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Our guarantee to the subscriber is that the material featured in the e-zine will not be published elsewhere for a period of at least 6 months after a new issue is released.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

Back in 1987, Michael Jackson amazed the world with his biomechanically impossible dance moves in his music video Smooth Criminal. In the routine, Michael leans from the ankle at a 45-degree angle, while keeping his body straight as a rod.

Manjul Tripathi and colleagues from the Postgraduate Institute of Medical Education and Research in Chandigarh, India, say in the Journal of Neurosurgery: Spine: "Most trained dancers with strong core strength will reach a maximum of 25 to 30 degrees of forward bending while performing this action. MJ pulled off a gravity-defying 45 degree move that seems unearthly to any witness."

If a person were to attempt the Smooth Criminal lean, they would notice that the bulk of the strain to strike the pose moves to the Achilles tendon in each ankle, rather than the erector spinae muscles of the back. This allows for only a very limited degree of forward bend, even for someone matching Michael's strong athletic abilities, explains Assistant Prof Tripathi.

So how did The King of Pop achieve the feat?

Here's what the problem looks like when mapped on to the Contradiction Matrix:

IMPROVING PARAMETERS YOU HAVE SELECTED:

Length/Angle of Moving Object (3)

WORSENING PARAMETERS YOU HAVE SELECTED:

Stress/Pressure (19)

SUGGESTED INVENTIVE PRINCIPLES:

1, 35, 3, 14, 12, 8, 17, 29

Figure 1: Smooth Criminal Contradiction

The illusion, which many have tried to copy, was thanks to specially designed (Principle 8, Anti-weight and 17, Another Dimension) shoes and the artist's (Principle 29, Fluid) core strength.

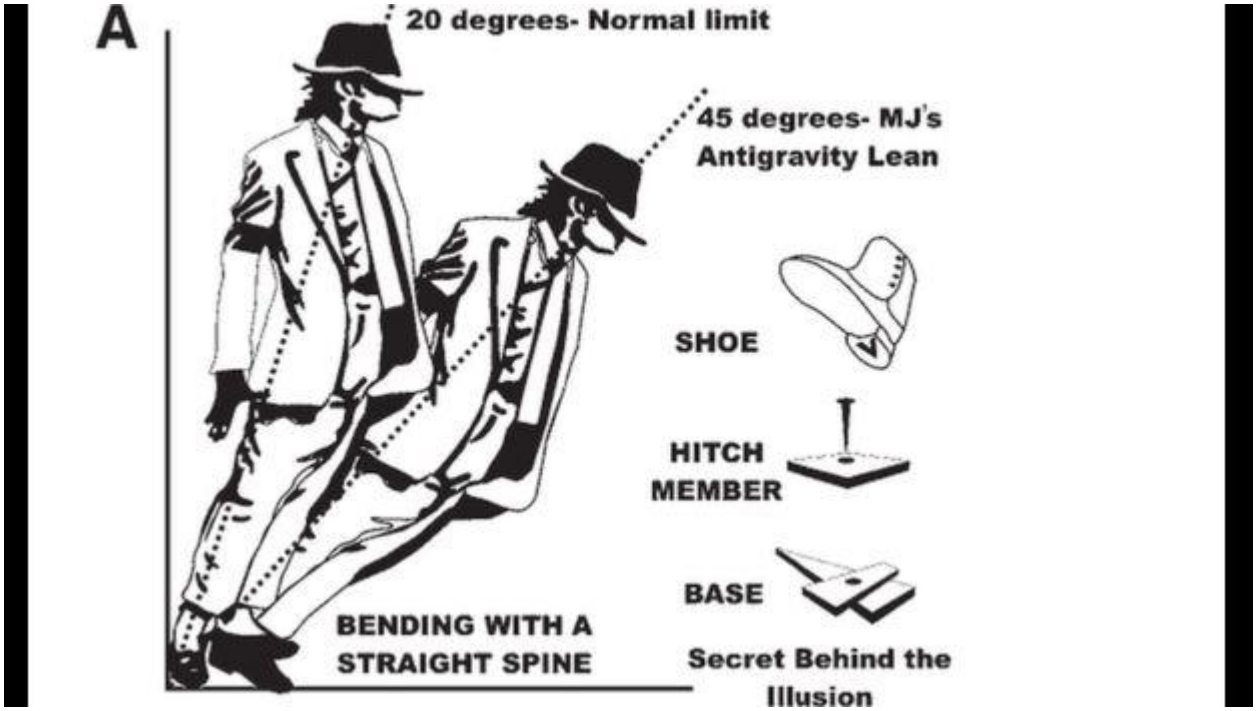

Figure 2: Smooth Criminal – Contradiction Resolution

A V-shaped slit (Principle 17) in the bottom of each heel of his spats slotted onto a strong nail or "hitch member" driven into the ground, allowing the dancer to pivot and lean further forward, for the gravity-defying move.

Prior to the patented footwear invention, Michael had relied on the much more difficult to hide solution of supporting cables and a harness around his waist. It's said that he and two Hollywood colleagues borrowed the footwear idea from US astronauts' boots, which can be docked to a fixed rail when working in zero gravity. But even with specially designed footwear and the support of the hitch member, the move is incredibly hard to pull off, requiring athletic core strength from strengthened spinal and lower-limb muscles, say the doctors. "Several MJ fans, including the authors, have tried to copy this move and failed, often injuring themselves in their endeavours," they caution. Dr Tripathi said: "The chances of injury to the ankle are significant. You need strong core muscles and good support around the ankle. It's not a simple trick."

The recent publication of the Smooth Criminal story reminded us that ‘magic’ is, exactly like humour, all about contradictions. The viewer of the magic trick is sent in one direction by the magician, who, meanwhile, takes the trick in a different direction. If the job is done well enough, unlike humour, the viewer, although they experience a contradiction only resolve it by assuming that it was done by ‘magic’. Now we have the Internet, it is very difficult for magicians to stay ahead of the game. The Magic Circle had the job of keeping the contradiction resolutions secret to the magicians. Nowadays we just have to watch a YouTube video to see how most tricks are done. Especially card tricks.

Here's a few contradictions we can set into the context of TRIZ and the Contradiction Matrix: A lot of card tricks revolve around the magician's uncanny ability to select your card from a deck. Here's what the trick looks like as a Contradiction:

IMPROVING PARAMETERS YOU HAVE SELECTED:

Ability to Detect/Measure (49)

WORSENING PARAMETERS YOU HAVE SELECTED:

Amount of Information (11)

SUGGESTED INVENTIVE PRINCIPLES:

19, 3, 7, 37, 25, 10, 13, 32, 4

Figure 3: 'Find My Card' Contradiction

The idea of using the Amount Of Information parameter is that, in theory at least, the backs of all of the playing cards in a deck are identical to one another. Not, as it turns out, with the decks that magicians use. Here's a cunning example of a combined Principle 3 (Local Quality) and Principle 7 (Nested Doll) means of establishing exactly what every card in the deck is:

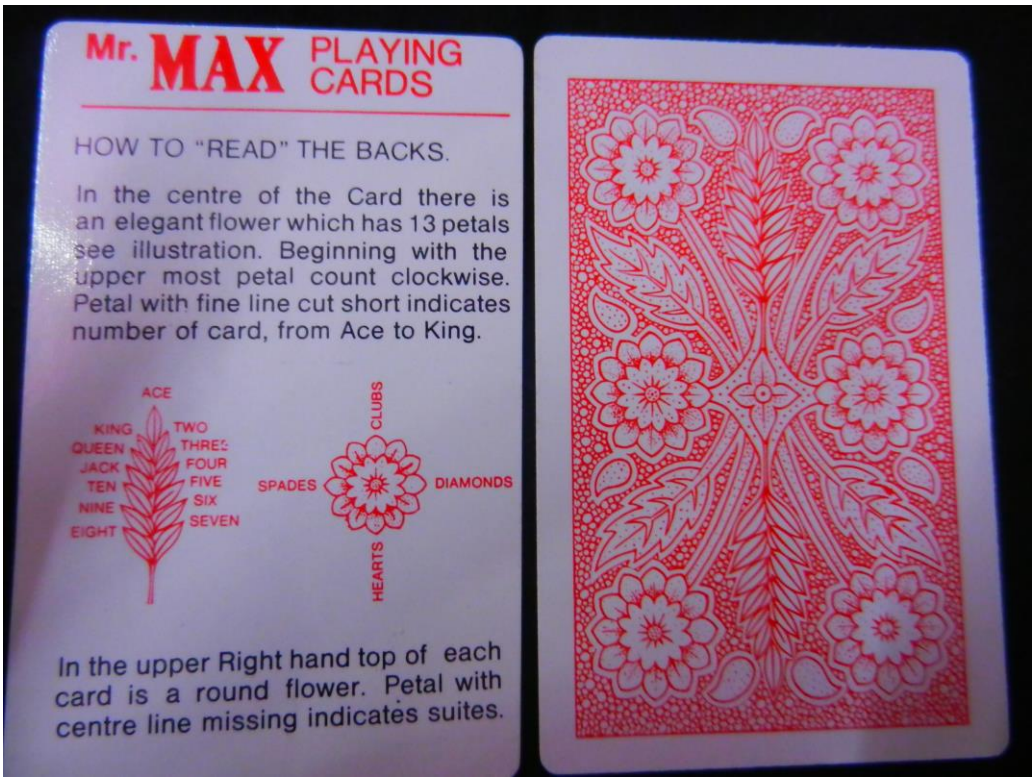

Figure 4: Principle 3/7 Solution To The Playing Card Detection Contradiction

After knowing this solution, I don't think I dare trust any card game ever again. This next solution is a bit more benign in terms of potential 'un-ethical' use, but is still a very simple wow moment for those tricks where the magician asks a person to select a card from the deck, look at it and then replace it. Enter Inventive Principle 17, Another Dimension and a deck of tapered cards:

