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In this month's issue:

Article – 36 Stratagems Of Ancient China And TRIZ

Article – Frames Of Reference - TRIZ, A Theory Of Everything And Edward DeBono

Humour – Portuguese Banking

Patent of the Month – Capillary Evaporator

Best of The Month – Lynn Margulis – Acquiring Genomes

Conference Report – IMechE Un-Manned Aircraft Conference

Investments – Materials Modification Inc.

Biology – Thorny Devil Lizard

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Readers' comments and inputs are always welcome.
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36 Stratagems Of Ancient China And TRIZ
(Alternative Conflict Resolution Strategies)

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無中生有　暗渡陳倉　隔岸觀火　笑里藏刀　李代桃僵　順手牽羊
打草驚蛇　借屍還魂　調虎離山　欲擒故縱　拋磚引玉　擒賊擒王
釜底抽薪　混水摸魚　金蟬脫殼　關門捉賊　遠交近攻　假道伐虢
偷梁換柱　指桑罵槐　假痴不癲　上屋抽梯　樹上開花　反客爲主
美人計　　空城計　　反間計　　苦肉計　　連環計　　走爲上

The idea of contradiction elimination is central to the TRIZ philosophy. Most typically in the TRIZ context, the aim of resolving a contradiction – particularly in the business and management context – is to achieve a so-called 'win-win' outcome. The 40 Inventive Principles represent the signposts by which such solutions are achieved.

A different kind of contradiction situation occurs when there are two armies at war with each other. How to handle this kind of conflict has been the subject of several books in recent years relating to ancient Chinese warrior Sun Tzu, and his stratagems for successfully winning such conflicts. Generally speaking Sun Tzu's stratagems have been re-framed from the military to the business context. In most of these books, 36 such stratagems are described. References 1 and 2 are two of the ones we prefer. A cursory examination of the strategies reveals that, while they are not wholly consistent with the achievement of 'win-win', what is clear is that they all have something to do with jumping out of the current paradigm and into a surprising or unexpected new one.

The aim of this article is to examine each of the 36 strategies in a little more detail in order to establish any relationship with the 40 Inventive Principles. We begin that analysis by constructing a simple table, based on the stratagem sequence used in Reference 1:

Strategy	Title	Description/Example	Equivalent TRIZ Principle(s)
1	Fool The Emperor To Cross The Sea	A wary opponent is unlikely to fall into usual traps so he must be made to relax – therefore carry on as though nothing is afoot. Also – once an opponent is acclimatized to prolonged repetition of an action, they become acclimatized and no longer take notice of them; when this occurs, the opportunity to catch the opponent by surprise presents itself	9 20, 9
2	Besiege Wei To Rescue Zhao	When the enemy is too strong to attack directly, attack something he holds dear. Know that he cannot be superior in all things, that somewhere there is a gap in the armour, a weakness that can be attacked instead.	1A/3[*]
3	Kill With A Borrowed Sword	When you do not have the means to attack your enemy directly, then attack using the strength of another. Trick an ally into attacking him, bribe an official to turn traitor, or use the enemy's own strength against him.	24, 25
4	Await The Exhausted Enemy At Your	It is an advantage to choose the time and place for battle - in this way you know when and where the battle will take place, while your enemy does not. Encourage your enemy to expend his energy in futile quests while	10, 22B

	Ease	your enemy to expend his energy in futile quests while you conserve your strength. When he is exhausted and confused, you attack with energy and purpose; whoever is first in the field and awaits the enemy will be fresh	
5	Loot A Burning House	When an enemy is beset by internal conflicts, when disease and famine ravage the population, when corruption and crime are rampant, then he will be unable to deal with an outside threat. This is the time to attack	12/13*
6	Clamour In The East, Attack In The West	An enemy will re-inforce in places where he expects an attack to take place; in so doing a part of his army is neutralized if you then choose to attack in an unexpected place	3
7	Create Something From Nothing	Use the same feint twice. Having reacted to the first and often the second feint as well, the enemy will be hesitant to react to a third feint. Therefore the third feint is the actual attack catching your enemy with his guard down	19, 13A
8	Openly Repair The Walkway, Secretly March To Chencang	Against a seasoned and wary opponent a feint will prove ineffective. Instead make a direct attack in an expected direction and manner to gain attention. When the enemy forces are focused on this attack, begin a second attack from a different and unexpected direction	1
9	Observe The Fire On The Opposite Shore	Delay entering the field of battle until all the other players have become exhausted fighting amongst themselves. Then go in full strength and pick up the pieces	10, 39
10	Hide Your Dagger Behind A Smile	Hide sinister intentions behind a façade of friendship and loyalty	35/13*
11	Sacrifice The Plum Tree In Place Of The Peach	There are circumstances in which you must sacrifice short-term objectives in order to gain the long-term goal. This is the scapegoat strategy whereby someone else suffers the consequences so that the rest do not	2, 34, 16
12	Seize The Opportunity To Lead A Sheep Away	While carrying out your plans be flexible enough to take advantage of any opportunity that presents itself, however small, and avail yourself of any profit, however slight; adapt plans to suit prevailing circumstances	15
13	Beat The Grass To Startle The Snake	When you cannot detect the plans of an opponent, launch a direct but brief attack in order to observe their reactions	10, 26
14	Borrow A Corpse To Raise The Spirit	Symbols, myths, institutions and philosophies have moral and emotional power; appropriate this power to achieve your higher strategic goals and objectives. Take an institution or technology that has been forgotten or discarded and appropriate it for your own purpose.	38 25B
15	Lure The Tiger Down The Mountain	Never directly attack a well entrenched opponent, instead lure him away from his stronghold, separating him from his sources of strength	13, 2
16	To Catch Something, First Let It Go	Do not obstruct an army retreating home; if you besiege an army, you must leave an outlet; do not press an exhausted invader; do not corner an opponent as their only option is to fight for their lives	31
17	Toss Out A Brick To Attract	Prepare a trap then lure the enemy into it using bait – e.g. using an illusion of opportunity for gain, wealth,	

