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.

Our guarantee to the subscriber is that the material featured in the e-zine will not be published elsewhere for a period of at least 6 months after a new issue is released.

Readers' comments and inputs are always welcome.
Send them to **darrell.mann@systematic-innovation.com**

Case Study: EpiPens & Natasha's Law

This is a photo of Natasha Ednan-Leparouse, recently boarded on a plane from Heathrow to Nice in the South of France. Approximately two hours after this photo was taken, Natasha was tragically pronounced dead. She suffered from extreme food allergies and had unwittingly, just before boarding her plane, eaten a sandwich that contained sesame seeds. As an allergy sufferer, Natasha had two EpiPens with her. Both were injected into her, but neither worked.

The first story here is how come neither EpiPen worked. The simple answer to that question is that the design of EpiPens is not fit for purpose. The world now knows that in a typical year, EpiPens fail over 200 times, will result in over 35 hospitalizations and around seven deaths. The inquest following Natasha' tragic death concluded that the EpiPen design was 'inherently unsafe'.

The medical devices industry is understandably a conservative one. What this means in practice is that they are very slow to learn from experience. Clinical trials and 'clinical evidence' are what determines the rate of change. The industry also tends to be very insular. Whenever we have attempted to discuss TRIZ and particularly the Trends of Evolution aspects of TRIZ with engineers and scientists within the industry, the overwhelming reaction has been one of 'this does not apply to us'. Which is in effect a catastrophic illustration of what a sham 'clinical evidence' actually is. The TRIZ trends are built on literally millions of pieces of objective evidence. Their job is to point users in the right direction when it comes to designing better products. Of course, having given the design direction there still comes the job of adequately testing the specific design solution in order to achieve the relevant regulatory approvals. I get that part. But thinking forward to that part of the process should not be an excuse for not making use of the Trend knowledge during the design process.

The Resilient Design trend, for example, (Figure 1) plots a very clear trajectory for designers looking to create products and services that are safer and more reliable. We have enough data now to also be able to connect each Trend stage to the level of reliability they will enable, when measured in terms of the number of 'nines':

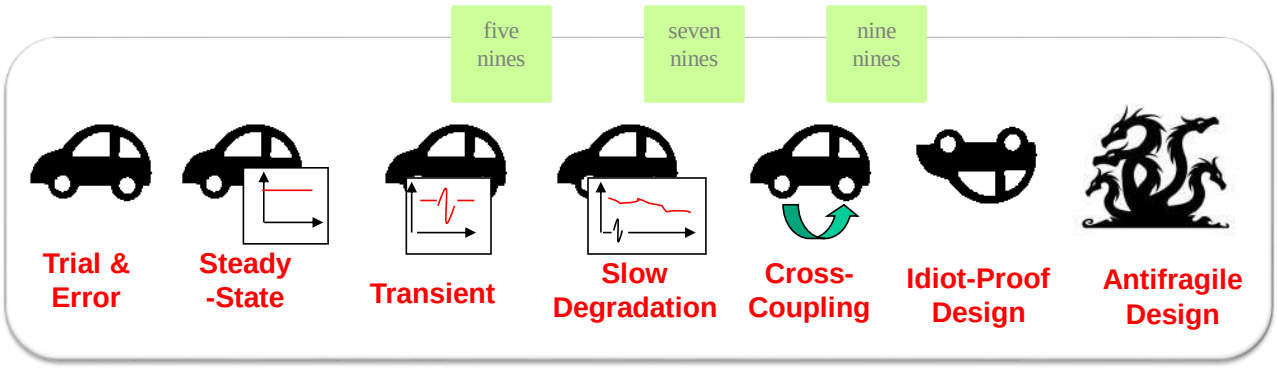


Figure 1: Resilient Design Trend And Connection With Safety Performance

What we now know about EpiPens is that they're capable of delivering about 99% (i.e. 'two nines') likelihood of doing what they were intended to do. This doesn't sound great. Which is why many allergy sufferers end up – like Natasha – carrying two. Two EpiPens should in theory give four-nines performance. But in reality, will probably be something less than this because if the person using the device gets it wrong the first time, there is a fair likelihood they will also get it wrong the second time as well.

Whatever the precise number of nines EpiPens achieve is, I believe that any medical device designer who wishes to sleep at night would conclude that the current level of performance is not good enough. In terms of the Resilient Design trend, the design method is very likely 'steady-state'. We can't say for certain, but the important point is not about the actual position (only the EpiPen designers could tell us whether they've built transient performance models, or looked at slow degradation effects, or cross-coupling effects, or 'idiot-proofing'). Rather the important point is the existence of the Trend and the fact that it should enable designers to think about how many nines reliability they need to achieve and develop the necessary design capability to ensure that reliability target is achieved. If it was me, I think I'd be looking at achieving nine-nines, and as such then set about designing a device that I knew would work no matter how stressed, confused or ill the user might be at the time they need to use my device.

Also relevant in this calculation is the Safetyism Threshold we discussed in the January 2019 issue of this ezine. With regard to the safety-measure/safety curve, I believe we can make another safe bet that the EpiPen is still on the left-hand side of the curve – Figure 2.

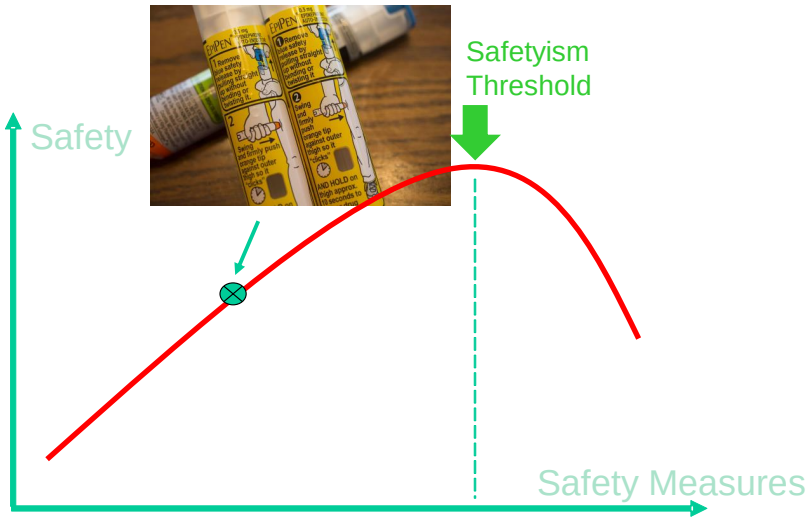


Figure 2: EpiPen And The Safety-Measure Versus Safety Curve

This being the case, we should know that adding more safety measures would be a good thing.

A third relevant way for designers to understand their task is to think about the type of design problem they've been tasked with working on. Using the Complexity Landscape Model (CLM) we can see that the EpiPen design is expected to operate in a Complicated environment (every patient will have different anatomy, skin thickness, body fat, etc that will give rise to a series of design contradictions). The lack of sufficient reliability, on the other hand is indicative of the fact that the design community has mistakenly assumed that they are operating in the Simple regime. Figure 3 plots these two aspects onto the CLM:

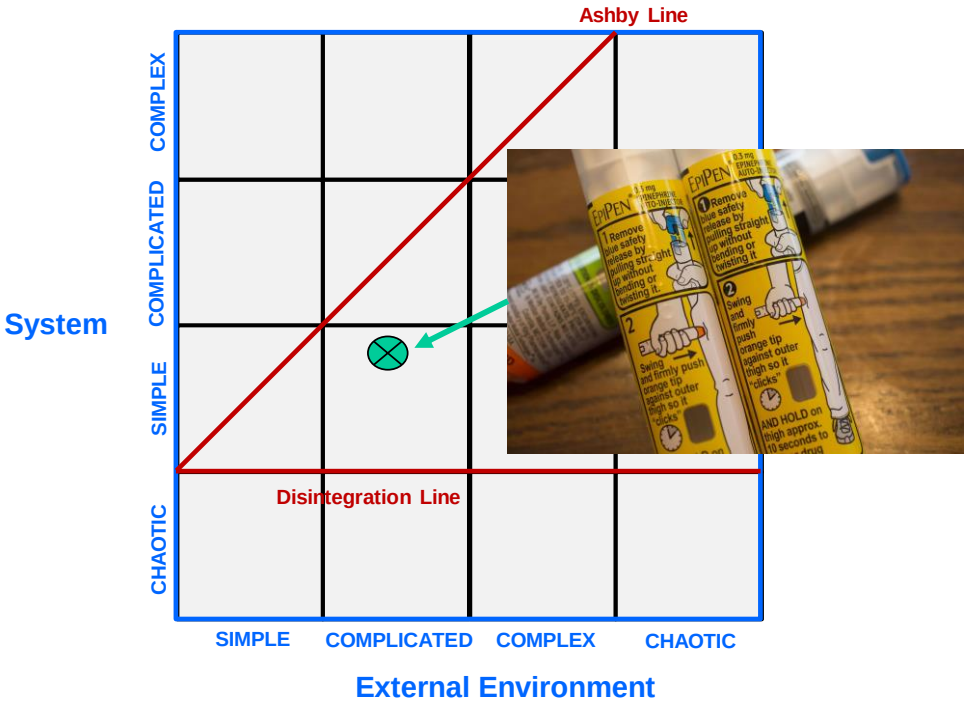


Figure 3: EpiPen Design And Complexity Landscape Model

Crucially, the design sits below the Ashby Line. The EpiPen does not satisfy Ashby's Law, there being insufficient variety in the pen design to cope with the level of variety in the patients into which it is to be administered. The design is not resilient, and as such, accidents are inevitable.