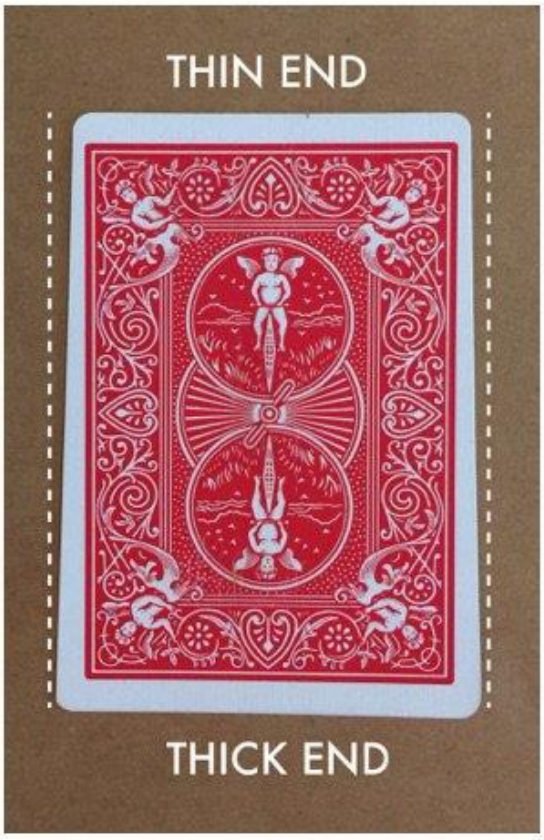

Fig. 1: Stripped cards are cut in a wedge shape. The wedge has been greatly exaggerated for illustration purposes.

Figure 5: Principle 17 Solution To The Playing Card Detection Contradiction

Or how about the classic, ‘sawing a person in half’ trick?
No contradiction any more, once you realise the answer is Principle 1, Segmentation…

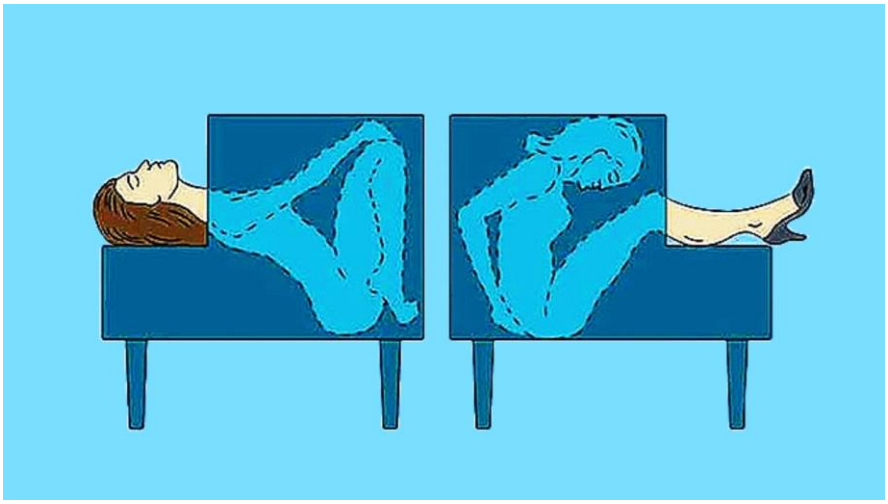

Figure 6: Principle 17 Solution To The Playing Card Detection Contradiction

Ultimately, the only magic is how the 40 Principles see through any magic. That plus a bit of human (Principle 29) flexibility and core strength.

Case Study: Level Crossing

Humans can be pretty dumb sometimes. Everything the automotive industry does to make cars safer, we all compensate for by driving worse. There's a similar phenomenon in the rail industry: the safer the level-crossing systems the rail industry puts in place, the dumber our behavior when using them becomes. The internet is full of people doing dumb things at level crossings. Sometimes getting away with the chances they take. Sometimes not being so lucky.

The railway industry – like their automotive counterparts seem to be caught in a horrible downward spiral: every time an incident hits the media, the more pressure the industry has put upon it to be seen to be making things 'safer'; the more they do that, the dumber we all become. The obvious – but politically unacceptable – solution would be to make level crossings (and cars) less safe. Then we might all be encouraged to travel through life looking at where we're going rather than playing Angry Birds 2 and checking out how many new BFFs we acquired on Facebook today.

Something else needs to be done. And, perhaps doubling the irony, the least likely fruitful direction of investigation would be asking the people why they sometimes do dumb things at dangerous places like level-crossings. The problem is this. When we're thinking rationally – in a commuter interview panel session for example (the usual industry means of capturing the 'voice of the customer') – we're using a completely different part of our brain to when we're in the middle of making dumb decisions like crossing railway line after the barriers have come down. If we wanted to get meaningful input we'd quite literally have to interview people in the half second before they started jumping the barrier. Not totally impossible, but there are better ways to think about the problem and that is to get ourselves down to the limbic brain and the first principles of human behavior: our desire for Autonomy, Belonging and Competence for example.

Putting ourselves in a position where we can see the barrier-jumping problem from this limbic perspective is something that any of us can make a conscious decision to do now we know how simple the rules are. When we do this job, using the COBRA process and

particularly the ‘B for But’ stage, we can construct a Perception Map based around a start question something like, ‘Ideally, people would always follow the instructions at level-crossing barriers, but…’ Then we can start putting ourselves in the position of a frustrated pedestrian stuck at the barrier, or a late-for-work driver. Figure 1 is a list of the ‘real’ main ‘yes, but’ statements such people might express were we to capture their (subconscious) thoughts at this critical moment:

Identifier	Perception Description
1	waiting for more than a minute feels like an eternity
2	lack of information about how long train will be
3	misjudgement of speed of large oncoming objects
4	we like to be in control
5	it's cool to 'beat the rules' - we didn't lost time like the other suckers did
6	we're late
7	we're stressed
8	past experience tells us it will be okay
9	past experience tells us wait will be a long time
10	we hate wasting our precious time
11	the wait is always longer than 'necessary' (5 minutes of wait for 5 seconds of train)
12	adrenaline rush
13	nihilistic/fatalistic view of the world
14	fight/flight part of brain wins over PFC/thinking
15	train operator doesn't care/'likes' keeping us waiting
16	rail-side fault

Figure 1: ‘Real’ Reasons Why People Sometimes Do Dumb Things At Level Crossings

Then we can turn the perceptions into a Perception Map using the usual ‘leads to’ method of mapping the relationships between each statement. The results of doing this are reproduced in Figure 2. Unlike the generation of the initial perceptions, there would be some merit in asking a broader spectrum of people their opinion about the ‘leads to’ connections. The Figure 2 map has been drawn based on a consensus of four SI team members. If, when you look at the map, you think we’ve got anything wrong, we’d love to hear from you. In the meantime, check out the map on the next page.

The first thing to notice is the presence of two downward-spiral loops. This should immediately tell us there are at least two independent problems that will need to be addressed if we’re going to identify any (politically acceptable) solution ideas. The first of these loops – on the bottom left of the figure – is all about the non-linearity of time when we don’t have any feedback to tell us how much longer we’re going to have to wait, when we could have been doing something useful with our valuable time. On the face of it, this doesn’t seem like a massive problem to have to solve. One of the iconic (very likely apocryphal, of course) TRIZ stories involves a similar problem involving occupant impatience in elevators for high-rise buildings. When the first complaints started to appear, engineers spent lots of time trying to make the elevators go faster. Then, along comes the

TRIZ expert and tells the designers to forget about faster elevators, just put mirrors on the inside of the elevator. Hey presto, problem solved: now we can be doing something ‘useful’ while we wait for our floor to arrive.

