cartoons. This time illustrating…. well, why don't you try and work it out.



Like most veterinary students, Doreen breezes through Chapter 9.

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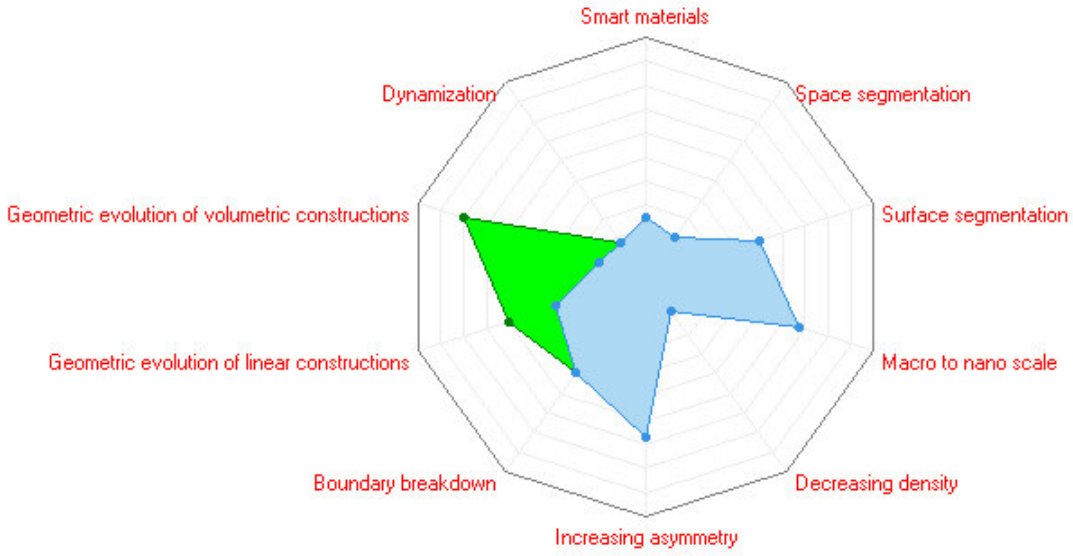
Patent of the Month

Patent of the month this month goes to the team at Hong Kong University of Science and Technology working on the production of three-dimensional circuits. This is and area that we have been looking at for some time – since the geometric evolution trend part of the systematic innovation method will tell us that the conventional world of 2D circuit boards will eventually evolve to make use of the third dimension. The simplified evolution potential plot illustrated below indicates the jump made by the inventors (the blue plot representing the state of the art prior to the invention; the green indicating the jumps made by the inventors):



As suggested by the evolution potential plot and the inventors ("It is widely believed that the future of integrated circuits (IC) lies in three-dimensional structures.") the direction towards 3D and the advantages of achieving a 3D solution are both fairly obvious. This direction offering capability is indeed the main purpose of the trends – each unused jump representing a direction that someone, somewhere has already found to offer a more ideal solution than whatever is current.

What is less obvious from the trends, however, is precisely how does one go about physically realising the desired direction. One very effective means of answering this question is to use the directions offered by the unused trend stages as a means of focusing a web or patent database search. In this case, the key search words offered by the geometric evolution trend are fairly obvious things like '3D' or 'non-planar'. In either case, we would have been fairly quickly pointed towards US patent 6,727,517 awarded to the Hong Kong team on 27 April:

United States Patent **6,727,517**

Chan , et al. **April 27, 2004**

Three dimensional integrated circuits

Abstract

Semiconductor crystal grains are formed by metal-induced lateral crystallisation. The positions of the grain boundaries normal to the crystallisation direction are controlled, to position the grains correctly for subsequent formation of electronic devices within them. In a first technique, the grains are positioned by depositing the metal in short strips which each induce the crystallisation of a single corresponding grain. In a second technique, the grains are positioned by pre-patterning the amorphous silicon which is used to form the grains. Electronic circuit elements can be formed in each grain. The resultant structure can be used in a microelectronic mechanical system. Several grains can be formed successively and circuit elements formed in each layer to form a three-dimensional integrated circuit.