Honestly, if I was an EpiPen designer I don't think I'd be happy with what I've done. I can imagine, too, that I'd be very frustrated at the 'clinical evidence' world in which I had to operate. But at the same time, if the information I needed to do better was out there, I don't think my conscience could stop me from going to look for it, and, once I'd found it, from then making use of it.

The inquest into Natasha Ednan-Laperouse's death certainly criticized the EpiPen design and made certain recommendations, but it also made it clear that the inquest team did not possess the requisite engineering skills to really know what had happened.

From the perspective of legislating to ensure Natasha's tragic case wouldn't see a repeat in the future, the inquest would have to be deemed a failure. Sadly, when people don't understand something, they tend to look elsewhere for easier things to blame…

…Which takes us to a very different take on the problem. Relative to understanding the technical functioning of an EpiPen, food labelling is a much easier problem for people to grasp.

Why wasn't Natasha's fatal artichoke, olive & tapenade baguette labelled to inform her that it also contained sesame seeds? Especially since the restaurant that she bought the sandwich from was part of a national chain. Everyone – especially the media – could understand this part of the problem. A scandal was duly declared. Followed by the usual witch-hunt. Followed, less than a year after Natasha's tragic death, by 'Natasha's Law'. Which basically means that every sandwich maker in the country, irrespective of whether they are a one-man-band bakery or a national chain, has to label every ingredient on every product they sell starting from next year.

Problem solved everyone now thinks.

But, sadly, that is not how the real world works. Like most similar knee-jerk reactions, all Natasha's Law will do is the precise opposite of what it has been designed to do. Lots of good intentions, granted, but because those well-intentioned actors don't understand the bigger picture, lots of terrible, terrible outcomes are the only inevitable result.

The CLM offers up the first hint of what's going on here:

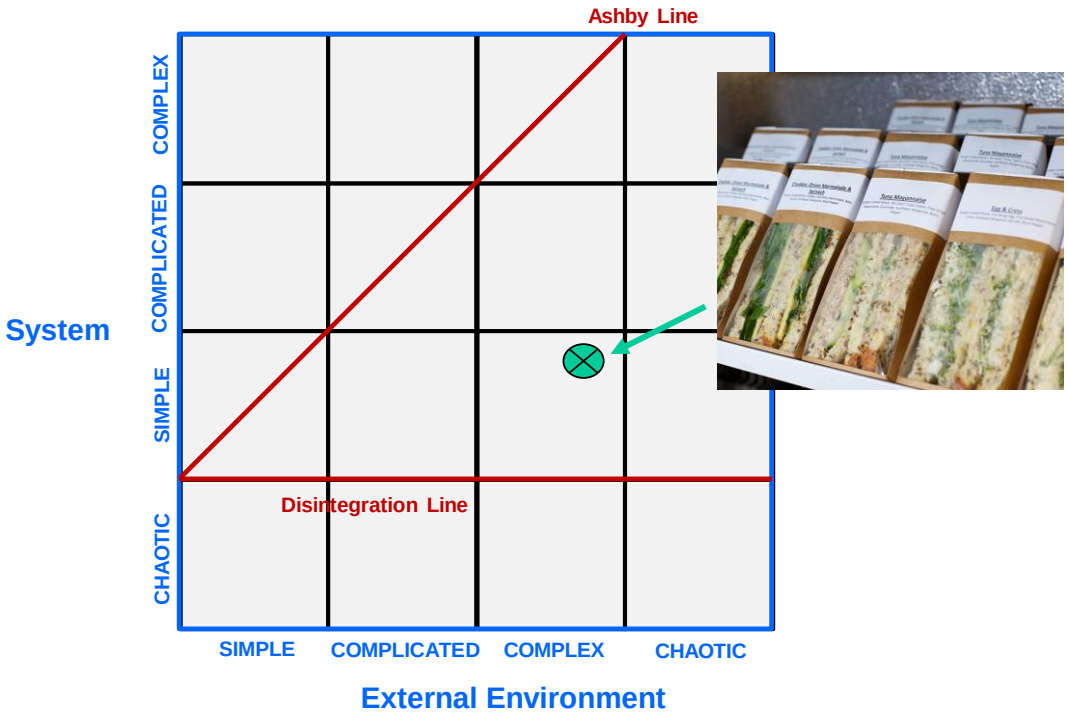


Figure 4: Natasha's Law And Complexity Landscape Model

Society-level food labelling is a complex issue, but Natasha's Law treats is as a simple one. It represents a classic case of the 'every complex problem has a simple, wrong answer' aphorism. It is about as far below the Ashby Line as it is possible to be without actually finding ourselves in chaos… there is not enough variety in the Law to handle the range of variety in the environment.

Crucially, when we shift focus to the Safetyism Threshold, food product labelling – in the UK at least - has already crossed the Threshold. Adding more requirements can thus serve to do nothing more than reduce safety. It is the equivalent of 20mph speed limits, No

Jaywalking restrictions and signs on stairways instructing people to hold on to the handrails. All done with the best of intentions, but all, too, a proven way to make society less safe.

Part of the issue here is plausible deniability. When someone falls down a staircase at work, those responsible for Health & Safety feel a need to be seen to be doing something. And so, putting up a sign is a very tangible thing for them to do. Putting up a sign fits most people's idea of common sense. But most people's idea of common sense is utterly wrong when it comes to complex systems. Still, the H&S officials can demonstrate they've done something. And that something is far easier than having to explain that sometimes adding more safety measures makes safety worse. That doesn't fit most people's idea of common sense.

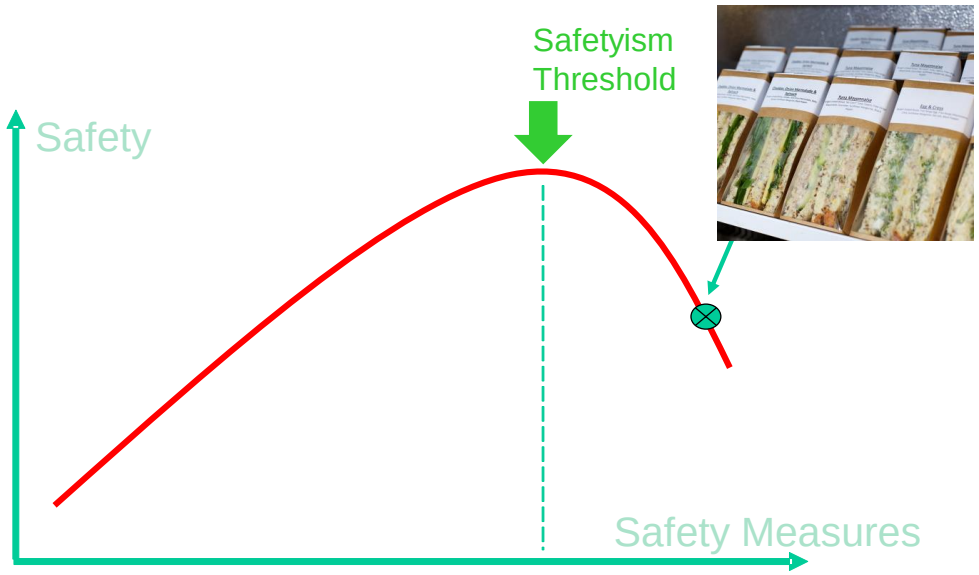


Figure 5: Natasha's Law And The Safety-Measure Versus Safety Curve

Because those responsible for Natasha's Law don't understand either this curve or how complex systems work, sadly for them, they've encouraged society to put in place another 'simple, wrong' solution. One in which everyone loses and society enters a vicious cycle that ultimately will lead to a much more fragile environment for everyone: small food companies go out of business; large food companies put in place ever more expensive, ever more stringent food 'hygiene' requirements; which makes those with allergies even more vulnerable when even a microgram of an allergen inevitably works its way through the system; the labels, meanwhile, increase societal paranoia, which means we all become more prone to placebo effects; we all get iller and society as a whole gets more fragile.

Perhaps what makes this all so tragic is the fact that the human body is one of the most resilient (one might go so far as to say 'antifragile') systems on the planet. We all of us face a constant battle against the microcosm of viruses and bacteria. Our anti-bodies do a fantastic job of protecting us, but for them to help us, we also have to help them. Take the resilience problem down to first principles, and our body is only able to protect itself if it is constantly stressed. By making our world's ever more clean and hygienic, we make our bodies less able to cope. Particularly small children. Infants used to eat dirt. Parents today have been told this is a bad thing. They have been mis-informed. The world has an allergy epidemic largely because we've all been encouraged to remove the things that made us strong.

In theory, everything – human body included – evolves in the direction of increasing ideality. But that means being able to *deal with* bad stuff, not removing bad stuff. The human body is supposed to self-repair. By cleaning up the world and filling ourselves with drugs the moment the faintest flicker of illness appears, we've gone in precisely the wrong direction. And now with things like Natasha's Law, we find ourselves legislating to keep going in that wrong direction. And before long the vicious cycle we naively set up by not understanding how the world works, turns itself into a tailspin.