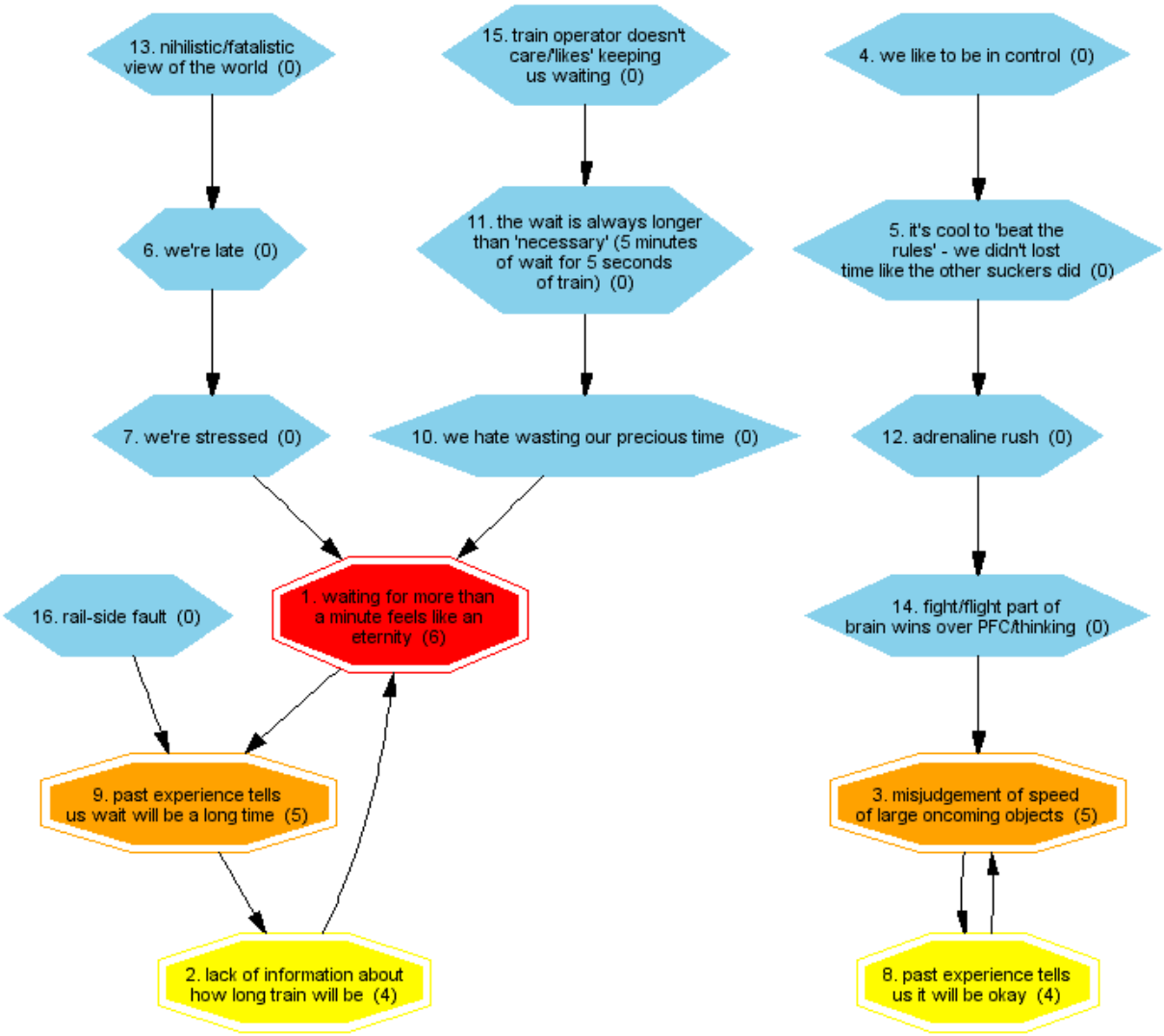

Figure 2: Perception Map Of Reasons People Sometimes Do Dumb Things At Level Crossings

More recently, we’ve started to see the ‘feedback loop’ problem being solved by the addition of simple information screens. Figure 3 illustrates the sort of solution found in non-rail public-transport sectors in the UK:

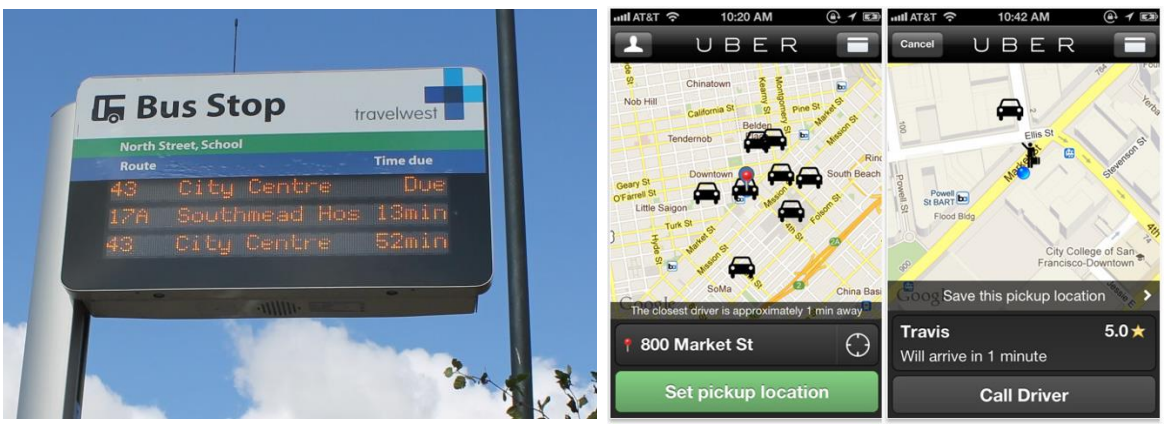

Figure 3: Possible Single-Step Breakthrough Solution Strategy

This leaves us with the second loop from the Figure 2 Perception Map. This loop is all about the combination of a cruel optical illusion and the fact that the large majority of barrier-racing efforts do not result in any kind of injury – physical or to our pride. The loop indicates that these two things create a potentially very sinister downward spiral that tells us the more we get away with our poor decisions, the less likely we are to realise the magnitude of the optical illusion problem. Indeed, the more we get away with things, the greater the likelihood that the optical illusion becomes greater and greater… until the tragic day when… ker-splat.

This second problem has all the hallmarks of a rather stubborn contradiction problem with both tangible and intangible elements to it. I mapped it onto the Contradiction Matrix as reproduced in Figure 4:

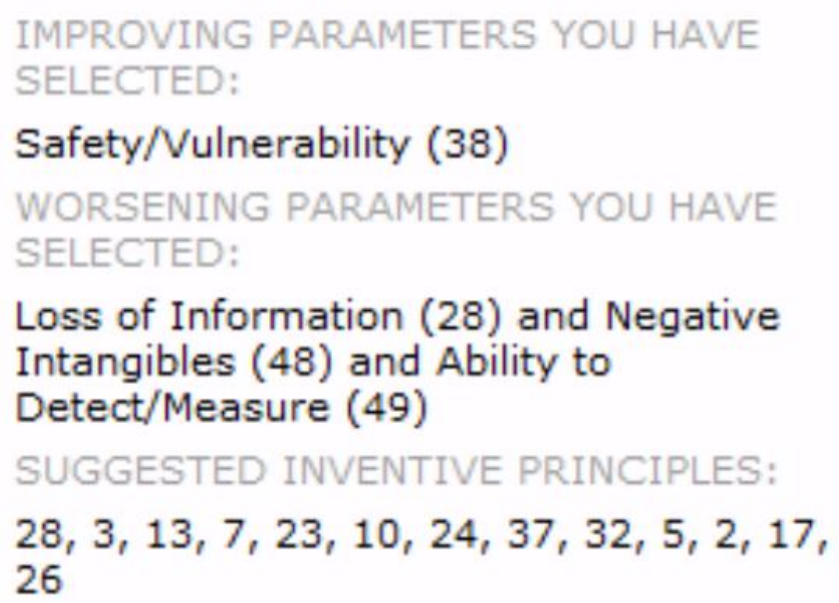

Figure 4: Mapping The Safety-Versus-Optical-Illusion Conflict

It's quite unusual for Principle 28, Mechanics Substitution to head up the list of suggested solution directions. The message that mechanical solutions should be replaced with 'fields' prompted a patent search for such solution strategies to the level-crossing problem. There are indeed several 'field-based' barrier solutions (laser, RFID, radar, etc) albeit the fields tend to be used as sensors rather than to solve the optical illusion problem at hand. Principle 28 as beginning to look like, if it was relevant at all, was very much a pointer to a long term future of autonomous vehicles and very accurate GPS location and thus a much more super-system oriented solution to the safety problem.

We were about to move on to the next Principle, when we remembered the more modern alternative interpretation, 'Another Sense'. The problem at hand is all about an optical illusion issue, so why not think about introducing another sense into the story becomes the provocation. Sound probably being the most obvious connection. A patent search revealed nothing (other than one or two 'ultrasound' – again used as a presence detection sensor rather than directly solving the problem), but it did force us to recognize the existence of a currently untapped resource in the system. One that old Western movies featured a lot: how do the baddies work out the train is coming? Answer they put their ear to the line and listen. Why not amplify and/or maybe exaggerate that noise to emphasise the presence and speed of the arriving train? Why not – a bit more radical – use a combination of detection of someone or something ignoring the barrier and blast them with

some directional sound (so we don't pollute everyone else) to shock them out of their optical illusion?

Figure 5: Potential 'Another Sense' Train Approaching Resource?

At the very least, we know it would be easy enough to test the idea. And, if we think about it, this wouldn't be the first time or place acoustic-shock has been used to trigger our limbic brain to halt an important fight/flight response…

Not So Funny – Freudian Slippers

Freudian Slips. When you say one thing but mean your mother. So the old cliché goes. Freudian slips reveal contradictions. Or their resolution. Are they Inventive Principle 9, Prior Counter-action? Or Principle 10, Prior Action? Or maybe Principle 7, Breasted Doll?

Here are a few examples. So you can decide for yourself.
Let's start with the world of the Freudian designer…

Quite scary. This one's a bit more subtle:

I said 'a bit'. We haven't started the really subtle bit yet:

I'm still not sure whether the missing 'P' is part of the story?
But isn't that the ultimate flaw in Freud's whole argument. Sometimes a cigar is just a cigar. Sometimes a banana is just a banana…

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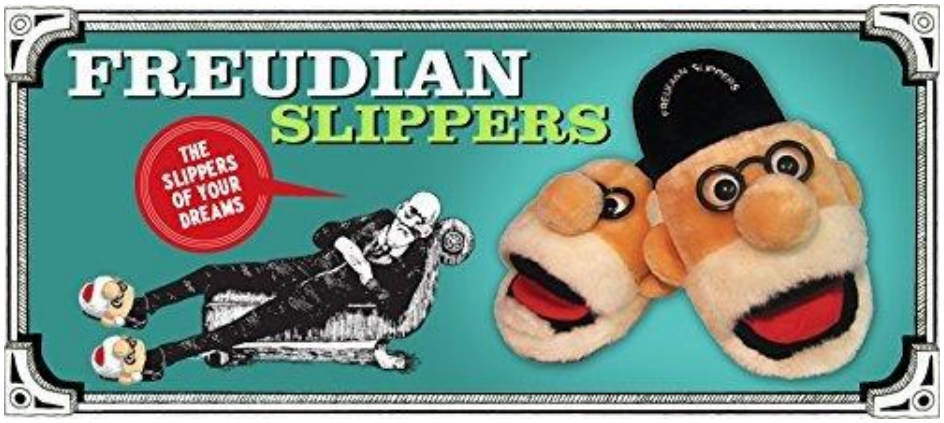
Remember, only six months shopping time until Christmas…



Or maybe…

Personally, I think the failure to rethink the shape of the bottle is a lost opportunity. A cigar might just be cigar, but a bottle is rarely just a bottle.