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	Brick To Attract Jade	power, sex	7/26[*]
18	To Catch The Bandits, First Capture Their Leader	If people are allied to their leader only by money or threats, aim at the leader. If he falls the people will disperse (if they are allied they will fight for vengeance). To kill a poisonous snake, you must cut off the head	2
19	Steal The Firewood From Under The Pot	When faced with an enemy too powerful to engage directly, first weaken him by attacking vulnerable areas, undermining his foundations, or attacking his sources of power	3
20	Trouble The Water To Catch The Fish	Before engaging an enemy, create confusion to weaken perceptions and judgment; do something strange or unusual to disrupt normal thinking patterns	35, 37, 17
21	Shed Your Skin Like The Golden Cicada	When in danger of defeat and your only chance is to escape, create an illusion. When retreating, leave something behind that will divert or slow the progress of the enemy	26 1
22	Shut The Door To Catch The Thief	If you have the chance to completely defeat or capture an enemy, then do so. To allow an enemy to escape plants the seeds for future revenge	20
23	Befriend A Distant Enemy To Attract One Nearby	To attack any objective, enlist the aid of those that are antithetical to your opponent (when you are the strongest in your field, your greatest threat comes from the second strongest; not the strongest in another field)	5/17[*], 24B
24	Borrow The Road To Conquer Guo	Borrow the resources of an ally to attack a common enemy. Once the enemy is defeated, turn on the now weakened ally and defeat them too (as they may consider doing the same to you)	5, 34, 27
25	Replace The Beams With Rotten Timbers	Disrupt the enemy's normal methods of operation, change the rules and habits they are used to following, thus taking away physical and moral foundations	35
26	Point At The Mulberry But Curse The Locust Tree	Point at one to scold another - criticize an enemy indirectly (using analogy and innuendo), getting your point across without direct confrontation	24/26[*]
27	Feign Madness, But Keep Your Balance	Hide behind the mask of a fool, drunk or madman in order to create confusion about your intensions, luring your enemy to drop his guard and thus making him easier to attack	9, 35
28	Lure Your Enemy Onto The Roof, Then Take Away The Ladder	Using baits and deception, lure your enemy into treacherous terrain, then cut off his lines of communication and avenue of escape	17, 13
29	Tie Silk Blossoms To The Dead Tree	Through artifice and disguise, make something of no value appear valuable; make something dangerous appear safe; make something useful appear useless	13, 27
30	Exchange The Role Of The Guest For That Of Host	When the enemy is strong, deflect him from within under the guise of co-operation, surrender or a peace treaty, then strike when their guard is relaxed	39, 9
31	The Strategy Of Beautiful	Beautiful women arouse intense feelings in those around them – lust, envy, jealousy, envy, etc – thus	38, 4, 12/13[*]

	Women	creating an atmosphere of irrationality and confusion that can be exploited to achieve victory	
32	The Strategy Of Open City Gates	In a desperate situation, often the only recourse is to do something completely unexpected; e.g. act casually in the face of an enemy that knows they are in a dominant position	13
33	The Strategy Of Sowing Discord	Disrupting the environment of the enemy will disrupt his harmony thus interfering with the ability to make a coherent attack or defence	38, 35
34	The Strategy Of Injuring Yourself	Feigning injury means you are perceived as less of a threat, and so your enemy relaxes his guard. Or; ingratiate yourself with your enemy by attributing a feigned injury to a mutual enemy	25, 13, 8
35	The Strategy Of Combining Tactics	Launch multiple, simultaneous attacks; Plant a succession of traps so that if one doesn't work there are still others for the enemy to fall into; Do not repeat past tactics	1, 35, 15
36	If All Else Fails, Retreat	If all else is lost, escape – unlike surrender or compromise, escape is not defeat	11, 13

*: Inventive Principles described as A/B denote that those Principles are used in combination – e.g. 12/13 means 'Reduce Tension' and 'The Other Way Around' – i.e. 'Increase Tension'

Broadly speaking the 36 Stratagems may be seen to fall into six loose categories:

> 1-6 - Stratagems when in a Superior Position
> 7-12 - Stratagems for Confrontation
> 13-18 - Stratagems for Attack
> 19-24 - Stratagems for Confused Situations
> 25-30 - Stratagems for Gaining Ground
> 31-36 - Stratagems for Desperate Situations

As may be seen in the right hand column of the Table, for each of the categories and each stratagem, it is possible to make a correlation with the Inventive Principles. There is nothing, in other words, in the 36 Stratagems that adds anything new to the 40 Principles framework.

A closer analysis of the Stratagem/Principle correlation reveals that 30 of the 40 Principles are featured somewhere amongst the 36 Stratagems. Principle 13, The Other Way Around, appears the most frequently, with Principles 35, 1, 9 and 26 also appearing at least four times. There is no reason to surmise that the other 10 Principles could not also be used in the Sun Tzu context.