Meanwhile, the real problem – poor EpiPen design – goes unnoticed.

People might have had enough of experts right now, and I can see why. We've unwittingly conspired to create a world of expertise in the wrong things. Too many engineering silos; not enough complex systems thinking.

Constructed Crisis?

The main thesis of last month's Book of the Month, Crisis & Renewal, is that real change only happens when there is a crisis. This creates a potential problem for innovation teams, because, turning the book's finding the other way around, if there is no crisis, it is very unlikely that their innovation efforts will come to anything. A potential answer to this challenge, therefore, involves *creating* a crisis. Which in turn creates the potential for a number of far bigger problems. If we create a real crisis and fail, then it's likely that we sink the ship. If we create an artificial crisis and get found out, we lose the trust of the team and they throw us off the ship.

I made a point, when I was studying for my engineering degree, of socializing with people who weren't engineers. This had its downsides. The most noticeable of which was engineers had a lot more lectures than philosophers, historians, zoologists and mathematicians. One of my best friends was studying philosophy. The last three months of his final year was ostensibly dedicated to writing a 30,000-word thesis. In practice, however, the first two and a half months was spent watching daily matinee performances of Return Of The Jedi, and constantly flipping a homemade tape with the best of Creedence Clearwater Revival on one side and Bob Dylan At Budokan on the other. The first of the 30,000 words was typed two and a half days before the submission deadline. He finally submitted the requisite 30,000 words, bound and photocopied, with approximately two minutes spare before the deadline. This remains, today, my default example of the use of constructed crisis to ensure a job got done. To an extent, what Colin did with his thesis, a lot of us are prone to do with our own work: procrastinating for as long as possible and then starting only when there isn't quite enough time to sensibly achieve the goal before the deadline. Most of us make use of constructed crises to ensure change happens. Per the Leonard Bernstein quote, 'To achieve great things, two things are needed; a plan, and not quite enough time', not having enough time is a simple way to construct such a crisis.

A less visible, but equally important aspect of what is happening in these situations is that we need to have some real skin in the game. If Colin missed his deadline, he would have failed his degree. If I submit a late tender document, I lose the bid.

An extreme example of this skin-in-the-game attribute, the epitome of decisiveness and entrepreneurialism, is Hernan Cortes. Cortes and his small band of 16th-century adventurers risked everything in a bold gamble for the Aztec empire. Cortes famously ordered his men to sink the ships they arrived on in order to ensure they fought to the end. If they didn't beat the Aztecs, there was literally nowhere to run away to. Let's label Cortes' action at the far end of the constructed crisis axis, and use it as a way to dig deeper into some of the universal phenomena associated with crisis and change.

A good place to start is Joseph Campbell's work on the Hero's Journey:

The critical part of the Journey as far as constructed crisis is concerned is the 'Call To Adventure'. In many ways, this is what the crisis is: a call to change. Campbell, however, sees this critical moment being followed by a 'Refusal'. The Hero finds an excuse not to embark on the adventure. Luke Skywalker 'can't' leave the farm. Or, 'we missed our last quarterly figures, but it was because of Brexit uncertainty, everything will be okay again next quarter'. Etc.

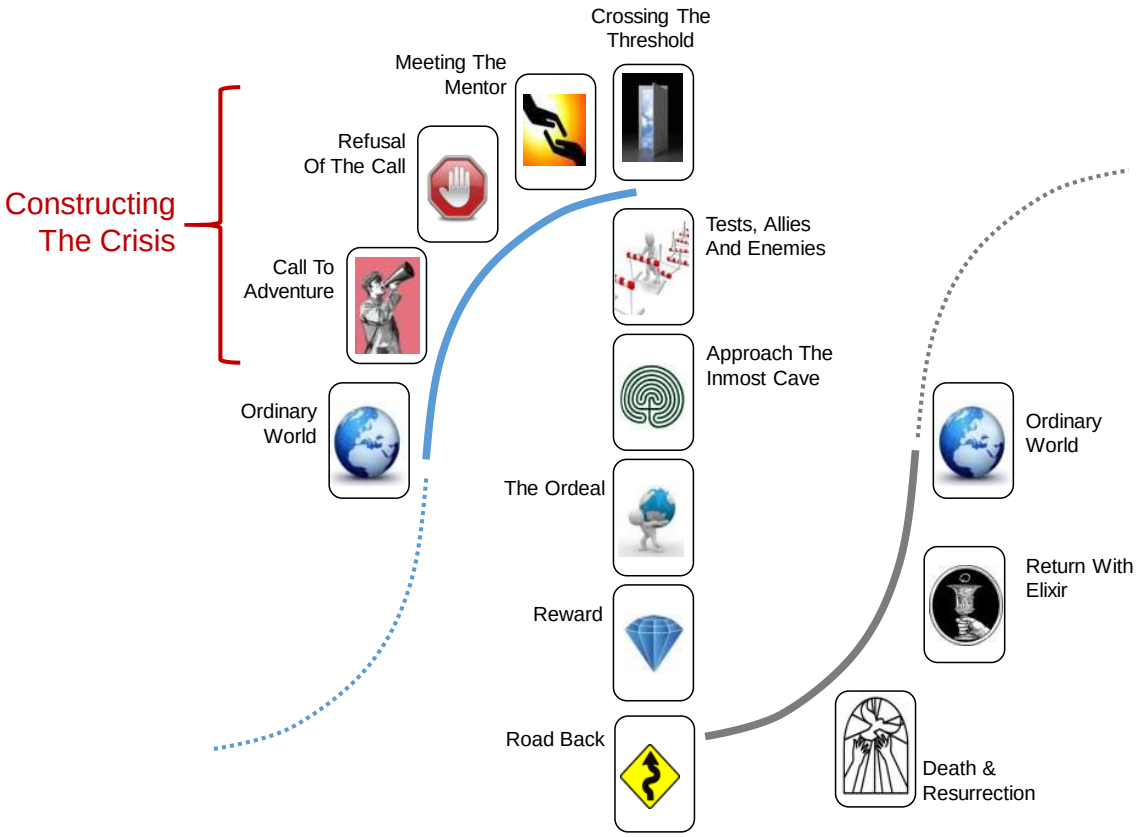


Figure 1: The Hero's (Innovation) Journey

Next, though, comes a very important part of the Journey, 'Meeting The Mentor'. Here's the bit where the Hero receives a nudge that triggers them to Cross The Threshold. Crossing The Threshold – i.e. literally jumping off the cliff that is the current S-curve, even though we have no idea what the new S-curve is going to look like yet – is very likely the most crucial stage of any innovation project. In many ways, the entire purpose of the crisis is to force the team to jump off this cliff. For, once they've jumped, there is no un-jumping that will bring them back to safety.

The Mentor – which might be a physical person from inside or (more likely) outside the organisation or it could simply be a new piece of knowledge, a magazine article, for example, or the words in a book – bears a lot of the responsibility for the jump. If we need to construct a crisis in order to ensure the jump happens, the Mentor possesses a lot of the control over how and when this jump happens. It is the Mentor that tells us we don't have enough time to finish our dissertation. It is the Mentor that tells us our biggest competitor is about to launch an industry re-defining product. Or that our industry is about to be disrupted by a heavily backed outsider.

One of the biggest advantages of having the crisis constructed (and/or 'confirmed') from outside the organisation is that there is someone that the blame can be handed to afterwards without jeopardizing the harmony of the internal team. Indeed, on more than one occasion, I've seen consultants brought into an organisation supposedly to act as the bringer of bad news where in fact their primary role has been to increase internal harmony. Humans are strange creatures. Every 'us' needs a 'them'. And very often 'them' makes for an excellent basis for constructing crises. Even if their advice or provocation turns out to be wrong, provided the team harmony-boost sees them safely across the project Threshold, and the 'point of no return' that comes with it, it has done its job.

To some extent, having the outsider deliver the message that triggers the crisis overcomes the trust problem inherent to tricking people into believing there is a crisis when it later transpires there wasn't one. No-one likes to feel like they've been cheated. Especially if it happens more than once. There are only so many times a person can cry wolf before their credibility is shot. That number is about one. Which means playing pretend-crisis is a dangerous game indeed. And especially so if we try and achieve it without a one-off outside Mentor.

The smart innovator (or mentor) would be well-advised to stay away. Certainly, if they know TRIZ and the importance of contradiction-solving, they'd be well advised to see the constructed-crisis-versus trust as a contradiction to be solved, rather than one to be manipulated and managed.

One possible 'get-out-of-jail-free' card way of bringing potential crises into play involves the exploitation of complex meta events that no-one can 'know' for certain will play out one way or the other. The ongoing Brexit debacle in the UK is perhaps a good example of such a crisis trigger. If the UK leaves the EU with 'No Deal', the vast majority of commentators have been saying, it will be catastrophic for the economy. As such, I know several large UK-based organisations that have used the fear and uncertainty these kinds of prophecy carry to spark some major 'anticipatory' change programmes. The media might be seen to be serving as the Mentor here, but more importantly, the general dis-ease across the entire population also comes to the assistance of the prospective change agent. If everyone in the team is feeling uncertain, it is far easier to nudge them over the edge of the cliff in the search for better, more certain, times ahead.