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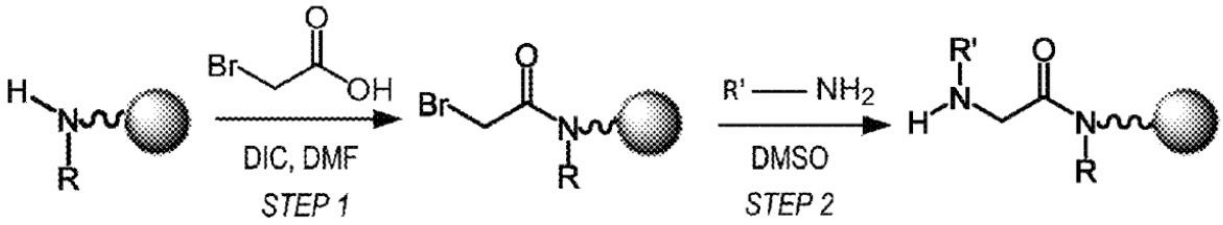
Patent of the Month – Reducing Ice Crystal Formation



Our patent of the month this month is US9,986,733, granted to Bay Area start-up, X-Therma (x-therma.com, 'biomimetic nanotech') on the 5th of June. Here's what the company has to say about the problem being solved in their invention:

Cryoprotective agents (CPAs) are compounds that when present in solution can reduce or inhibit ice crystal formation in solutions exposed to sub 0.degree. C. temperatures. Current CPAs include small molecules (often referred to as penetrating CPAs), synthetic polymers, and antifreeze proteins.

Organ transplantation is currently the best treatment for end-stage organ failure in terms of survival, quality of life, and cost effectiveness. Unfortunately, a steep gap exists between supply and demand of organ transplants, and is one of the major medical obstacles that forces patients of debilitating disease to suffer low quality of life over a long period wait time. The apparent lack of organs is due to considerable waste from the absence of a reliable preservation method. In fact, over 50% of lungs, pancreas, and hearts remain unharvested from deceased donors.

In order to properly preserve organs, they have to be flushed with a preservation solution to remove blood and stabilize the organs. Even once stabilized in the preservation solution, there is only a limited time available for organ allocation, transportation, and transplantation after removal from the donor (.about.6-12 hours). This small timeframe results in most organs going to local patients because remote patient matches often cannot be confirmed in the limited time. As a result of this shortage and in spite of laws which exist in almost all countries prohibiting the sale of one's organs, illicit organ trade and human trafficking has risen to supply demand.

Current penetrating CPAs used in organ preservation include ethylene glycol, 1,2-propanediol, dimethyl sulfoxide, formamide, glycerol, sucrose, lactose, and D-mannitol, generally among others. In order to reduce or inhibit ice crystal growth at organ preservation temperatures, the effective concentration of the penetrating CPAs must be very high (.gtoreq.60% is often required). At such high concentrations these compounds can be toxic to the tissues they are attempting to preserve, and the massive removal of CPAs upon warming before transplantation can lead to irreversible cell death.

Other CPAs used to reduce or inhibit ice crystal formation include synthetic polymers and antifreeze proteins. Similar to the penetrating CPAs, each of these have their drawbacks. Synthetic polymers, for example, are not capable of permeating the cellular membrane. As such, synthetic polymer CPAs can only control extracellular ice formation. In order to effectively preserve the biological sample, ice crystal formation must be controlled both inside and outside the cell. Naturally-occurring antifreeze proteins, such as those isolated from fish, plants, or insects, are highly effective at preventing ice formation, but current antifreeze proteins that are available are of low purity and are extremely expensive. Additionally, the use of antifreeze proteins to preserve a biological sample introduces a potential source of immunogenicity.

As such, there is a need in the art for novel non-toxic compounds to effectively reduce or inhibit ice crystal formation at sub 0.degree. C. and cryogenic temperatures.

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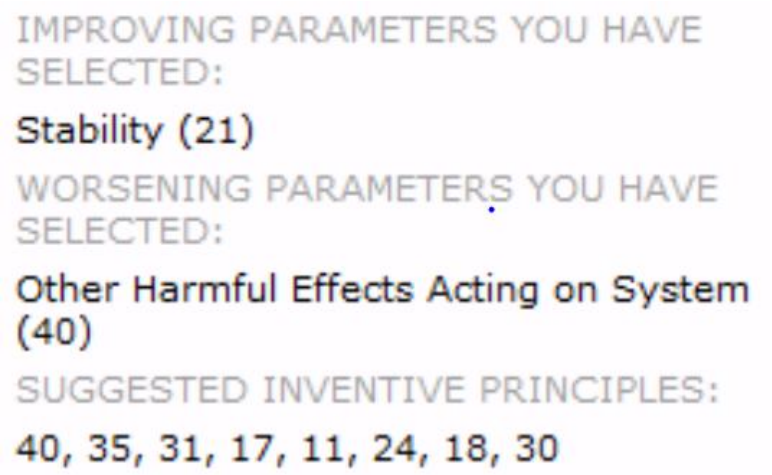
Learning that there's only a 6 to 12-hour window of opportunity for donated organs to travel from donor to recipient is a fairly shocking number. Increasing this number is clearly a great problem to work on. The contradiction, based on this background description is the amount and toxicity of chemicals used to prevent organ-destroying ice particle formation while organs are chilled. Here's how we can best map the problem onto the Contradiction Matrix:



And here's how chemist and CEO, Xiaoxi Wei, solved the problem:

The present invention is based, in part, on the surprising discovery that N-substituted biomimetic amino acid polymers (peptoids) and peptoid-peptide hybrids have ice crystallization inhibition properties. Provided herein are polymers for reducing or inhibiting ice crystal formation at sub 0.degree. C. and cryogenic temperatures. These polymers are useful in making cryoprotectant solutions.

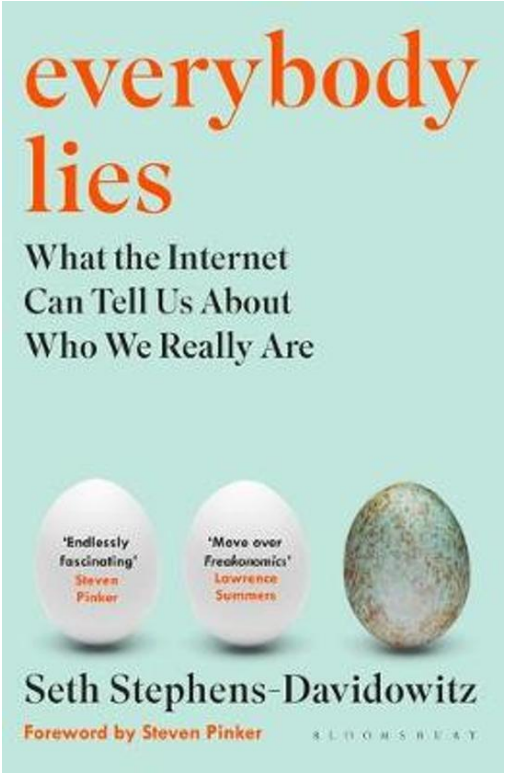
In other words, a classic Principle 35, Parameter Change solution.
Or, digging a little deeper…

…In another aspect, the present invention provides a peptoid-peptide hybrid comprising a peptoid polymer described herein and one or more amino acids, wherein the one or more amino acids are located at one or both ends of the peptoid polymer and/or between one or more peptoid monomers. In some embodiments, the one or more amino acids are selected from the group consisting of alanine, cysteine, aspartic acid, glutamic acid, phenylalanine, glycine, histidine, isoleucine, arginine, lysine, leucine, methionine, asparagine, proline, glutamine, serine, threonine, valine, tryptophan, tyrosine, and a combination thereof. In particular embodiments, the one or more amino acids are selected from the group consisting of isoleucine, leucine, serine, threonine, alanine, valine, arginine, and a combination thereof.

…which sounds rather like Principle 40.
As ever, the trick with these kinds of chemistry problem is knowing what Parameter Change and what Composite are going to be useful amongst the millions of possible combinations. The fact that X-Therma have found what sounds like to be a very elegant solution to a very generalizable problem suggests to me that their future is bright. Organ transport is an archetypal 'high value niche' launch opportunity. Looking at their website, follow-on applications, where ice-formation is also a big problem – from pipelines, to ice-cream to anti-aging creams – look like they offer up a bright future.

We like this one a lot.

Best of the Month – Everybody Lies



Here's one of those polarizing choices for our 'Best Of' feature. It's pop-science, and, these days, that in itself is enough to alienate many potential readers. When book covers declare 'New York Times Best Seller', that's usually a warning sign. And, of course, there is a fair amount of lowest-common-denominator, salacious content to plough through (author, Seth Stephens-Davidowitz wanted to call the book How Big Is My Penis?, as an early example of a case-study-come-story). But there are also a host of nuggets that take this book beyond Cambridge Analytica Big-Brother-Is-Not-Only-Watching-You-But-Making-You-Do-Stuff-The-Real-You-Would-Never-Have-Done danger territory. Stephens-Davidowitz settled for Everybody Lies. The book is subtitled What the Internet Can Tell Us About Who We Really Are and it's a polished display of some of the early fruits of "big data" science.