The high degree of correlation between Principles and Stratagems should not be too great a surprise since the most fundamental of Sun Tzu's principles for the conduct of war is that 'all warfare is based on deception'. We wish, in other words, to imply to an enemy that we are going to do one thing, only to then go and do something different. This works in a manner similar to the way that humour works – we send the recipient of a joke in one direction and then reveal a punch-line that has traveled in a different, unexpected, direction. In humour too we see the presence of the Inventive Principles.

Another key Sun Tzu principle is that 'the supreme art of war is to subdue the enemy without fighting'. What the 36 Stratagems tell us that there are distinct ways to solve this contradiction. What the 40 Principles are perhaps telling us that there are a number of additional strategies that were not thought about or visible in 500BC. Perhaps, too, this means that there are means of countering an opponent attempting to use the 36

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Stratagems against you or against your business. The only sure thing is that solving one contradiction will sooner or later reveal the existence of another, and the war will go on.

References

1) Verstappen, S.H., 'The Thirty-Six Strategies Of Ancient China', China Books & Periodicals Inc, San Francisco, 1999.
2) McNeilly, M., 'Sun Tzu And The Art Of Business', Oxford University Press, 1996.

Frames Of Reference
TRIZ, A Theory Of Everything And Edward DeBono

There are many ways to slice a cake. Several research teams have sought to find meaningful ways of dividing a cake called 'the world' into manageable portions. In TRIZ, the most familiar whole-world slicing tool comes via the 9-Windows. As illustrated in Figure 1, the 9-windows present a simple means of dividing space and time dimensions into regions that help problem solvers think holistically about the situations they are trying to innovate.
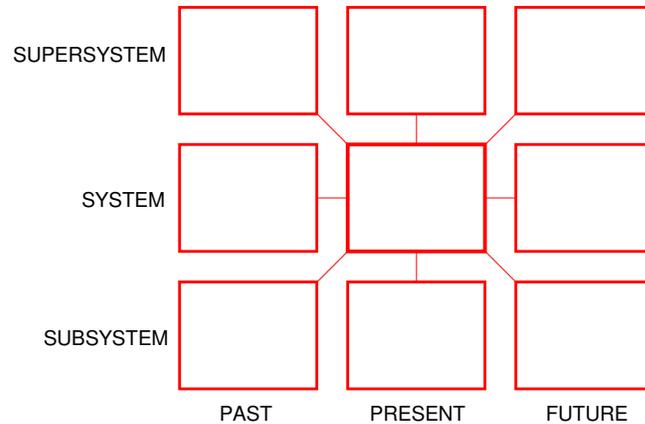

Figure 1: TRIZ 'Nine Windows' Tool

More recently, in work to explore commonalities between TRIZ and Neuro-Linguistic Programming (NLP), the 9-Windows concept has been expanded into a third dimension. This third dimension may be seen to represent different mental perspectives. As shown in Figure 2, NLP divides this third dimension into 5 different levels. The details of each of these levels need not worry us unduly for the purposes of this article. Needless to say, for most practical problem solving purposes it is often a major advance if we can simply recognize the existence of the lowest two levels – the physical (i.e. the actual world), and the behavioural (i.e. our individual perception of that actual world).
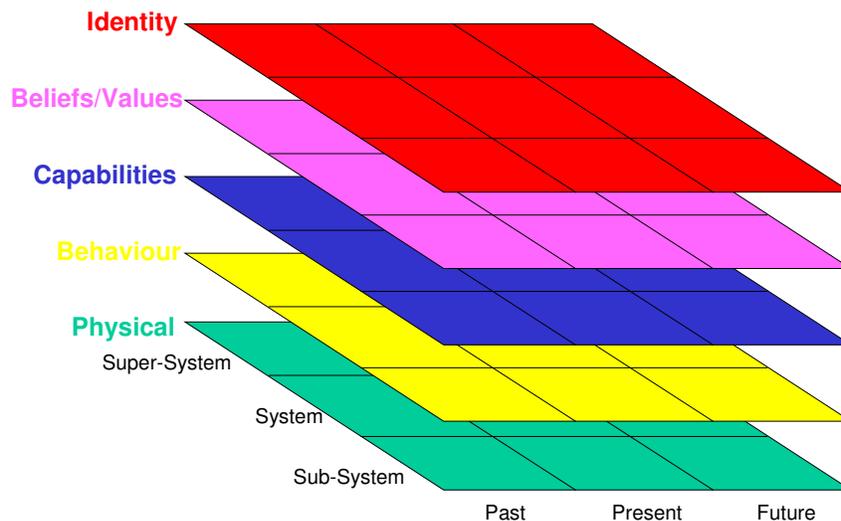

Figure 2: TRIZ 'Nine Windows' Plus Third Dimension Defined By NLP

For the purposes of the discussion here, we need note only that this third dimension seeks to recognize that a truly over-arching model of the world needs to account not just for space and time dimensions, but also a perceptual one.