All that's required is that team members mentally click their own 'crisis' switch. Once we have flicked this switch, we give ourselves permission to break the rules and start the process of looking for better rules. Prior to the switch being flicked, there's always the temptation to think that 'maybe' the current rules are still the right ones to be using.

Figure 2: The Business-As-Usual/Crisis Switch

The trick for the change agent here is to achieve a critical mass of team members to flick their own personal crisis switches. Once a critical mass has flipped, it creates a thermal-runaway-like reaction which causes everyone else in the team to flip. The really smart change agent works out who the influencers in the team are, and works to make sure their crisis switch is flicked as early as possible.

As with all things ‘meta’, the parallel skill required by the change agent is knowing how meta to go. Brexit has reached a point where it works as a trigger for a critical mass of British employees, but, to take another example, ‘the impending environmental catastrophe’ for the most part hasn’t. It is too big an issue for any but the most ardent individuals to get their heads around. This is certainly the case when it comes to flicking a genuine, ‘the-rules-have-changed-now’ crisis switch. Only people that have lived through a local version of climate-change catastrophe will have done that. And, large as that number of individuals is, it is nothing like the critical mass needed for mankind as a whole to really start taking the problem seriously.

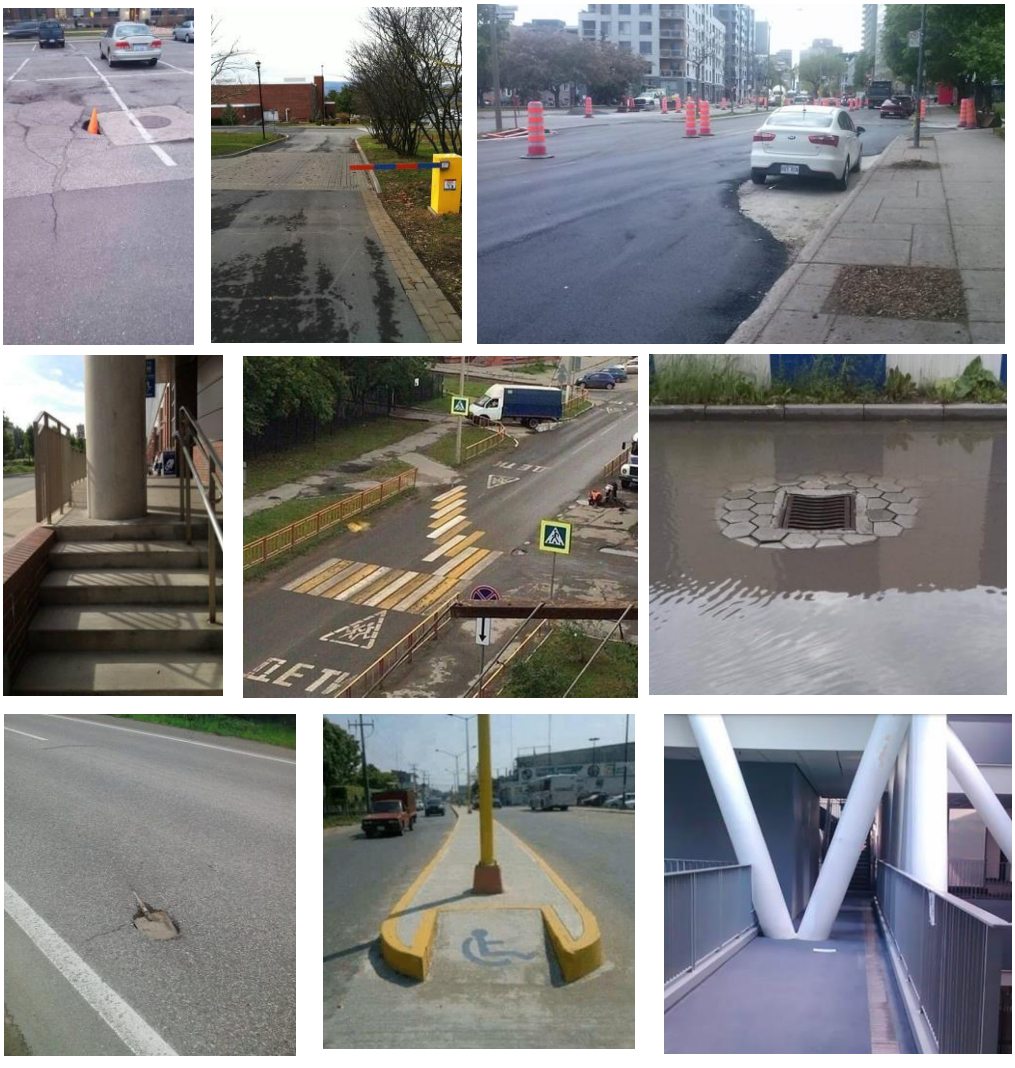
In many ways, if we look at the other, climate-change-denier, side of the environmental story, we see the perfect example of what happens when the experts are perceived to be ‘crying wolf’: ‘you told us fifty years ago that there was a problem, and still nothing has really changed’. A big part of the issue here is that another set of human flaws – our inability to think either long-term or comprehend non-linearities – make it all too easy to come to the conclusion that the climate experts were wrong before and are therefore wrong now.

Achieving a critical mass of real solutions to the climate-change challenge is only going to happen after a critical mass of local climate catastrophes have occurred. Or, at each the level of individual industries or enterprises, they need to hear from a Mentor that can convince them that their own crisis is real and imminent.

Like, I imagine, when Bob Dylan read the reviews that described the At Budokan live album as the worst thing he’d ever done. Enter constructed crisis. And, not long after, another step-change wave of amazing records.

Not So Funny – You Had One (Principle 17) Job

No shortcuts. It should be everyone's mantra. Like these people:



…especially important when kids are involved…





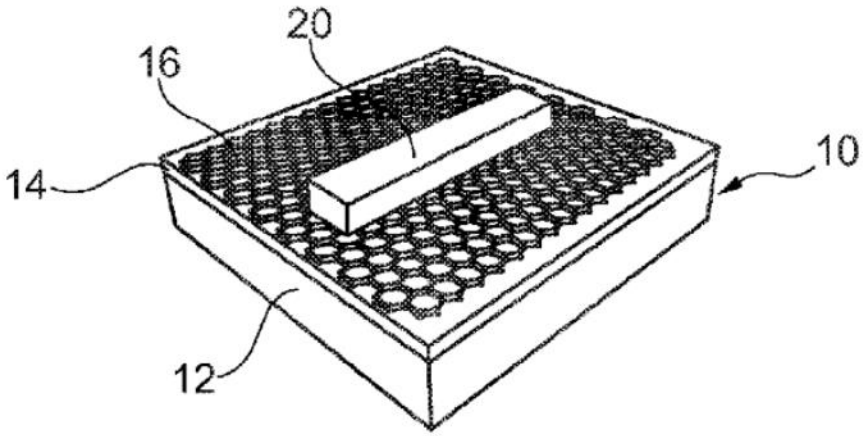

…so they grow up to be the kind of public servants we need them to be…

…always ready to go beyond the call of duty…

…always ready to take on life's biggest challenges…

…Principle 17, we salute you.

Patent of the Month – Plasmonic Structures



We head to the University of Manchester for our patent of the month this month. US10,345,490 was granted on July 9 to a trio of inventors, two of whom are Nobel-Prize winners. Andre Geim and Konstantin Novos won the prestigious award for their pioneering work on graphene. Their latest invention shifts the focus to plasmonics…

Plasmonics has established itself as a branch of physics which, among other applications, has the potential to revolutionize data processing, improve photovoltaics, and increase sensitivity of bio-detection. Plasmonics generally relates to the interaction between light and electron plasma oscillations in metals. Surface plasmons are coherent oscillations of free electrons that exist at an interface between two materials where the real part of the dielectric function changes sign across the interface (e.g. a metal-dielectric interface).

Gold is the current metal of choice for plasmonic applications due to its strong plasmonic response. However, gold is not compatible with standard silicon manufacturing processes (e.g. complementary metal oxide semiconductor (CMOS) technology) due to an efficient diffusion of gold into silicon. This incompatibility, together with the relatively high cost of gold, has hindered the widespread use and adoption of plasmonic devices.

There is an on-going search for inexpensive alternative materials that may replace gold for plasmonic applications and make plasmonic devices more economically attractive.

In one numerical (i.e. theoretical) study (Choi et al; Graphene-on-silver substrates for sensitive surface plasmon resonance imaging biosensors. Optics Express, 17 Jan. 2011, Vol. 19, No. 2, 458) it is hypothesized that a silver film coated in graphene may improve the sensing performance of a silver-based surface plasmon resonance (SPR) imaging biosensor beyond that of an equivalent gold-based SPR imaging biosensor. However, experimental attempts to date have not resulted in a device that possesses the desired plasmonic response required to make a functional plasmonic device. As an example, Salihoglu et al. (Plasmon-polaritons on graphene-metal surface and their use in biosensors. Applied Physics Letters, 23 May 2012, vol. 100, 213110) reports an experimental attempt to use graphene coated silver for use in a plasmonic device. However, it was found that the addition of the graphene to the silver significantly degraded the plasmonic response of the material.