Stephens-Davidowitz's first source, when he set up as a data scientist, was Google Trends, which records the relative frequency of particular searches in different places at different times. He soon added Google Adwords, which registers the actual number of searches. Then he moved on to other vastnesses: Wikipedia, Facebook and then PornHub, one of the largest pornographic sites in the world. PornHub gave him its complete data set, duly anonymised: every single search and video view, and then we get into the seamier territory of a host of, ahem, niche sites like neo-Nazi-central, Stormfront.

Ignoble metadata flowed in. And thus we get things like the discovery that searches for racist jokes rise about 30% on Martin Luther King Day in the US, and that in the recent Republican primaries, regions that supported Donald Trump in the largest numbers made the most Google searches for the n-word. Data from Prosper, a peer-to-peer loan website, showed that there are five expressions in particular that one should beware of when reviewing applications for loans: "God", "promise", "will pay", "hospital" and "thank you".

Making promises “is a sure sign that someone will … not do something”. “God” is particularly bad news.

There are many such facts waiting to be harvested. For a social scientist such as Stephens-Davidowitz, big data has four central virtues. First, it’s a “digital truth serum”: it supplies honest data on matters people lie about in surveys, for instance racist attitudes, but above all sex. Second, it offers the means to run large-scale randomised controlled experiments – which are usually extremely laborious and expensive – at almost no cost, and in this way uncover causal linkages in addition to mere correlations. Third, the sheer quantity of data allows us to zoom in precisely on small subsets of people in a way that was previously impossible. Finally, it provides new types of data.

Stephens-Davidowitz thinks searches of internet pornography habits are probably “the most important development … ever … in our ability to understand human sexuality”. They deliver data that “Schopenhauer, Nietzsche, Freud and Foucault would have drooled over”.

Some of his sexual facts are depressing, others are funny and touching. Some are engaging because we find them extraordinary, others because we find them all-too-human. The search data suggests that hundreds of thousands of young men are predominantly attracted to elderly women. Many heterosexual men feel about their partner what William Wordsworth felt about his wife Mary (they wish she’d put on weight). Anal sex is on course to overtake vaginal sex in pornography before the end of the decade. Pornography “in which violence is perpetrated against a woman … almost always appeals disproportionately to women”. More than 75% of searches of the form “I want to have sex with my …” are incestuous. Men search for ways to perform oral sex on themselves as often as they search for how to give a woman an orgasm.

There are many unwavering specialisations. For some women, only short fat men with small penises will do; for some men, only massive nipples. Thirty per cent only ever watch pornography of the ugliest kind. But many of us are not as weird as our online behaviour may suggest. Distortion is introduced by the fact that certain types of Google searches “skew towards the forbidden”, and there are numerous subtleties and traps when it comes to the interpretation of data, many of which Stephens-Davidowitz expounds clearly. For all that the numbers are big, and they add up.

“The next Foucault will be a data scientist. The next Freud will be a data scientist. The next Marx will be a data scientist.” This is unlikely, I think, unless the data scientist educators start teaching students how the world works from a first-principle level. Or, better yet, that the other disciplines learn how to do meaningful data science. In any event, by the end of Everybody Lies Stephens-Davidowitz has almost earned his flourishes (“What constitutes data has been wildly reimagined … Everything is data!”). What he hasn’t done is say enough about the dangers. I expected a reference to Cathy O’Neil, who shows in her book Weapons of Math Destruction (2016) how programs based on big data introduce a frightening new efficiency into predatory advertising, “distort higher education, drive up debt, spur mass incarceration, pummel the poor at nearly every juncture, and undermine democracy”. Programs designed with the very best intentions fall into deadly self-confirming feedback loops that confirm their efficacy even as they spiral away from the truth and increase injustice.

One of the greatest dangers of the internet, noted by Daniel Kahneman in his crucial book, Thinking, Fast and Slow (2011), arises from the fact that “people can maintain an unshakable faith in any proposition, however absurd, when they are sustained by a

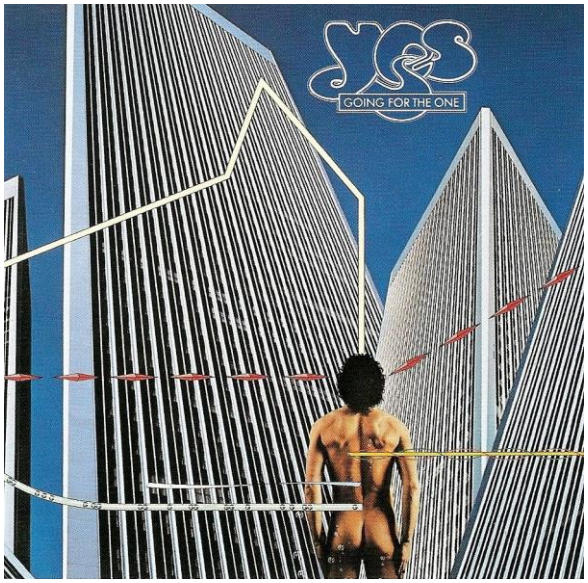
community of like-minded believers". This isn't any sort of exaggeration; the trouble is that any belief – any prejudice or hatred – can now fairly easily find a critical-mass sized supporting community on the internet.

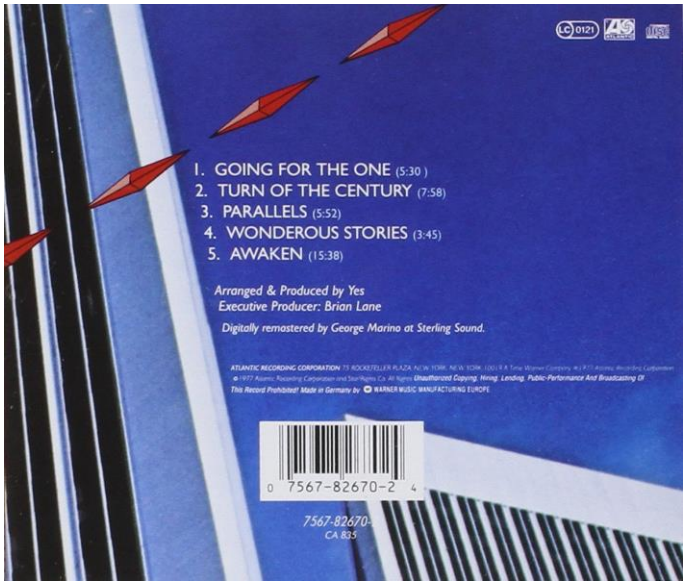
Stephens-Davidowitz has a reply to some of these worries. He's a social scientist, and malignant programs aren't data science in his sense of the term. Their creators aren't simply trying to describe and explain human behaviour; they're directing it and manipulating it. Big data isn't intrinsically dangerous or evil, and it can be extraordinarily valuable and engaging. New facts spring up everywhere. For him "the big point is this: social science is becoming a real science. And this new, real science is poised to improve our lives".

I like Stephens-Davidowitz's suggestion in a recent interview: "Sometimes I think it would be a good thing if everyone's porn habits were released at once. It would be embarrassing for 30 seconds … then we'd all get over it and be more open about sex." But I don't share his general optimism. I suspect the easy availability of pornography is turning out to be one of the great tragedies of human history, destructive of the best kind of sexual relations. If we had an infallible happyometer that could measure the overall gains and losses to human existence caused by the internet, I think we'd find that the balance was – will increasingly be – negative. Which sounds kind of glass-half-empty. So, just in case we ever want to take the future seriously, we should also say that, as the contradictions against 'Big Data' grow, so will the desire to solve them. Which will then loop back to the new breed of first-principle-lead-data-scientists. People that will have understood that rooting out contradictions is one of the main jobs of Big Data, and that society's most important job is to then set about solving them. The future's bright. Just after the darkest hour before the dawn.

Meanwhile, all we need to remember is that Everybody Lies is nothing more nor less than a PanSensic source book. Aha, that's why we like it.

Wow In Music – Awaken





1977. Punk had arrived. Which meant if you were Prog, you had suddenly become a dinosaur. Literally overnight. Some prog bands never recovered. Archetypal prog band, Yes, instead took the bit between their teeth and produced one of their best albums, Going For The One. On the second side of which was one of their best long songs. Awaken is fifteen minutes of glory. The only thing I think betters it is when I saw the band live in Cardiff a decade ago and they played an amazing version at the end of their set which had the fans on their feet for a five minute ovation. There might have been a tear in my eye.

Yes fans are a dedicated people. Awaken's rise to classic status was actually a fairly slow one. Early reviews barely mentioned it, but then after 1000 listens, and we can't imagine the world without it. Here's why we're so into it.

This song in its 15 minutes of inspired genius can be thought of simply like many other pop songs, and broken down into (Principle 1) 4 different sections. The main difference is, Yes does it bigger:

Intro/outro
A: mostly a drone guitar riff in E minor. at 1:33
B: all the major triads in ascending pattern of 4ths at 5:13
C: Ambient bridge of many organ scales at 6:35

The B' after C at 10:35 is our favorite part... It's the mostly the same harmonically as B, but in a different rhythm (Principle 19). Less predictable at first listen, more satisfying as you start to feel it.

I want to especially look at the harmony of the B and B' sections. That's what makes Yes fans weep. (Really, weep).

There has been a lot of fascinating research on music and the brain. My favorite study of the moment concludes that we receive dopamine from being able to predict music. For most people: Music that's too predictable is boring. Music that's completely unpredictable is unsatisfying. The predictability of Awaken is a perfect storm for Yes fans. The constant feeling at first listen to the B section is: "What a confusing harmonic structure, but a small part of me knew that particular chord that was coming". WHY?