Approaching the holism subject from a completely different angle has been philosopher Ken Wilber. Wilber's book 'A Theory Of Everything' also seeks to assemble a complete map of the world. Figure 3 represents a simplified version of Wilber's published perspective. What this figure shows is the 'total solution space' segmented into four quadrants, the horizontal axis of which represents the distinction between interior (I, We) and exterior (It, Its) perspectives. The vertical axis then further segments this pair into singular (I, It) and collective (We, Its) elements.
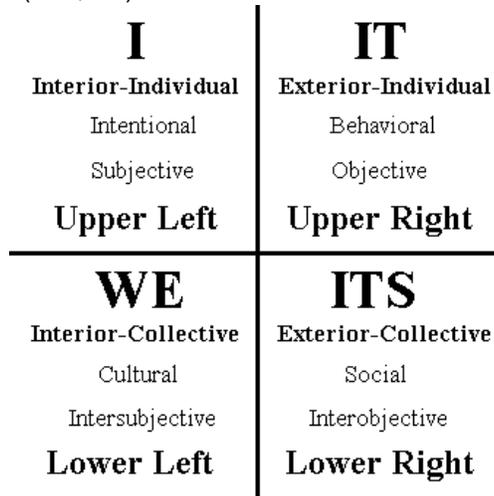
I	IT
Interior-Individual	Exterior-Individual
Intentional	Behavioral
Subjective	Objective
Upper Left	**Upper Right**
WE	**ITS**
Interior-Collective	Exterior-Collective
Cultural	Social
Intersubjective	Interobjective
Lower Left	**Lower Right**

Figure 3: Ken Wilber 'Theory Of Everything' Four-Quadrant World View.

Again we need not delve too far into this world-view to recognize that it has segmented things in a manner considerably different to that of either TRIZ or NLP. Things begin to converge a little when we see time added as a third dimension to this four-quadrant model – Figure 4.
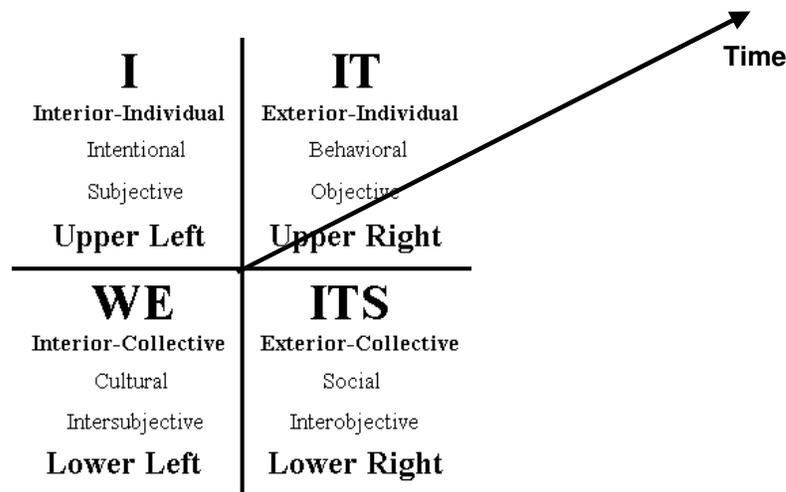
I	IT	**Time**
Interior-Individual	Exterior-Individual	
Intentional	Behavioral	
Subjective	Objective	
Upper Left	**Upper Right**	
WE	**ITS**	
Interior-Collective	Exterior-Collective	
Cultural	Social	
Intersubjective	Interobjective	
Lower Left	**Lower Right**	

Figure 4: Ken Wilber 'Theory Of Everything' 3D World View.

Things get a little bit more complicated though when Wilber then starts to add his equivalent of the NLP physical-behavioural-capability-belief-identity axis. With Wilber we

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see this dimension coupled to the time dimension. The idea behind doing this is to plant the idea that as an individual human grows up (i.e. as time passes), their mental development passes through a number of different states. We can see how Wilber segments these different states (a good way to think about each is as a different s-curve – more on this topic in a future issue) in the top-left quadrant in Figure 5.
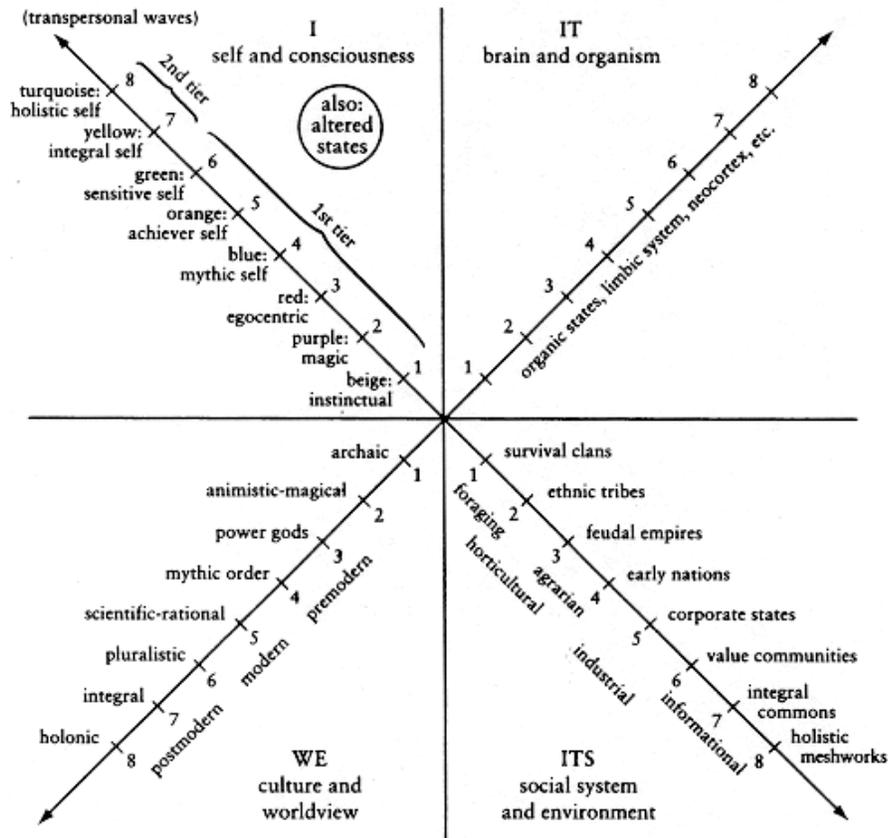