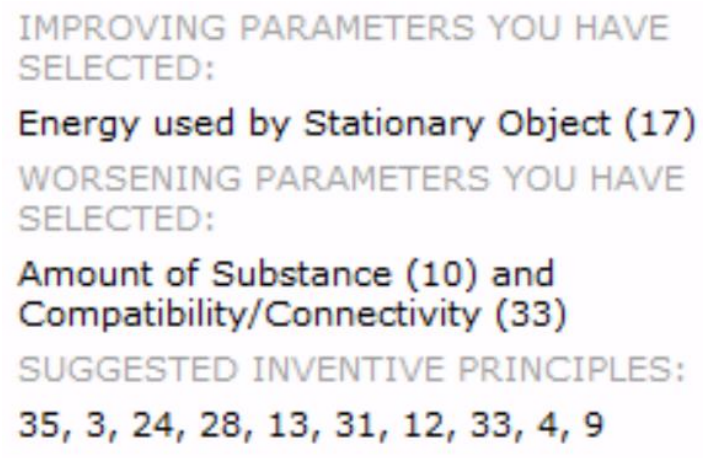
There still exists a need, therefore, for alternative plasmonic structures that will enable commercially viable plasmonic devices.

It is an aim of certain embodiments of the present invention to provide a plasmonic structure that is resistant to oxidation.

Another aim of certain embodiments of the present invention is to provide a plasmonic structure that may function in a wet environment.

A further aim of certain embodiments of the present invention is to provide a plasmonic structure that is compatible with complementary metal oxide semiconductors (CMOS) and CMOS fabrication methods.

Here's how the main compatibility and expensive material aspects of the conflict are best mapped to what the invention is all about:

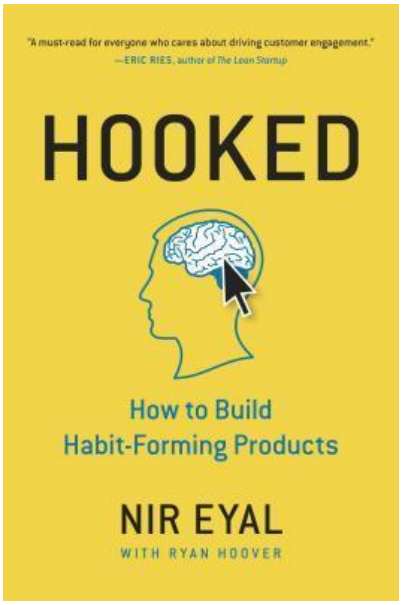


And here's how the inventors have overcome the problems:

…there is provided a plasmonic structure comprising: a layer of metal in which the metal is selected from: a Group 8 to Group 11 transition metal, aluminium, germanium, antimony or bismuth; and a barrier layer formed from a 2-D material disposed on a surface of the layer of metal; wherein the metal layer has a roughness that permits the propagation of running plasmons along the interface of the metal layer and the barrier layer.

Which sounds an awful lot like a Principle 35, Principle 3 one-two combination. Change the material and add some Local Quality roughness. Easy when you know how. Nobel-prizing easy.

Best of the Month – Hooked



Something of a controversial choice this month. ‘Hooked’ is pretty much the playbook for Silicon Valley start-ups intent on addicting customers to their products. The reason why seventy-nine percent of smartphone owners check their devices within fifteen minutes of waking up. And why industry experts believe that on average we check our phones around 150 times per day.

How did we get here? How is it that some apps can control the minds of their consumers? What makes these products addictive? Why do some products capture widespread attention while others flop? What makes us engage with certain products out of sheer habit? Is there a pattern underlying how technologies hook us?

Nir Eyal answers these questions (and many more) by explaining the Hook Model—a four-step process embedded into the products of many successful companies to subtly encourage customer behaviour. Through consecutive “hook cycles,” these products reach their ultimate goal of bringing users back again and again without depending on costly advertising or aggressive messaging.

Hooked is based on Eyal's years of research, consulting, and practical experience. He wrote the book he wished had been available to him as a start-up founder—not abstract theory, but a how-to guide for building better products. Hooked is written for product managers, designers, marketers, start-up founders, and anyone who seeks to understand how products influence our behaviour.

As with a large proportion of pioneers, Eyal goes to great lengths to stress the importance of not using his findings for immoral purposes. The whole of Chapter 6, 'What Are You Going To Do With This' is basically a plea to those using the Hook Model to act responsibly and ethically. Would you use this product yourself? Does it improve life (i.e. is what you're doing meaningful)? These are the two questions he poses.

Unfortunately, like a lot of acolytes that follow the pioneer, the morality of the pioneer is very easily lost. It is comparatively easy to follow the Hook Model recipe found in the first five chapters, but rather more difficult to follow the guidelines there in the sixth.

Like all technologies, the Hook Model and the Hooked book are morally and ethically neutral. They can be used for good or bad. The fact that, if we look at today's Social Media world in which billions of people have been deliberately and calculatedly addicted to trivial things, a majority of adopters have swung in the direction marked 'easy', should not stop those on the other side of the battle from reading the book. The social media playing field is not a level one, but if we all know the rules of the real (addiction) game, at least we can begin to do something to give customers a fighting chance of retaking control of their lives.

PS There's a lot of TRIZ thinking in the Hook Model

Conference – ICSI'10

The 10th International Conference on Systematic Innovation was convened at the University of Liverpool from 9-11 July. Statistics-wise, the event was attended by over 100 people, from 16 different countries. They got to listen to 4 plenary presentations, 77 papers and 14 entries for the Global Competition. Considering that the organisation is largely done from its home in the Chinese-speaking world, this has to be considered as something of an achievement.

As ever, the atmosphere at the conference was convivial, and there were lots of good conversations to be had from different parts of the TRIZ/SI spectrum. The breadth of possibility was increased substantially through a new policy of encouraging contributions from a much broader array of innovation related topics. I'm not sure how well this worked ultimately, however. Great to get more people. Not so great that the TRIZ/SI and non-TRIZ/SI worlds turned out to be so far apart. Sitting listening to a non-TRIZ/SI-based paper was likely to provoke looks of confusion from the TRIZ-people. Why didn't they use TRIZ? If they'd used TRIZ/SI, they would have asked a different question. Or gone down a different direction. And for the non-TRIZ people listening to TRIZ/SI content for the first time, I'm pretty certain there was a similar level of confusion. Albeit this way around it looked more like a confusion around, 'what one earth are these people talking about?' 'What do you mean contradiction?' etc.

If the aim was to bring the two worlds together, other than the social events, I suspect nothing was achieved. Everyone's confirmation bias ultimately kept them inside their respective echo chamber. Will any of these non-TRIZ/SI people be back again next year? I seriously doubt it.

This is clearly a problem for the community. As was the lack of participants from industry. Their absence either means that the content is not relevant to them, or they've reached the same basic conclusions that Samsung have: why should I tell the rest of the world the secrets of my success? Either way, this is another big problem that needs to be solved.

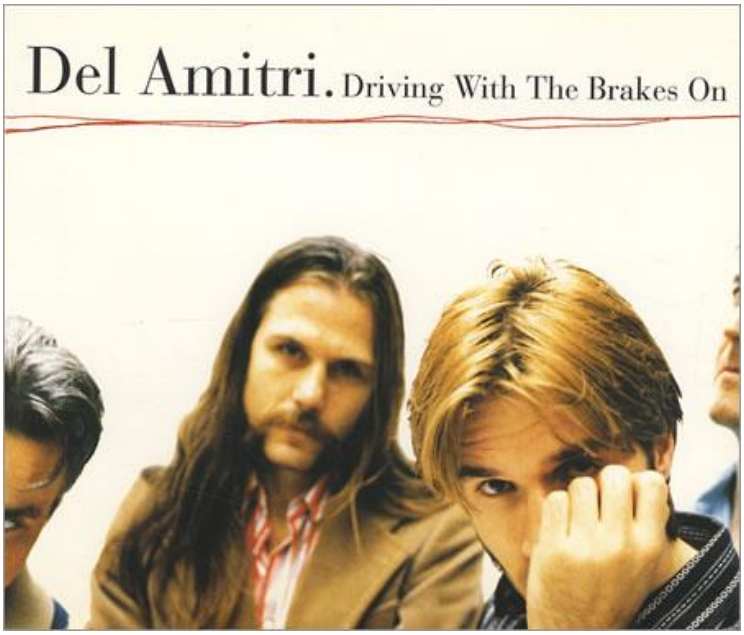
Personally, if I had to speculate on the heart of the problem, I'd point to the keynote presentation on the subject of 'how to get your paper published in academic journals'. Which was a bit like stepping back into the 1970s. If the main job of conferences is to make me angry, the objective was certainly achieved during this hour. Unless you're a career academic, the world is no longer interested in approval cycles of over a year. Especially in light of the fact that the whole paper refereeing process seems to be a game of spite and jealousy.

Everyone is right and everyone is set to 'transmit' mode. No-one is listening. And as a consequence, we get authors talking about their discovery of something that was first written about, in some cases, twenty years ago. If TRIZ/SI is built around the idea of 'someone, somewhere already solved your problem', it is quite remarkable that so few (academics) take the time to go and find the previous TRIZ/SI authors that have already covered their topic. Maybe this is one of the reasons academia-at-large hates TRIZ? Academics are becoming the world's worst re-inventing-the-wheel offenders. And if it's happening in the TRIZ world, heaven help us regarding the noise coming out of the non-TRIZ world (on which topic, see my 'Two Mountains' blog… written in the immediate aftermath of my post-'how to get your paper published' anger).