SYSTEM ATIC INNOVAT ION

Reason #1: It's a perfect pattern. The first chord goes up a 4th to the next chord, then up a 4th to the next chord, then up a 4th to the next chord. Here's the chord progression:

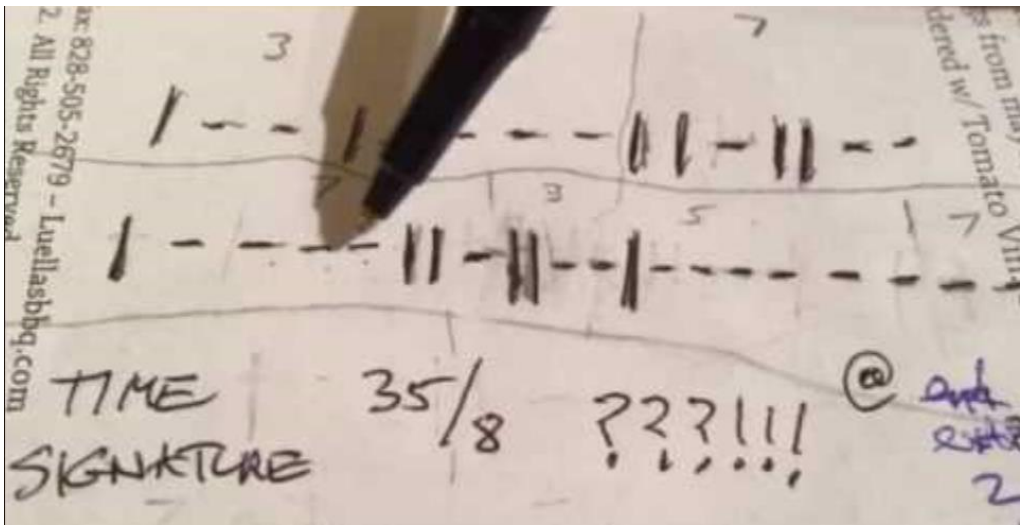
E A D G C F Bb Eb Ab Db Gb B
| | | | | | | | | | | |

Reason #2: Going up the interval of a 4th from one major triad to another also happens to be the "AUTHENTIC CADENCE". If you freeze any two of the adjacent chords in this chord progression, and play them in order, what you get is the most familiar cadence in the tradition of western music. For example, if you play the major triads E, then A, you feel like you have gone from unstable to stable, and you are now in the key of A. That authentic cadence happens over and over again (Principle 20) - 12 times in the chord progression. The feeling of the music getting more and more powerful comes from constantly moving to what feels like a more resolved place (Principle 12) in the harmony after being in a place you thought was the final resolution. That is the musical illusion of this song. From there they use other musical devices to increase the drama as that chord progression is repeated. By repeating the chord progression, they are resolving the B back to the E again, which is another authentic cadence. The constant temporary resolve doesn't end at the B chord, it just keeps looping.

It was an inspiring moment when journalists spoke to Jon Anderson about the song. He said: "I heard Steve Howe playing the A section riff down the hall and I really liked it, so I wanted him to develop it. I asked him to do it in a few different keys, and that section came together easily. Then I said Ok. Now I want you to play as many chords as you can." Steve Howe, being an excellent musician and guitar player threw down all of the major triads one by one in an ascending pattern of perfect 4ths and the epic B section was conceived. "We wanted to bring that section back and Chris said 'Wait! Do it in Halftime!'" (Principle 19). Exciting music often comes from simple ideas.

But then again, special prize to anyone that can work out what the A section time signature of Awaken is.

I'm going with a mind-boggling 35/8.
Check this out: https://www.youtube.com/watch?v=aK5zn0yGWes



And if you want to see real genius at work, try this live version, with Jon Anderson and an Icelandic choir. If it doesn't bring more tears to your eye, you're officially dead.
https://www.youtube.com/watch?v=CwspoyRdeV0

Investments – Battery-Free Smart Toys

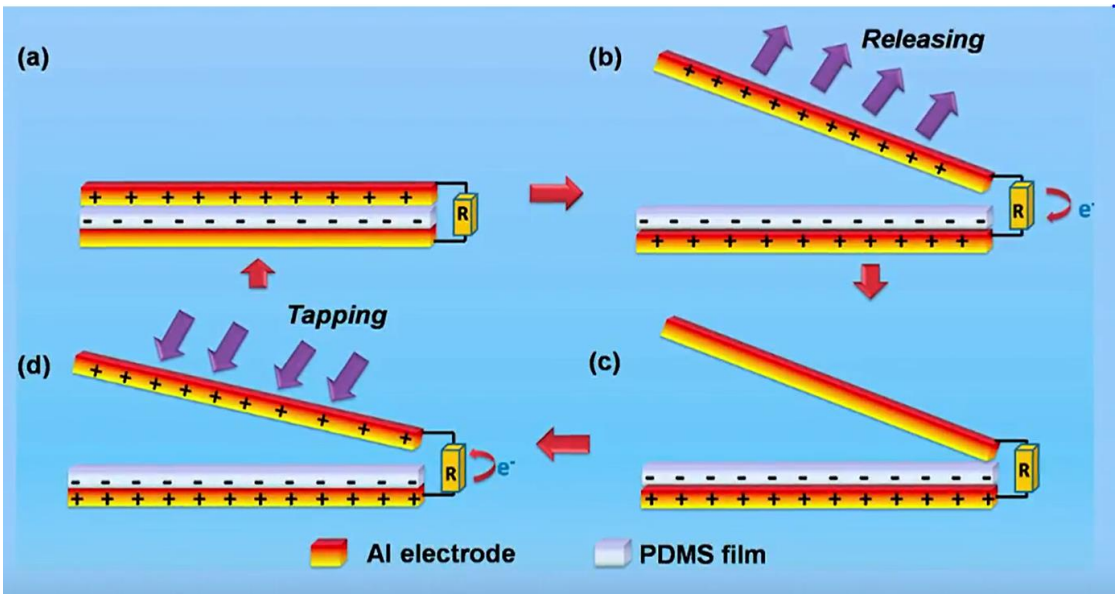
It is often said that the majority of innovations start their lives in the war, sex or toy domains. This month's investment candidate is looking like it will make the transition from great idea to important reality via the latter route. Tribolelectric nanogenerators will eventually find a multitude of serious applications, but for the moment, these Korean inventors have found a far less testing application of the technology.

And so, rubber ducks could soon be at the forefront of an electronic revolution. In ACS Sustainable Chemistry & Engineering, scientists report they have used specialized nanogenerators that gather energy from mechanical vibrations to transform squeaky bathtub companions and other conventional children's toys into 'smart' electronics. They say the finding could have broad commercial applications, leading to the development of battery-free, self-powered toys, medical sensors and other devices.

By age 4, virtually every child has had contact with an electronic toy or mobile device, according to the American Academy of Pediatrics. Keeping these devices blinking and beeping is tedious, often requiring frequent charging or battery changes. Researchers have explored alternative ways to produce and store energy for these devices without using batteries. One promising approach involves the use of triboelectric nanogenerators, or TENGs. TENGs gather electrical charges from friction, similar to the static that builds up on a balloon when it is rubbed against someone's head. TENGs amplify and convert this biomechanical energy into a usable form. However, ramping up these devices for commercial applications has been challenging, possibly because of low energy storage and conversion efficiencies. To address some of these issues, Sang-Jae Kim and colleagues at Jeju National University in South Korea sought to more effectively harness the energy from TENGs and use it to transform traditional toys into commercially viable, self-powered 'smart' toys.

The researchers designed and incorporated TENGs – made with aluminum electrodes and an eco-friendly silicone-like film between them – into rubber ducks and clapping toys. Squeezing or shaking the toys alternatively separated and brought the electrodes into contact with film, creating an electrical charge. Once activated, the TENGs harvested enough biomechanical energy to illuminate several LED lights attached to each toy. The

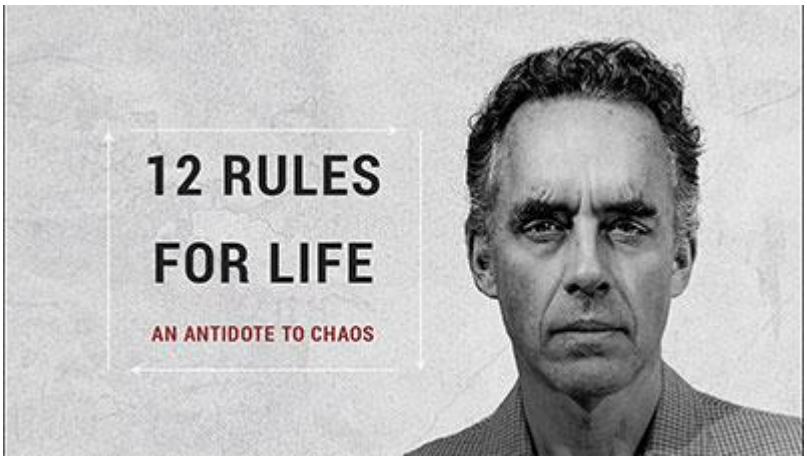
TENGs were durable, suggesting they could operate for substantial periods. The researchers conclude their unique approach can transform traditional toys into battery-free interactive ones and raises the prospect of successfully using TENGs commercially in other "smart" gadgets including medical devices and wearable electronics.



Watch a video of prototype toys: www.youtube.com/watch?v=zL2LR-iqE5Y

Journal Reference:
Arunkumar Chandrasekhar, Gaurav Khandelwal, Nagamalleswara Rao Alluri, Venkateswaran Vivekananthan, Sang-Jae Kim. Battery-Free Electronic Smart Toys: A Step toward the Commercialization of Sustainable Triboelectric Nanogenerators. ACS Sustainable Chemistry & Engineering, 2018; 6 (5): 6110 DOI: 10.1021/acssuschemeng.7b04769

Generational Cycles – 12 Rules For (Millennial) Life



Could the plight of today's 20-something white American male be cured with a self-help book? For tens of thousands, the answer appears to be a surprising yes.