Figure 5: Ken Wilber 'Theory Of Everything' World View Including Time/Development Elements

There is far too much going on in this model to even attempt to do it justice here. Interested readers are invited to take a look at Reference 1 – incidentally a past 'best of the month' recommendation.

What does concern us here, however, is how we might begin to see how Wilber's world-view and the TRIZ/NLP world-view can look so apparently different and yet both represent a valid and whole model of the world. A good clue to see how the two might actually be fully consistent with one another comes when we try and plot some of the pictures on top of each other.

The first thing to do if we are to achieve a valid overlay of one plot onto another is to swap the rows and columns of Wilber's four-quadrant model. Once we have done that, we might observe that there is some kind of correlation between the singular and collective and the 9-Windows idea of system hierarchy. Having spotted this, we might then overlay the four quadrants onto the 9-Windows as shown in Figure 6.

The primary importance of this overlay is that it suggests the 'internal' and 'external' distinction identified by Wilber element is missing from the 9-Windows model. By itself, this is – we think – a useful addition for those people familiar with the 9-Windows model –

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forcing us to think not just about the subsystem-system-supersystem hierarchy but the differences between the subjective and the objective, the cultural and the social at each point.

Also worth noting is Wilber's belief that all four quadrants need to be considered in any given problem situation. The presence of all four in the 'System, Present' box in the 9-Windows should serve to confirm this intended interpretation.
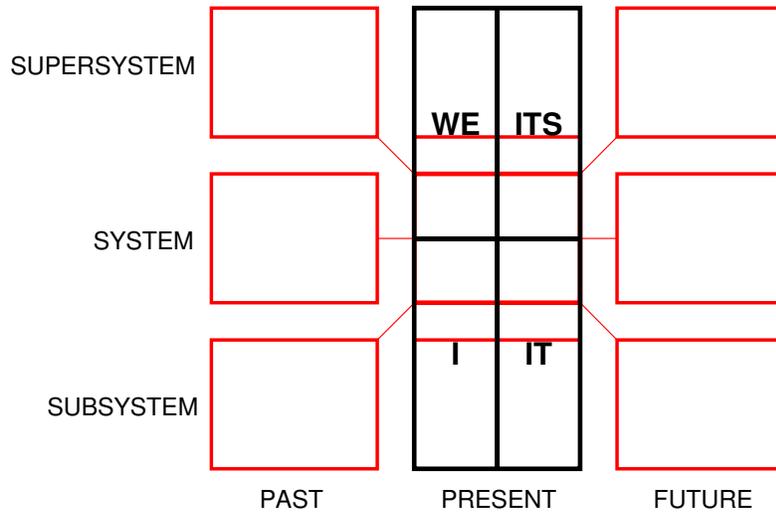

Figure 6: 9-Windows Plus Wilber Four-Quadrant Model

Add the time dimension to this model and hopefully we can see the four-quadrant overlay repeated in the 'past' and 'future' 9-Window columns – Figure 7. The figure is complicated this time by the fact that TRIZ/NLP de-couples time and mental-state dimensions, while Wilber sees them as inherently coupled. This coupled-versus-uncoupled discrepancy should also give us pause for thought when we come to think about practical applications of either or both models.
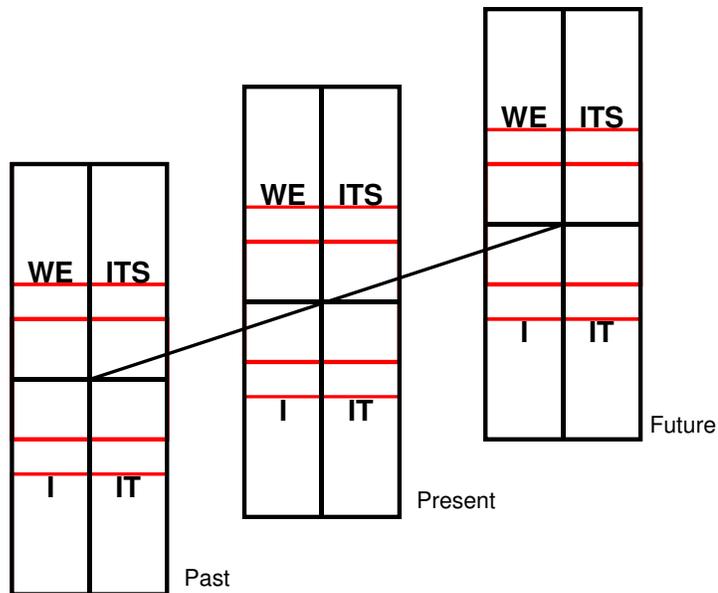

Figure 7: 9-Windows Plus Wilber Four-Quadrant Model With Time Dimension

This model now gets us far closer to one that we might consider a truly holistic framework. It is not quite at the end, however, as we started to see in last month's review of Edward DeBono's latest book (Reference 2). The DeBono view of the world is totally consistent with the I/IT/WE/ITS four-quadrant model of Wilber, it is also consistent with the mental-state dimension (albeit only thinking about it in two-levels as opposed to the five within NLP or the 8 within Wilber's world). But then DeBono also goes on to suggest that this world-view cannot be complete if it does not include consideration of movement. The Figure 7 model, in other words, ought not be considered as a pattern of static boxes, but one where we also need to consider how the process of *movement* from one box to another also influences our understanding of a situation and how we then seek to respond.