Inventors: **Chan; Man-Sun John** (Causeway Bay, HK); **Chan; Philip C. H.** (Kowloon, HK); **Chan; Wing-Chung Victor** (Sham Shui Po, HK)

Assignee: **The Hong Kong University of Science and Technology** (Kowloon, HK)

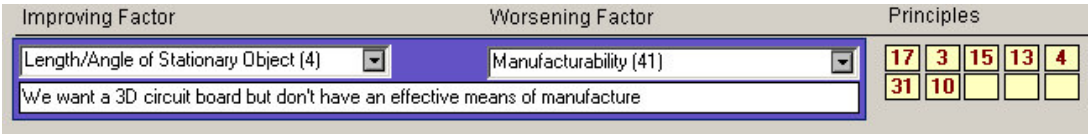
Once located, the patent will quickly reveal the problems that have had to be overcome in order to achieve the desired three-dimensional structures. Again taken from the invention disclosure, we have:-

One of the challenges in developing 3-D technology is to build high quality single crystallised silicon on an insulating material to form the second layer and beyond. Several methods have been reported, such as laser recrystallisation [1], and selective lateral overgrowth epitaxy [2]. However, the methods mentioned are complicated and may cause dislocation defects. Another recent method uses a germanium seed to recrystallize the polysilicon film laterally, but the grain size is limited to few microns [3].

A new recrystallization technique called Metal Induced Lateral Crystallization (MILC) has been proposed [4] to form a high quality silicon film in which thin film transistors (TFT) can be formed. Initially, a 3000 Angstroms layer of oxide is formed on a silicon wafer. 1000 Angstroms of amorphous silicon was deposited at 550.degree. C., followed by 3000 Angstroms of low temperature oxide (LTO). An elongate trench was then opened next to the desired region for crystallisation, and 100 Angstroms of Ni was deposited in a layer covering the surface of the structure and in particular covering the bottom and side walls of the trench. Lateral crystallisation was carried out at 550.degree. C. for 25 hours. It was found that crystallisation of the amorphous silicon proceeded to either side of the trench such that the interface between the crystallised and amorphous silicon gradually moved away from the trench (analogous to a spreading wavefront) at about 2.5 micrometers per hour. The Ni and LTO were then completely removed, and the wafers subsequently annealed at 900.degree. C. for 30 minutes to enlarge the silicon grains. Conventional techniques were then used to form NMOS and PMOS transistors in the grains, and it was found that the grains were large enough that most devices having a 1 micrometer channel length and a channel direction perpendicular to the length direction of the trench, were substantially in a single grain and thus exhibited useful properties. However, devices with a longer channel (e.g. 9 micrometers) could not be formed entirely within a single grain, Furthermore, devices in which the channel length was parallel to the trench length could not be formed entirely within a single grain, even if the channel length was as short as 1 micrometer, since in this direction grain boundaries occurred at random positions.

What the search shows us first of all is that there have been a number of attempts to achieve the 3D manufacture capability – laser re-crystallization, selective lateral overgrowth epitaxy, and MILC. Each of these may be considered to represent entries in a function/effects database.

What the invention disclosure, however, also allows us to do is identify the strategies used by the inventors to overcome limitations in the prior art. In this case, we see the following contradiction being challenged:



This figure illustrates the Inventive Principles recommended by the 2003 version of the Contradiction Matrix. As it happens, several of the Principles recommended by the Matrix turn out to be the same two deployed by the inventors:

"In general terms, the present invention proposes that metal-induced lateral crystallisation is performed while controlling the positions of the grain boundaries normal to the crystallisation direction. By doing this, it can be ensured that the grains are correctly positioned for subsequent formation of electronic devices within them."

Or, more specifically from Claim 1:

A method of forming a semiconductor device, the method comprising:
forming a layer of amorphous semiconductor on a surface,
forming a plurality of metal strips contacting the amorphous semiconductor, and
performing metal induced lateral crystallization of the amorphous semiconductor, the metal induced lateral crystallization including a first annealing phase at a first temperature and for a first time period whereby each metal strip forms a respective semiconductor crystal in a region defined by a side of one of said strips, and a second annealing phase at a second temperature which is higher than the first temperature and for a second time period which is shorter than the first time period, and
fabricating a semiconductor device on a said semiconductor crystal.

The inventors, in other words, have achieved the 3D manufacture capability by using a Preliminary Action in conjunction with a pair of Asymmetries – one relating to temperature and the other to time.

Best of the Month

A chance to combine the best of the month with the biology feature this month. Nature, as we all know is an amazing thing, and has evolved enormous numbers of solutions that we are only just beginning to understand.

One example that perhaps serves us how much further our understanding needs to travel is the Monarch butterfly story described in ‘Four Wings And A Prayer’ by Sue Halpern.