The author, Jordan Peterson, is a clinical psychologist and college professor from Canada. He derives answers from theology, psychiatry and philosophy for questions about life, gender roles, and other hot button topics. His book, 12 Rules of Life: An Antidote to Chaos, has become a near-global bestseller.

Flipping the pages, this isn't a book of Oprah Winfrey mantras on positivity. Its theme is simple – life is not supposed to be easy. In fact, life is "a catastrophe." Peterson's advice runs the gamut from the simplistic and common-sense – standup straight with your shoulders back at all times, and don't forget to make your bed and clean up your room in the morning – to the more life-changing and revelatory. Happiness is a worthless pursuit in life, according to Peterson.

The book, his subsequent lecture videos, and a very public and pugilistic interview on UK's Channel 4 against anchor Cathy Newman (the video has been watched 7 million times on YouTube), have skyrocketed Peterson to a rare level of celebrity. He's the public intellectual of the moment in the United States, much to the chagrin of the 'neo-Marxist' liberal left he goes out of his way to berate. And here's where the problems begin. The left's response is to label Peterson 'Alt Right', very likely in an attempt to discredit him by association to the less savoury Trump and Brexit voters.

To me, Peterson has nothing at all to do with this version of Alt Right. What he actually is, is a latter-day Stoic. Albeit with a strong grounding in psychology. He's certainly not an innovator however. And that's perhaps the significant issue from a Generation Cycle perspective. If he were able to look forward with any kind of problem-solving insight he'd be advocating new ways of looking at the world. Maybe even the idea of revealing and solving contradictions a la TRIZ. Instead what we get is someone with a lawyer's ear for language, a good shot of mythology and, for many, too strong a propensity to quote from the Bible and use the words he finds there to try and justify his 'scientific' arguments.

Peterson was born in Canada in 1962. Which places him right on the cusp of the Baby Boomer and Generation X divide. As with all cuspers, it's very difficult to sit on the fence in life, and I'd have to say – having read 12 Rules For Life – that he falls very clearly on the Boomer side of the fence. Which means his tone is much more Moralistic than it is Pragmatic. And that he feels justified in saying things in the book like, 'well, there's this

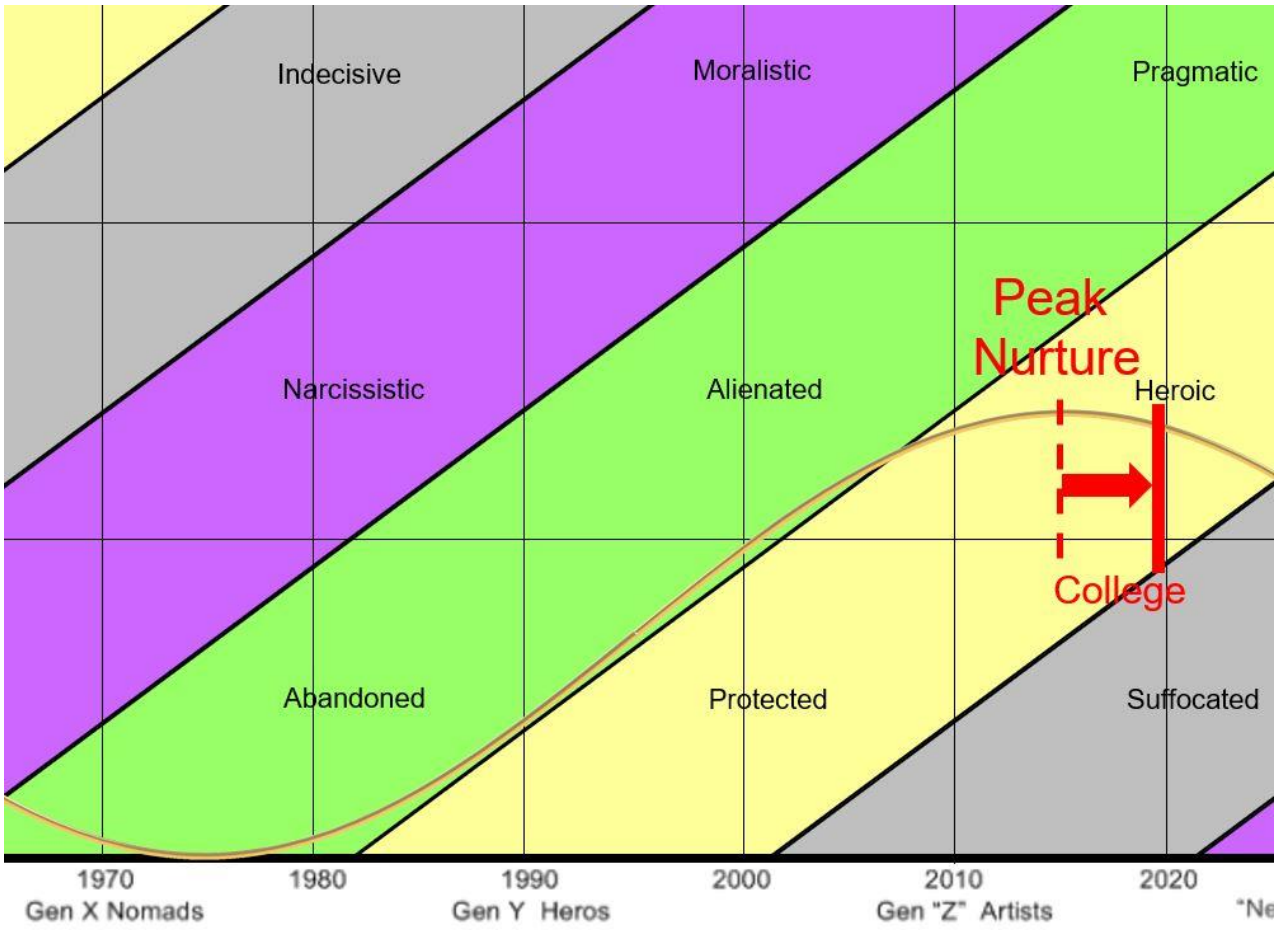
really odd verse in the Bible and it took me years to work out what it meant'. As if his thinking on the subject somehow trumps that of any other scholar of the past two Millenia. The arrogance could only come from a Boomer.

Falling on the Boomer side of the generation divide, however, comes with a big advantage. For Peterson at least. It makes it much more likely that the Millennials will pick up on his messages.

However, because Peterson is only able to look back rather than help design a better way forward, all that's happening is that he's becoming the catalyst causing the societal oscillation between over-protection of the young to start swinging in the opposite direction.

A few weeks ago a wrote a short blog article about 'Peak Snowflake' – the point when the cohort of young adult Millennials collectively hit their peak fragility. My conclusion was that we're still a year or so away from that peak. In no small part because the over-protection that late-teen Millennials received when they lived at home now falls foul of the aforementioned neo-Marxist liberal left intelligentsia that Peterson claims has pretty much taken over the college system in most parts of the West.

We may still be a year away from Peak Snowflake, but I think it is legitimate to say that 12 Rules For Life will turn out to be one of those iconic calls-to-arms that history will deem to have triggered the turnaround of the societal pendulum.



Peterson's concern for young men and boys has set him on an emotional quest– he openly cried during a radio interview describing emails and social media messages he has received from his viewers (very attractive to Millennials!) – that has gained him a

passionate following, sell-out lectures wherever he goes, and a YouTube channel that will probably allow him to dominate the Millennial airwaves.

Part of Peterson's fame reflects a feared crisis in young American men today. They are often stereotyped as either basement dwelling video game addicts or frat boy alpha male misogynists, out of touch both with society and their female counterparts – many with no real ambition or suitability for marriage.

Peterson sees young men as victims of a society that hasn't prepared them to be men, where postmodern, identity group politics has leaked out of the campuses and into the elementary schools, where being an energetic boy is considered a mental health defect, as social media rumors say.

What they find in Peterson is a guide and someone who is fire-and-brimstone-preacher level frank, and honest about reality. Peterson doesn't simplify the world's problems, he acknowledges them as complex and that has given him credibility among his fans, who are navigating the new world of ever changing sexual politics, be it at school, work or the dating sphere. His lectures combine his expertise in clinical psychology, along with religious themes and Jungian psychiatry. He skips postmodern and ideological meanings, and gives answers in metaphors that run the range from philosophy and religion to Greek mythology. The answers are complicated, and in many cases there are no answers, but young men have found guidance in his videos and now his book, and believe they have found an authentic (those tears!) honest broker.

Peterson painting the world as a dark place isn't surprising for Generation Xers, who came of age during the Cold War and the possibility of nuclear annihilation. But it's revelatory to some of Peterson's younger interviewers and even shocking.

Young men have found a public advocate, after years of real or imagined blamed for being the cause of all the world's problems; and for not meeting the expectations of anyone. The Millennial male is neither sufficiently manly as a whole, or is toxically masculine, depending on the given think piece, magazine article or girlfriend. But watching and reading Peterson, and analysing what his audience is attracted to most, it suggests young men are crippled by a prolonged adolescence. They were never given the tools to progress to maturity or the tests to gain the confidence to take their place in the world as adults.

And so the pendulum swing towards under-protection begins in earnest. Sorry, Dr Benjamin Spock (the author that triggered the previous swing in the direction towards over-protection with his 1946 classic 'Baby And Child Care'), all of your work is about to be undone. At least until your successor comes along in another 40-50 years to set the pendulum swinging the other way again…

…unless society can somehow begin to recognize that these frustrating, time-wasting pendulum swings occur because we don't recognize they symbolize unsolved contradictions. And that such contradictions are eminently solvable, provided we give ourselves permission to start designing new (third-way) contradiction-solving ways to actually make some societal progress.