So now we not only have a static time-space-perspective framework (with time and perspective dimensions coupled in Wilber's model and un-coupled in the TRIZ/NLP world), but a way of using it that incorporates the effect of movement and movement vectors from one part of the frame to another.

Now we are closer still to a truly holistic model. We are certainly close enough from the perspective of this article. In a future article, we will take the story to what may well be its final stage, when we take into account what quantum physics has to say on the holism subject.

References

1) Wilber, K., 'A Theory Of Everything', Gateway, 2001.
2) DeBono, E., 'The Six Value Medals', Vermilion, 2005.

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Humour – Portuguese Banking

Not our picture – it actually comes from a website focusing on 'bad design' – but an interesting example of Principle 10B nonetheless. 'Pre-arrange objects or systems such that they can come into action at the most convenient time and place'. I guess things work a little differently in Portugal.

Patent of the Month

Patent of the month this month is focused on thermal management in electronic devices. It is anticipated that thermal management of future high-power laser instrumentation, next- and future-generation microprocessor chips, and other electronics, will require power dissipation in the range of 2-5 kW at heat fluxes greater than 100 W/cm^2. The ITANIUM.RTM. microprocessor from Intel Corporation, for example, is already reaching local heat fluxes of about 300 W/cm^2. In contrast, most conventional evaporators do not work at heat-fluxes in excess of about 12 W/cm^2. Although some more recent evaporator designs, such as the bi-dispersed wick design, have demonstrated good performance at localized heat fluxes of 100 W/cm^2, there is, and will continue to be, a need for evaporators capable of routinely handling average heat fluxes of 100 W/cm^2 and greater.

US Patent 6,863,117, 'Capillary Evaporator' is aimed at achieving cooling performance levels up to 1000 W/cm^2 – a non-linear increase in performance approaching 10 times the previous state of the art. The patent was granted to Mikros Manufacturing Inc, on 8 March.

As may be seen from the figure below, the essence of the patent essentially involves increasing heat transfer surface area in the evaporator, and the creation of 'thermal bridges'. Specific mention is made of 'fractal' layers. The term "fractal" is a term of convenience used by the inventors to indicate that the various layers of bridge have an internal structure generally defined by openings configured and arranged so as to provide the bridge with the ability to spread heat from ribs as evenly as practicable over outer surface of a capillary wick, while also providing the bridge with a high permeability to vapor. This conflict between heat transfer capability and permeability is challenged by using a plurality of layers each having openings of differing sizes, with the layers closer to the ribs having larger and fewer openings and the layers more closer to the outer surface of the capillary wick having smaller and more openings.
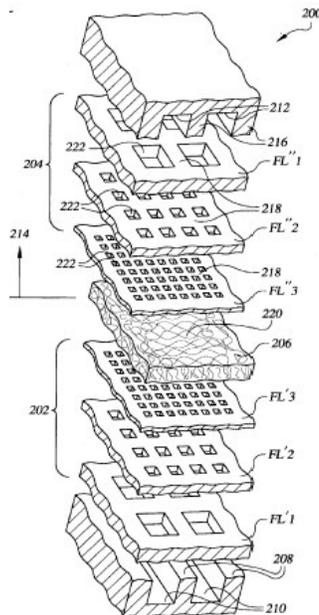
In addition to demonstrating the use of surfaces as an evolution resource, an important aspect of the invention in this case is the parallel use of asymmetry. It is not just a case of increasing surface area, but increasing it in a way that takes best advantage of the prevailing external asymmetries.

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We can observe the new Contradiction Matrix pointing us towards both directions if we examine the heat-transfer versus permeability conflict:

Improving Factor	Worsening Factor	Principles
Temperature (22)	Function Efficiency (24)	3 24 10 15 19
we want high heat transfer and good permeability		13 4

Principle 3, Local Quality, being, of course, the Principle pointing us towards increasingly smaller size-scales. It would be interesting to speculate on how some of the Principles mentioned in the Matrix but not deployed by the inventors might be used to further enhance the cooling performance achieved by the capillary evaporator.

Best of the Month – Acquiring Genomes

Recommendation this month is 'Acquiring Genomes' by Lynn Margulis and Dorion Sagan. The book serves as an excellent follow-on to 'Microcosmos'. Microcosmos is a classic pop-science work in which Margulis hypothesizes a model of global evolution from the time when the Earth was first formed to the present day. Somewhat controversially in that book, Margulis suggested that that the neo-Darwinists were wrong to suggest that random mutation was the primary mechanism by which species evolve. Instead, she speculated, the primary means of speciation were gene-trading in bacteria (the primary occupants of the microcosmos) and the permanent merging of different species. Margulis does not discount the possibility of random mutation as a speciation mechanism, but suggests that it plays only a minor role.
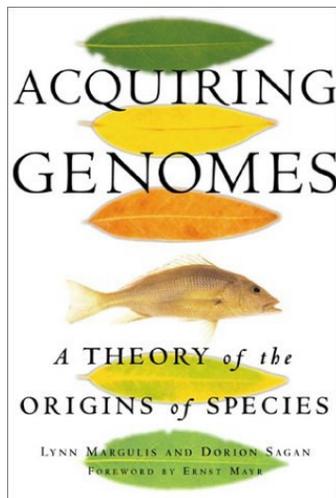
Acquiring genomes devotes much of its content to the second of the speciation mechanisms identified by Margulis; that of permanent merging of different species, or the term used in the book, 'symbio-genesis'. The book presents a compelling case for this mechanism, citing many examples – both historic and present day (e.g. lichens) – to illustrate the concept of a symbiotic relationship between different organisms turning into a permanent one.