When I look back on the conference, much as I enjoyed the social side of it, and offer my continued admiration and support of Professor Sheu for all the time and effort he puts into keeping the event running every year, it feels to me like we're definitely stuck at the top of the current S-curve right now. Which means, unless some serious contradictions get solved in the coming months, the ICSI world, like a lot of academic-driven conferences is going to find itself in an unrecoverable tailspin before too long.

Fingers-crossed for ICSI'11 in Tianjin next year.

Wow In Music – Driving With The Brakes On



It's difficult for me to think of a band more criminally underrated than Del Amitri. I can't think of a weak track across the course of their half dozen albums released between 1985 and 2002 – including some of the best B-sides by any band ever – and any of the variants of their Greatest Hits albums is a non-stop cavalcade of great tunes, greater middle-eights and supremely singable choruses. And yet they were never really fashionable, caught as they were in a post-punk period when rhythm finally won the battle against melody. I could probably have picked any of a dozen of their songs to feature in this section of the ezine, but ultimately, it had to be Driving With The Brakes On, the second single and final track on their 1995, fourth album, Twisted.

The song is a hook-y, slow ballad featuring a number of wow moments. Starting, before the song even starts with the intriguingly contradictory title. When the music begins, it begins with a Casio-like programmed ultra-precise drum loop that counts the song in and sets the beat, which is then later countered (Principle 37) by the kicking in of a real snare drum that is so off-beat it almost feels like it's from a drummer who isn't able to hear what the rest of the band is playing. It shouldn't work, but, when the snare starts, it serves to take the second half of the song to a whole new level. This level then gets boosted again by one of main songwriter, Justin Currie's best Middle-8 sections.

I love a good (Principle 3) Middle 8. Especially when it's not in the middle of the song (Principle 4). A good Middle 8 is an opportunity to break out of the verse-chorus pattern common to most popular music. In a lot of ways, it serves as the resolution of a conflict. Both musically – where the melody is usually a twisted or lifted jump to a new pattern – and also lyrically. Most people think a song is 'about' the subject matter contained in the chorus. While that might be the case superficially – the 'good' meaning – the Middle 8 offers us the 'real' meaning.

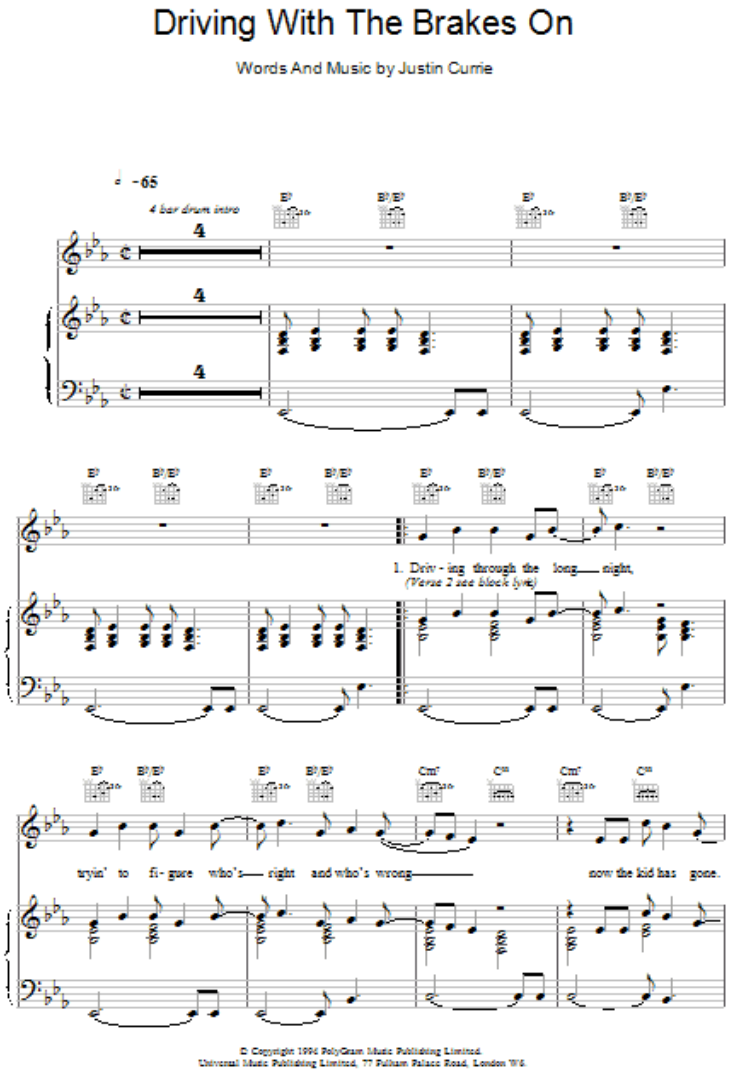
The verses tell us that Driving With the Brakes On is ostensibly about a couple having an argument in a car, 'trying to figure who's right and who's wrong'. The chorus gives us another lovely contradiction:

“It's hard to say you love someone
And it's hard to say you don't.”

And then, almost at the end of the song, comes the Middle 8:

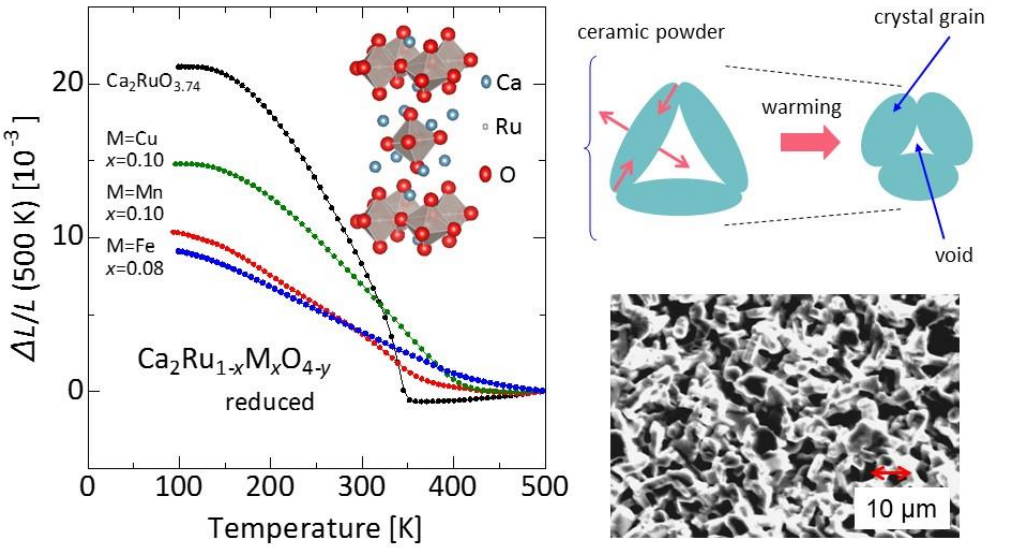
“But unless the moon falls tonight
Unless continents collide
Nothing's gonna make me break from her side”

They might be arguing, but the Middle 8 tells us, from the singer’s side at least, it will be okay.



Investments – Negative CTE Materials

Colossal Negative Thermal Expansion in Ca_2RuO_{4-y}



Scientists have created materials that shrink uniformly in all directions when heated under normal everyday conditions, using a cheap and industrially scalable process. This potentially opens up a new paradigm of thermal-expansion control that will make electronic devices more resilient to temperature changes.

One way that heat damages electronic equipment is it makes components expand at different rates, resulting in forces that cause micro-cracking and distortion. Plastic components and circuit boards are particularly prone to damage due to changes in volume during heating and cooling cycles. But if a material could be incorporated into the components that compensates for the expansion, the stresses would be reduced and their lifetime increased.

Everybody knows one material that behaves like this: liquid water expands when it freezes and ice contracts when it melts. But liquid water and electronics don't mix well – instead, what's needed is a solid with ‘negative thermal expansion’ (NTE).

Although such materials have been known since the 1960s, a number of challenges had to be overcome before the concept would be broadly useful and commercially viable. In terms of both materials and function, these efforts have only had limited success. The experimental materials had been produced under specialized laboratory conditions using expensive equipment; and even then, the temperature and pressure ranges in which they would exhibit NTE were well outside normal everyday conditions. Moreover, the amount they expanded and contracted depended on the direction, which induced internal stresses that changed their structure, meaning that the NTE property would not last longer than a few heating and cooling cycles.

A research team led by Koshi Takenaka of Nagoya University has succeeded in overcoming these materials-engineering challenges. Inspired by the series of work by

Noriaki Sato, also of Nagoya University -- whose discovery last year of superconductivity in quasicrystals was considered one of the top ten physics discoveries of the year by Physics World magazine – Professor Takenaka took the rare earth element samarium and its sulfide, samarium monosulfide (SmS), which is known to change phase from the "black phase" to the smaller-volume ‘golden phase’. The problem was to tune the range of temperatures at which the phase transition occurs. The team's solution was to replace a small proportion of samarium atoms with another rare earth element, giving Sm1-xRxS, where "R" is any one of the rare earth elements cerium (Ce), neodymium (Nd), praseodymium (Pr) or yttrium (Y). The fraction x the team used was typically 0.2, except for yttrium. These materials showed "giant negative thermal expansion" of up to 8% at ordinary room pressure and a useful range of temperatures (around 150 degrees) including at room temperature and above. Cerium is the star candidate here because it is relatively cheap.