Biology – Arctic Ground Squirrel (*Spermophilus parryii* or *Urocitellus parryii*)

Every September arctic ground squirrels in Alaska, Canada and Siberia retreat into burrows more than a meter beneath the tundra, curl up in nests built from grass, lichen and caribou hair, and begin to hibernate. As their lungs and hearts slow, the rivers of blood flowing through their bodies dwindle and their core body temperatures plummet, dipping below the freezing point of water. Electrical signals zipping along crisscrossing neural highways vanish in many areas of the brain. Seven months later the squirrels wake up and return to the surface—famished, eager to mate and perfectly healthy.

How hibernating mammals survive for so long at such low temperatures without any food or water beyond what they have stored in their own fat fascinates scientists for many reasons. Hibernation is an amazing biological feat and an opportunity to learn new ways of pushing the human body beyond its ostensible limits, as well as healing it when it breaks down. The arctic ground squirrel's brain, in particular, seems to be incredibly resilient. When ground squirrels hibernate their neurons shrink and many connections between neurons shrivel. But their brains periodically compensate for this loss with massive growth spurts, multiplying neural links beyond what existed before hibernation. Learning how the ground squirrel's brain recuperates could not only help scientists understand the brain's plasticity, but also suggest new ways to reverse or prevent cellular damage in neuro-degenerative diseases. In particular, recent research on hibernating brains is changing the way some scientists think about misshapen tau proteins, which are a hallmark of Alzheimer's disease.

Brain freeze

Most small hibernating mammals—hamsters, hedgehogs, bats—turn down their body's thermostat during hibernation, relinquishing one of the defining features of all mammals: warm blood. Arctic ground squirrels are the most extreme example. In August 1987 Brian Barnes of the University of Alaska Fairbanks (U.A.F.) captured 12 arctic ground squirrels and implanted tiny temperature-sensitive radio transmitters in the animals' abdomens. He transported the squirrels to outdoor enclosures in Fairbanks—wire cages with borders

reaching more than 1.2 meters belowground. By September the ground squirrels had dug burrows within the enclosures and begun to hibernate. Their body temperatures dropped to –2.9 degrees Celsius, almost three degrees below the freezing point of freshwater and probably the lowest core body temperature ever recorded in a living mammal. Despite this, ground squirrel blood remains liquid, most likely through a phenomenon known as supercooling.

In laboratory experiments, Barnes also measured the temperature of various body parts as the squirrels hibernated in a chamber kept at –4.3 degrees C. Although their colons, feet and bellies dropped below zero C, their necks never grew colder than 0.7 degree C, suggesting that the brain remains a little warmer than the rest of the body. Most mammals would die within hours if their brains were cooled so low, yet ground squirrel brains survived near freezing temperatures for weeks at a time. Every two to three weeks the squirrels shivered themselves back to their typical body temperature of 36.4 degrees C, which they maintained for 12 to 15 hours before becoming frozen pop-squirrels once more. Later, scientists would confirm that these intermittent periods of arousal are crucial to the ground squirrels' survival—without them their brains would wither long before spring's arrival.

Doom and bloom

Hibernation devastates the ground squirrel brain, wilting thousands if not millions of vital connections between brain cells, known as synapses. But its brain has evolved impressive resilience, repeatedly renewing itself at astonishing speeds, like a forest erupting through the scorched earth in a matter of days. Victor Popov of the Institute of Cell Biophysics in Russia discovered some of the earliest evidence of this plasticity. In the early 1990s Popov and his colleagues captured wild Siberian ground squirrels and kept them in temperature-controlled enclosures as they hibernated. The researchers sacrificed different animals at three distinct stages—during hibernation; two hours after one of the intermittent arousal periods; or one day after emerging from hibernation—and removed their brains to stain and examine the neurons within the hippocampus, an area crucial for memory. Neurons from squirrels that were in the middle of hibernation were shrunken and had far fewer dendrites—branches that receive signals from other neurons—compared with brain cells from fully awake and aroused squirrels. The dendrites in hibernating brains also had fewer dendritic spines, which jut out from the main branch like thorns on a rose stem and increase the number of possible synapses with nearby cells.

Whereas neurons in hibernating brains looked like barren tree limbs in the dead of winter, brain cells from squirrels that had just emerged from hibernation into a period of arousal sported dense crowns of overlapping dendrites. In only two hours the squirrels' brains had not only compensated for all the synapses lost during hibernation—their brain cells now boasted many more links than those of an active squirrel in the spring or summertime. One day later, however, their brains had pruned many of these ties, probably recognizing them as superfluous, much the way the developing mammalian brain shears its blooming neural forest.

Since Popov's study other researchers have observed similar loss and recovery of synapses in the brains of hibernating hamsters and hedgehogs. In a 2006 study Craig Heller of Stanford University discovered that the hibernating brain is incredibly plastic overall, not just in the hippocampus. Heller thinks that squirrels and similar hibernators lose dendrites during hibernation because their metabolism is too slow and their brains too cold and idle to keep those living wires in working condition.

Perhaps it's more efficient to let them shrivel, like a houseplant withering from neglect, and quickly nurse them back to life during those intermittent bouts of arousal. That way the mammals save as much energy as possible yet still preserve vital neural connections. Even so, researchers have estimated that many small hibernating mammals devote between 80 and 90 percent of all energy used during hibernation to keeping their brains alive.

Here’s what the ground squirrel’s brain re-building feat looks like as a conflict resolution strategy:

IMPROVING PARAMETERS YOU HAVE SELECTED:

Loss of Energy (27)

WORSENING PARAMETERS YOU HAVE SELECTED:

Temperature (22)

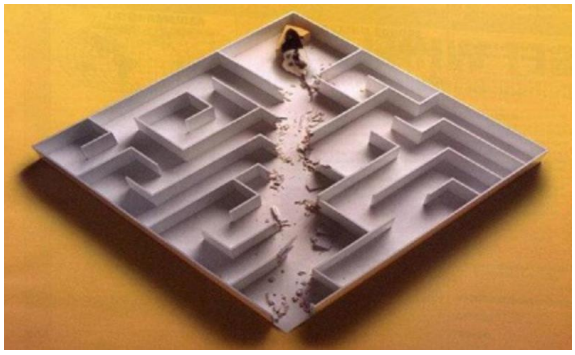
SUGGESTED INVENTIVE PRINCIPLES:

35, 7, 31, 34, 19, 21, 1

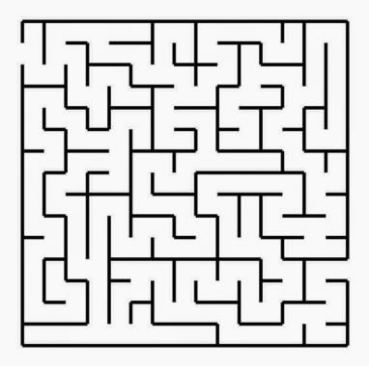
Principle 34, Discarding & Recovering – or should that be ‘doom and bloom’? – looks like as good a match as we’ll ever get between problem and solution. If only life always worked out that way.

Short Thort

We often use the mouse-in-maze metaphor to describe the innovation process. The basic idea is that we, first, need to know where the cheese is. This is the Ideal Final Result in TRIZ. Knowing where the destination is shows us the which walls in the maze we need to break down. These are the contradictions.



Some people object to the model, suggesting instead that a far better strategy is to navigate (optimize) our way through the maze. This is all well and good, but, in real life, and in the metaphor, most mazes are like this:



There is no way out of this maze without knocking at least one or two walls down. When life looks like this, the basic choice is whether we take the most direct – contradiction-blitzing – route, or whether we get smart and work out the minimum number of walls needed to break through to the reward. This question is all about resources. If you're Samsung and have thousands of contradiction solvers, your best bet is probably to set them all off to knock all the walls down. If you're a start-up with limited resources, your best bet is to focus on the best contradictions to solve. One way to do this is to make the goal much clearer:

The other involves climbing the walls so you can check whether you're in the right maze:

News

Big Data Workshop

We will be running a “Big Data Analytics Workshop: The Opportunity for the Mining Industry” in Perth (Australian version) on 30 August with our partners, AMIRA. Check out their website for more details and to book a place.

University of Buckingham

Darrell will be doing a day (19 September) on the next ‘Foundations Standardisation & Disruption’ MSc Short Course. Check out the BLEU webpage at the University for more details and booking.

US

Darrell’s trip to the US during the weeks beginning 23 July and 30 July has been extended to, very likely cover both full weeks, with stops in Miami, Minneapolis, and – just added – over on the West Coast in the Bay Area. Most of the days are already full, but if anyone wants to explore doing something for a day (or 28-29 July weekend), please get in touch with Darrell directly to see if we can make something happen.

TRIZ Journal Twitter Account

Eagle-eyed followers of TRIZ Journal will have noticed a lot more activity in recent months, including, now, a Twitter account. We’ve been trying to tweet an illustration of one of the 40 Inventive Principles every day, with a view to eventually creating a living database of relevant examples. We’d be more than happy for Followers to join in the game. The 40 Principles lists are, by some margin, the most frequently viewed parts of the Journal, and since we started the Principle Tweets, we’ve already managed to double the number of Followers. It would be great to get this thing up its s-curve. We’d love it if lots of people joined in. Tiny efforts from thousands of Followers will quickly create the world’s biggest and best repository of Principle Examples.

New Projects

This month’s new projects from around the Network:

Housing – TrenDNA Study
Automotive – Innovation Project Mentoring
HR – PanSensic Study
Financial Services – Creditworthiness Assessment Study
FMCG – Innovation Capability Maturity Assessment
FMCG – Breakthrough Project
Agriculture – Turnkey Development Project
Transport – Eyes On The World Study
Politics – Voter Anthropology Study