For those that don’t know, the Monarch butterfly is a North American species that occasionally travels the 3500 miles across the US and Atlantic Ocean to Britain. The attraction of Britain appears to be the milkweed plant. Milkweed exists in the UK only as a very rare garden or greenhouse plant and consequently there is very little chance that the Monarch’s could sustainably stay and breed in the country. Influxes of the butterflies to the UK occur only periodically – 1968, 1981, 1991, 1993, 1995 and 1999 were the most recent migrations.

As if the mystery of why the butterflies do what they do (they also, incidentally a much shorter migration – only 1400 miles this time – south to Mexico) wasn’t big enough, the real interest of our best of the month recommendation concerns the fact that several generations of the butterfly take place between migration cycles. Hence, how is it possible for the new butterflies to ‘know’ the route that only their ancestors had traveled? Even more confusing is that different generations may only make a small part of the complete migratory route, and no one butterfly has ever flown the complete trajectory.

Anyway, a great read, and one that we recommend highly.

Investments – Towards The Ideal Stent

With several hundred patents present in the US database alone, the world of stents is big business. For those that don't know, a stent is a simple medical device used in angioplasty operations as a means of unblocking blocked or contracted veins or arteries. A typical stent is illustrated in Figure 1.

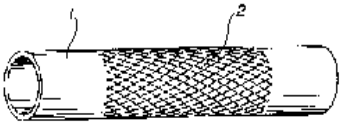


Figure 1: Typical Early Generation Stent

Some readers may be familiar with the stent story we sometimes use during our technical workshops. In that story we compare the evolution of the stent with some of the TRIZ trends of evolution. The one we usually start with is the dynamization trend. As illustrated in Figure 2, the latest generation stents have done a good job of progressing along the trend from the initial 'immobile' stage (the Figure 1 design) through to the 'completely flexible' design shown at the bottom of Figure 2.

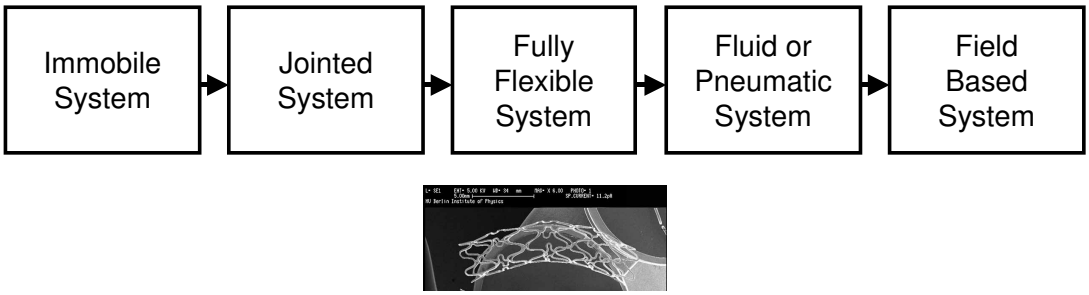


Figure 2: Current Stent Position On The Dynamization Trend

The trend, of course, shows that the stent is still not at the end of the trend. It still has 'untapped evolution potential' in other words. As it happens, like in many other sectors, the transition from the flexible stage to the next fluid, pneumatic or field stages can be a quite difficult technologically speaking as it means moving away from a mechanical solution.

Since stents are big business, it tends to be a market sector we watch quite closely. We are particularly interested if we see the story making progress along the Dynamization trend. That now seems to have happened.

The roots of the new capability lie in a medical mystery that surfaced nearly 30 years ago in a small town in northern Italy. By rights, the inhabitants of the town had a fairly unhealthy life-style (lots of smokers, high cholesterol, high fat diet) and statistically speaking there should have been a fair number of heart attacks. The actuality was somewhat different, however, and when analyses were conducted it was found that the arteries of the population were clear, with no sign of deposits or blockages anywhere. It was almost as if something had been sweeping away any deposits before they had a chance to stick to the artery walls. The magic ingredient turned out to be a protein produced by a mutation in one of the genes that make HDL cholesterol that had emerged from one man born in the town about 200 years ago.

During trials at Cedars-Sinai Medical Centre in Los Angeles last year, doctors were able to demonstrate that the protein had been successful in reducing the deposit build-up in a number of test patients.

The company responsible for the discovery and initial development of the protein is Esperion Therapeutics. Pharmaceutical giant Pfizer recently bid over a billion US dollars to buy the company. Probably too late to buy shares in Esperion, but expect this innovation to have a significant impact on Pfizer and the stent business in general in the coming months and next couple of years.