The primary relevance for TRIZ aficionados is, of course, the direct connection between symbio-genesis and the Mono-Bi-Poly(Various) trend. In the same way that symbio-genesis has been a vital source of discontinuous evolutionary jumps in nature, we can observe the same effect in both technology (witness the fact that there are more digital cameras now sold as integral features of mobile phones than stand-alone cameras), and business. The trend is a particularly relevant one in the business context at the moment following the emergence of 'complementors' as an important part of the value chain.

Whether or not you believe Margulis' hypothesis, 'Acquiring Genomes' is a highly readable book that we believe will add much to the reader's understanding of the mechanics of system evolution. Well worth a few hours of your time.

**Conference – IMechE Un-Manned Aircraft Conference,
14 April, Bristol, UK**

In 1995, when I was responsible for a possible future un-manned aircraft propulsion project at Rolls-Royce, the reaction by the potential users was something along the line that 'these new-fangled things' were mere toys that would never see a real application. So much for the TRIZ 'Decreasing Human Involvement' trend. What seemed bizarre to me at the time was that when many of the major contradictions present in aircraft systems centred around the need to make an inhospitable environment (cold, no-oxygen, high g-forces, potential missile threats, etc) habitable by a human. Take away the human and you save yourself an awful lot of design headaches. And cost.

So here we were ten years later, in a world inhabited by a growing host of unmanned aircraft, each capable of achieving a wide variety of roles from reconnaissance to combat, at a conference specifically discussing propulsion systems for unmanned aircraft. Call it a busman's holiday.

The conference featured a group of 8 papers, spanning a range of propulsion topics from gas-turbines to devices capable of propelling micro-sized vehicles operating in the low Reynolds number arena populated by birds and, particularly, insects. All of the innovation, disappointingly, appeared to be happening at the small-scale end of the spectrum. The visit to the conference was probably justified by the presentation on micro-propulsion systems given by the University of Bath. The description of the piezo-electric-vibrating (rhythm co-ordination), flexible (dynamization) hollow wing (space segmentation) capable of creating a jet propulsion means without the existence of an actual jet (!) represents both a triumph of ingenuity and high state of evolution along the known TRIZ trends.

Innovations was barely visible, however, at the other end of the size spectrum. One of the main driving requirements of an un-manned aircraft at present is cost. The desirable cost of a propulsion system is about an order of magnitude lower than that currently possible using today's gas-turbine technology. Whether or not you have any interest in gas-turbines and unmanned aircraft, as a general rule, if you are looking for an order of magnitude improvement in something, it is highly unlikely that the answer you are looking for will come through optimizing what you have already got. Especially when whatever you've already got is already mature. This message didn't seem to have occurred to any of the presenters – who, one after the other, trotted out a sequence of papers showing what happens when the dominant design style is trade-off and compromise. Rolls-Royce, for example, started from a fairly standard low-cost engine and showed that if the engine compromised on durability, efficiency and every other important design parameter, you could achieve an engine that was 28% cheaper than the one you started with. Big deal.

Another paper tried to sell the benefits of mixed flow compressors over the more common axial and centrifugal designs. This story is an almost textbook example of trade-off thinking: Axial compressors have a small diameter (important if you want to achieve a small engine), but are not capable of achieving a very high-pressure rise (important if you want high efficiency). Centrifugal compressors, on the other hand, can deliver a very high-pressure ratio, but can only do so by having a high diameter. Any guesses what the mixed flow compressor does? Find a midway point of average diameter and average pressure ratio perhaps? You got it.

Here we see yet another example of the 'optimum' solution as the enemy of the ideal solution. Step change specification requirements need step-change thinking. Without at
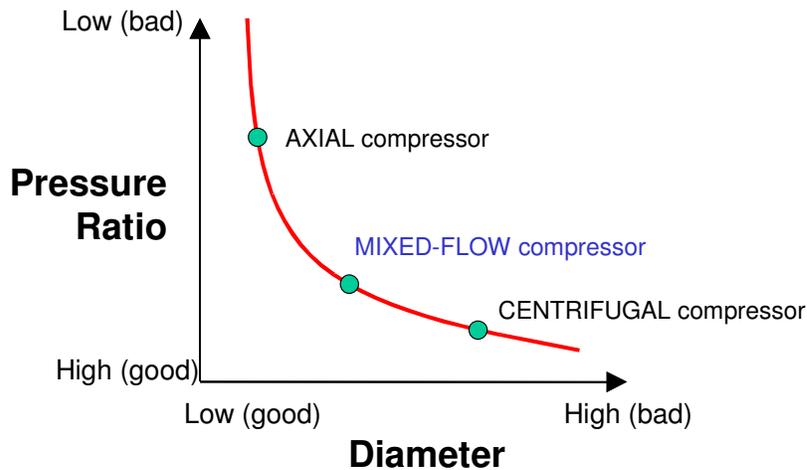
least some kind of jump along one of the TRIZ trends, the 10x cheaper propulsion system will remain no more than an empty wish.