The nature of the phase transition is such that the materials can be powdered into very small crystal sizes around a micron on a side without losing their negative expansion property. This broadens the industrial applications, particularly within electronics.
While the Nagoya University group's engineering achievement is impressive, how the negative expansion works is fascinating from a fundamental physics viewpoint. During the black-golden transition, the crystal structure stays the same but the atoms get closer together: the unit cell size becomes smaller because (as is very likely but perhaps not yet 100% certain) the electron structure of the samarium atoms changes and makes them smaller – a process of intra-atomic charge transfer called a ‘valence transition’ or ‘valence fluctuation’ within the samarium atoms . "My impression," says Professor Takenaka, "is that the correlation between the lattice volume and the electron structure of samarium is experimentally verified for this class of sulfides."

More specifically, in the black (lower temperature) phase, the electron configuration of the samarium atoms is (4f)6, meaning that in their outermost shell they have 6 electrons in the f orbitals (with s, p and d orbitals filled); while in the golden phase the electronic configuration is (4f)5(5d)1 – an electron has moved out of a 4f orbital into a 5d orbital. Although a ‘higher’ shell is starting to be occupied, it turns out – through a quirk of the Pauli Exclusion Principle – that the second case gives a smaller atom size, leading to a smaller crystal size and negative expansion.

But this is only part of the fundamental picture. In the black phase, samarium sulfide and its doped offshoots are insulators – they do not conduct electricity; while in the golden phase they turn into conductors (i.e. metals). This is suggesting that during the black-golden phase transition the band structure of the whole crystal is influencing the valance transition within the samarium atoms. Although nobody has done the theoretical calculations for the doped samarium sulfides made by Professor Takenaka's group, a previous theoretical study has indicated that when electrons leave the samarium atoms' f orbital, they leave behind a positively charged "hole" which itself interacts repulsively with holes in the crystal's conduction band, affecting their exchange interaction. This becomes a cooperative effect that then drives the valence transition in the samarium atoms. The exact mechanism, though, is not well understood.

Nevertheless, the Nagoya University-led group's achievement is one of engineering, not pure physics. "What is important for many engineers is the ability to use the material to reduce device failure due to thermal expansion," explains Professor Takenaka. "In short, in a certain temperature range -- the temperature range in which the intended device operates, typically an interval of dozens of degrees or more – the volume needs to gradually decrease with a rise in temperature and increase as the temperature falls. Of

course, I also know that volume expansion on cooling during a phase transition [like water freezing] is a common case for many materials. However, if the volume changes in a very narrow temperature range, there is no engineering value. The present achievement is the result of material engineering, not pure physics."

Perhaps it even heralds a new "golden" age for electronics.

Read more:
D. Asai, Y. Mizuno, H. Hasegawa, Y. Yokoyama, Y. Okamoto, N. Katayama, H. S. Suzuki, Y. Imanaka, K. Takenaka. Valence fluctuations and giant isotropic negative thermal expansion in Sm1–xRxS (R = Y, La, Ce, Pr, Nd). Applied Physics Letters, 2019; 114 (14): 141902 DOI: 10.1063/1.5090546

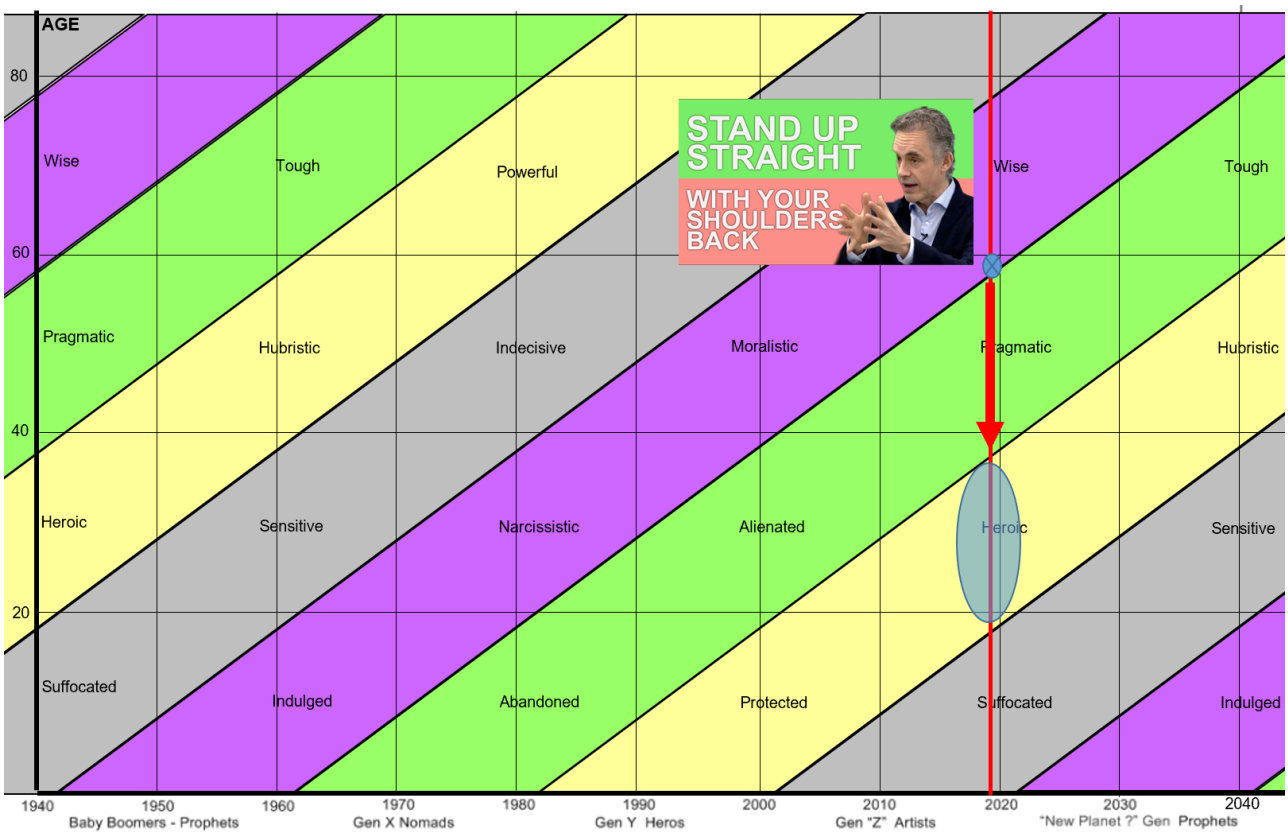
Generational Cycles – Jordan Peterson: Hero To Heroes

In a polarized world, there aren't many more polarizing figures at the moment than Jordan Peterson, the man responsible for the publishing phenomena that is, 'Twelve Rules For Life'. Peterson was born in Canada in June 1962. Which puts him right on the cusp between Baby Boomer and Generation X. It is difficult to sit on that cusp, however, and it doesn't take long to work out which side of the fence Peterson fell. In both his words and actions, he bears all the characteristics of the Moralistic Boomer.

Look at the attendees at any of his usually sold-out speeches, and at the subscribers to his YouTube channel, however, and you won't find many Boomers turning up. Ditto Generation X Nomads. Rather, the large majority of the audience are Generation Y Millennials. And the majority of that majority are white males. Usually wearing lobster t-shirts, in honour of Peterson's Rule One: 'Stand Up Straight With your Shoulders Back'.

This is not to say that Peterson is worshipped by all Millennials. His outspoken reputation and frequent mis-interpretation by the media as 'alt-right' means that many people are put off before they get anywhere close to actually reading the 12 Rules book. But he's

undoubtedly hit a nerve with un-heroic-feeling Hero males. A segment of the population that increasingly see themselves not living up to their Heroic aspirations and expectations. That much of what Peterson says is pure (bible-mangling) garbage is irrelevant. He's the mentor many uncertain, unfocused Heroes have been looking for. He brings apparent clarity in a world of confusion, and his smart-to-dumb ratio is marginally better than the majority of his public-figure contemporaries. And that seems to be good enough. Get yourself a 'Professor' title and speak in an authoritarian manner and the Millennials will lap it up. They want mentors, and they see the Baby Boomers as much better candidates than anyone from Generation X. Like lots of things in life, the alternating generations in the Strauss/Howe model tend to make great allies. Peterson and Millennials in that context makes for the perfect match…



Biology – Fogstand Beetle

Stenocara gracilipes, also known as the fogstand beetle, is a species of beetle that is native to the Namib Desert of southern Africa. This is one of the most arid areas of the world, receiving only 14mm of rain per year. The beetle is able to survive by collecting water on its bumpy back surface from early morning fogs.

To drink water, the S. gracilipes stands on a small ridge of sand using its long, spindly legs. Facing into the breeze, with its body angled at 45°, the beetle catches fog droplets on its hardened wings. Its head faces upwind, and its stiff, bumpy outer wings are spread against the damp breeze. Minute water droplets (15-20 µm in diameter) from the fog gather on its wings; there the droplets stick to hydrophilic (water-loving) bumps, which are surrounded by waxy, hydrophobic troughs. Droplets flatten as they make contact with the hydrophilic surfaces, preventing them from being blown by wind and providing a surface for other droplets to attach. Accumulation continues until the combined droplet weight overcomes the water's electrostatic attraction to the bumps as well as any opposing force of the wind; in a 30 km/h breeze, such a droplet would stick to the wing until it grows to roughly 5 mm in diameter; at that point it will roll down the beetle's back to its mouthparts.

Nature is great at evolving high-functioning tribological surfaces, but the fogstand beetle may have evolved one of the most cunning. The contradiction to be solved in the Namib Desert revolves around the need to acquire water when the only available water is in the form of atmospheric fog. Here's how we might map that problem onto the Contradiction Matrix:

IMPROVING PARAMETERS YOU HAVE SELECTED:

Amount of Substance (10)

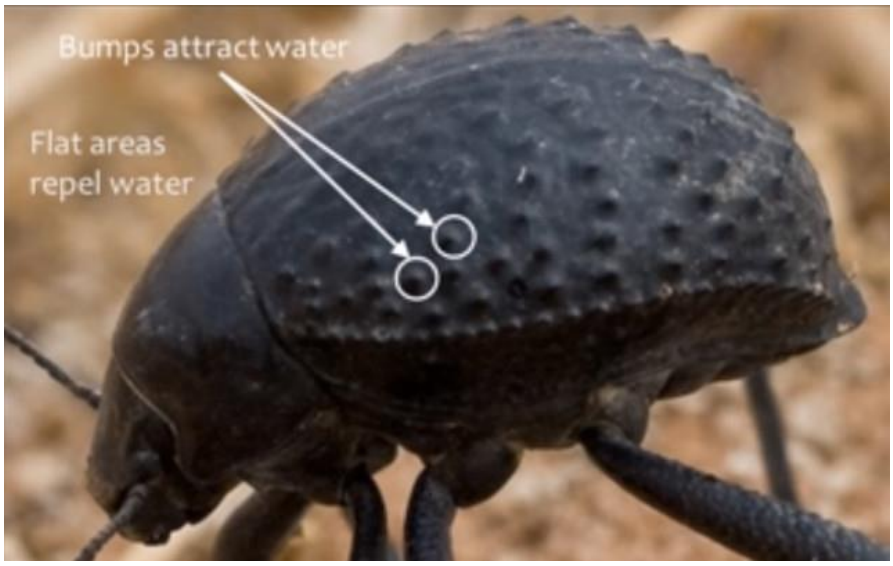
WORSENING PARAMETERS YOU HAVE SELECTED:

Loss of Substance (25)

SUGGESTED INVENTIVE PRINCIPLES:

24, 4, 10, 3, 34, 12, 6, 17

The most cunning part of the fogstand beetle solution is all about Principle 3, Local Quality, where, specifically, the wing-cases feature a lattice of hydrophobic and hydrophilic regions:

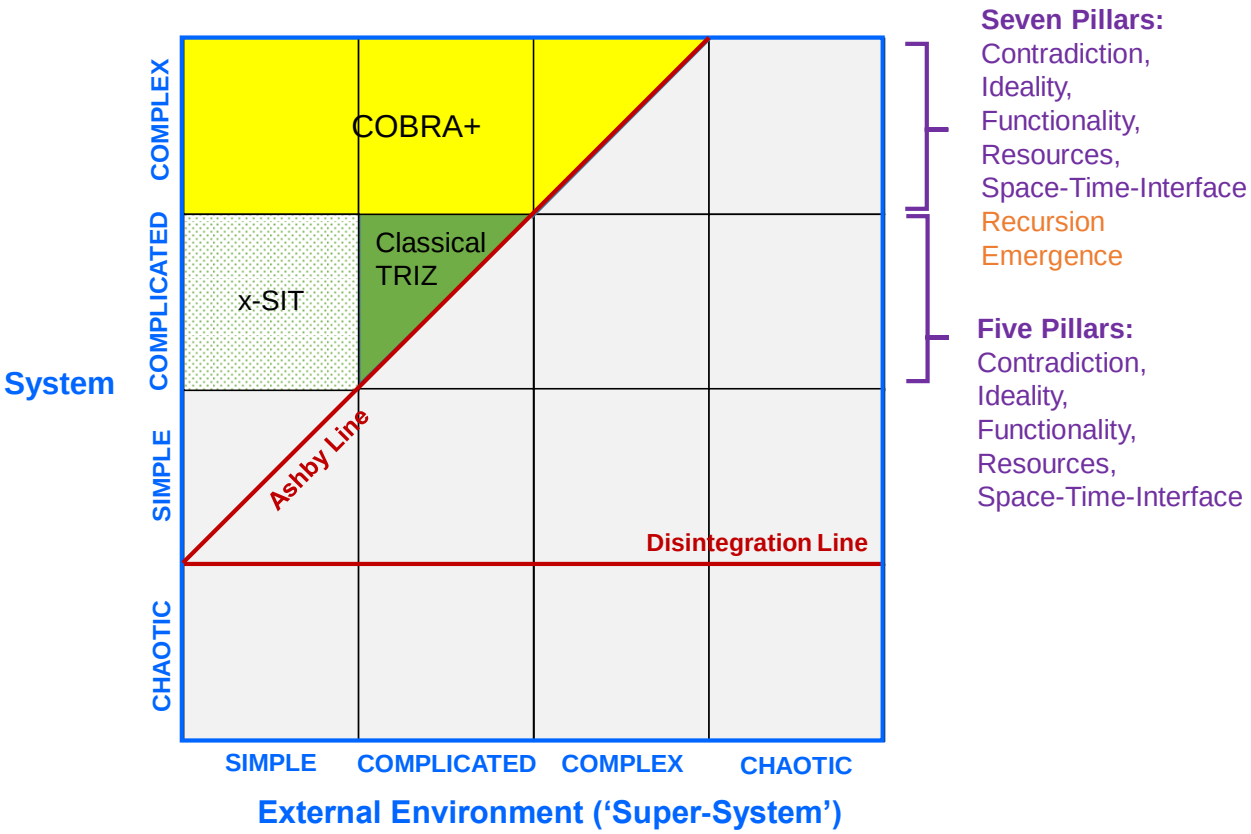


There's also a bit of Equipotentiality (Principle 12) in the way the surface tension forces at the hydrophilic regions cause the moisture to stick flat to the surface so it doesn't get blown away, and in the Asymmetry (Principle 4) of standing at an angle so the agglomerated water droplets run towards the beetle's mouth.

Expect to see a host of biomimetic versions of the same Principle 3 idea in the human engineered world in the not too distant future...

Short Thort

If the problem is Complicated, the Five Pillars of (technical) TRIZ are sufficient.
The moment the problem becomes complex, two additional Pillars need to be brought to bear if the problem is to be solved effectively:



News

India

Darrell's next trip to India will take place from 10-19 September, beginning with three days in Bangalore and then spending the bulk of the time in Mumbai. All of the days have been reserved by clients. There is still an opportunity for him to travel a day or two earlier if there is a desire from other clients. Otherwise, he is aiming to make himself free during the evenings if anyone is interested in a discussion. Get in touch as soon as possible to see what might be possible. As ever, first-come-first-served will be the way the diary gets filled.

TRIZ Future Conference

Despite some of the dumbest referee comments ever (see Darrell's blog!), our paper for this year's ETRIA conference in Marrakech has been accepted and will be included in the conference proceedings in its original form. 9-11 October is the date for your diary. If the (academic) stupidity of the refereeing has extended to other authors, the main reason for attending might well be the fact that it is in Marrakech.

TRIZ Expert Day 2020

Darrell has been invited to present at Robert Adunka's annual Expert Day next year. The event is actually 1.5 days, starting on the afternoon of 6 February, and through the 7th. The

venue will be Sulzbach-Rosenberg, which means flying in to Nuremburg. More details at Robert's website after the summer vacation season is over.

IMechE UAS Challenge
We've been a close follower of this student-focused drone competition for a couple of years now. The 2019 competition was won last month by the Pakistan National University of Science & Technology with an entry that, while undoubtedly more impressive than the other 31 global entries, still looks an awful lot like optimization rather than innovation. So we thought perhaps 2020 ought to be the year of bringing some TRIZ/SI to the competition. At the moment we're exploring sponsorship of a couple of different UK University teams, but if any academia-based readers of the e-zine want to explore working with us, get in touch at the usual address. More details about the competition can be found here: https://www.imeche.org/events/challenges/uas-challenge

New Projects
This month's new projects from around the Network:

- Automotive – Innovation Strategy Workshop
- Education – COBRA+ Workshops
- Agriculture – Train-the-Trainer Workshops
- Automotive – Minimum-Viable Demonstration & IP Generation Project
- Automotive – (Horizon 3) Technology Roadmapping Project
- Conglomerate – Design-Thinking & TRIZ Workshop Series
- IT – Creativity Measurement Project
- Government – Industry Strategy Project
- FMCG – SI Workshops
- Fintech – SI Workshops
- Automotive – Quality Breakthrough Workshops