Exactly the same problem occurs in a later paper. Only this time the efficiency versus diameter trade-off centers around another engine variable – by-pass ratio. The details of what by-pass ratio is need not be of concern to anyone outside the gas-turbine industry. Needless to say, the general message here is that whenever we find ourselves in a situation where we want something to be both high and low, big or small, then chances are the real problem has nothing to do with whatever that something might be. The solution to the efficiency versus diameter debate, in other words, will ultimately be seen to have nothing to do with by-pass ratio.

The only real glimmer of hope (albeit a very loud one at the moment – the engine purportedly generates 150dB) was a paper on the pulse-detonation engine. At least here we have a concept that has made such a jump along one of the trends (rhythm co-ordination – from 'continuous' (i.e. gas-turbine) to 'pulsed'). It may not be the right one, of course, but at least this paper was showing us a way of getting out of the twilight maturity of the box called 'gas-turbine.

Investments – Materials Modification Inc.

Materials Modification Inc (MMI) is a US-based company specializing – as the name perhaps suggests – in the manipulation and formation of materials. The company was founded in 1986 and has been involved in cutting-edge research projects for federal agencies and private industry. Thanks to their diverse group of scientists and engineers, the company has developed several novel materials and processes. This interdisciplinary approach has helped MMI perform research in difficult areas, where traditional approaches have been unsuccessful. MMI is a pioneer in the field of nano-materials and coatings technology. Visit the company website at
http://www.matmod.com/ProdandServ.html to see some of the diverse applications on that the company offers.

It is difficult to select any one of the various offerings on show, but we were initially drawn to the website after searching for means of creating nano-precision surface profiles. The following picture illustrates the capability of the centrifugal float polishing process developed by the engineers at the company:

3D Profile and Line Plot of Hot Pressed SiC <u>before</u> *Centrifugal Float Polishing*
Surface roughness (R_a) is 90.74 nm.
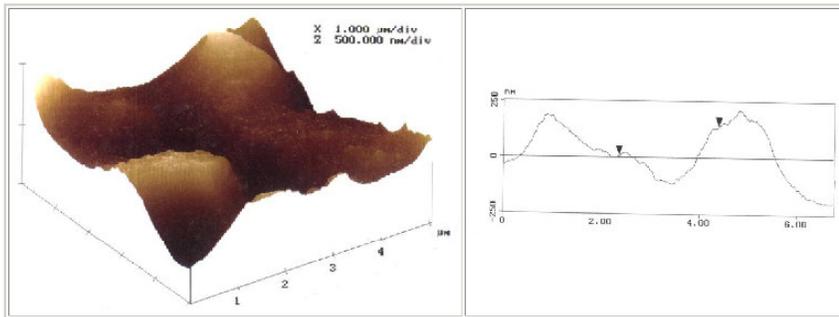
3D Profile and Line Plot of Hot Pressed SiC <u>after</u> *Centrifugal Float Polishing*
Surface roughness (R_a) is 2.29 nm.
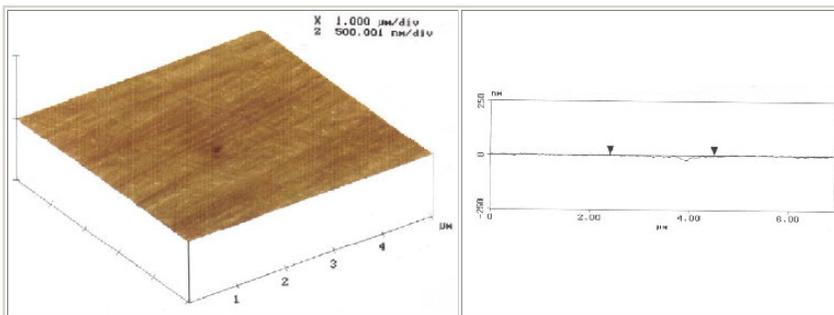
One of the nice thing about being in the materials and material-surface business is that a) just about everything around us contains materials, and b) on every one of those things, it is the surfaces that ultimately come to determine how that system behaves.

SYSTEM·ATIC·INNOVAT·ION

Biology – Thorny Devil Lizard

The thorny devil lizard (*Moloch horridus*) lives in harsh desert environments, where water is a precious commodity and predators are many. The lizard has evolved a highly unusual way of collecting water: Deserts become very cold at night and when dew forms on the lizard's skin, thousands of tiny hygroscopic grooves allow the dew to spread quickly over the lizard's body. Many of these capillary channels are oriented in such a way that any moisture finds its way to the lizard's mouth. A gulping oral mechanism then serves to accentuate the effect. The capillary effect is effective enough that if a Thorny Devil Lizard steps in a puddle, water will find its way to the mouth without the lizard having to take its attention away from its environment and potential predators.

This elegant little creature offers yet another example of the importance of surfaces as a resource, and in particular the additional functions offered by evolution from smooth to roughened textures.

Find out more about the Thorny Devil Lizard at Dr. Eric Pianka's "Moloch horridus" (On-line) digital morphology website: http://digimorph.org/specimens/Moloch_horridus/whole/

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