Systematic Innovation

e-zine

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In this month's issue:

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Our guarantee to the subscriber is that the material featured in the e-zine will not be published elsewhere for a period of at least 6 months after a new issue is released.

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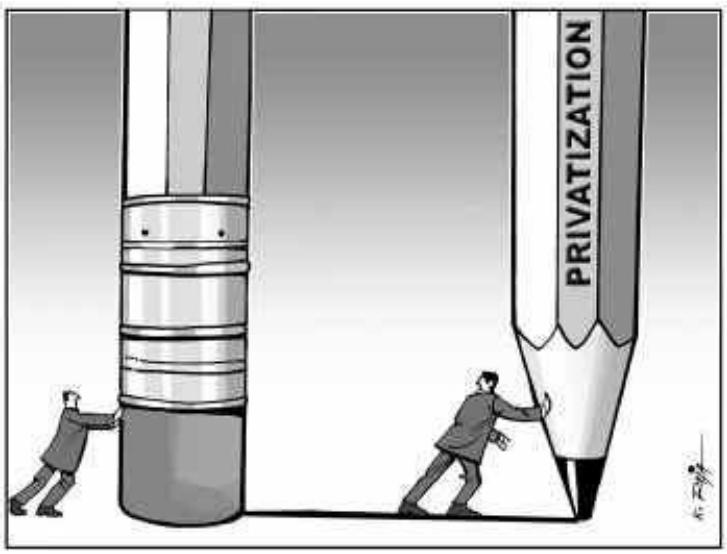
Case Study: Nationalisation Versus Privatisation



Politics depresses me. For the most part I try and stay away. I blame TRIZ. Or possibly Edward de Bono. Or possibly Socrates. He was the one that forced politicians into thinking the world had to be either black or white, and that the way you decided the 'right' answer was through a combination of logic and who-shouts-loudest-wins. DeBono told us the better solution involved 'designing' a solution that achieved the best of both worlds. TRIZ tells us the job is to eliminate contradictions.

Both teach us that whenever we hear politicians arguing over A versus -A topics, they're wasting their time. And ours. The only result, we now know, being that society as a whole is going to end up with the worst of both worlds. We're told we need to privatise our national assets in order to make them more efficient. To achieve this, we introduce armies of 'managers' to seek out and deliver those efficiencies. The incumbent clinicians and medical staff think they're idiots and so quickly realise their best strategy is to nod their heads, pretend to do what they've been told, and find secret work-arounds so they can keep on doing what they 'know' is the right thing to do. Do that for a couple of years and everyone begins to realise costs have gone up, patient mortality rates are worse and everyone is talking about leaving the profession. So then the nationalize-privatise pendulum starts swinging in the other direction. We tried one option and it didn't work, so now we need to go back to the 'good old days' of the other option. It's classic lose-lose behaviour. And it's time we put a stop to it. Socrates, you're fired.

Here's a far better way of looking like any of these kinds of A/-A debate, whether it be nationalization-versus-privatisation, centralization-versus-de-centralisation, selective-education-versus-non-selective, or any other futile, wrong-question-dummy debate. They're contradictions and need to be treated as such. It's shouldn't be a case of privatisation *or* nationalisation, but rather how we design situations in which society achieves the best of both worlds. Where everyone wins. The socialists *and* the capitalists. A 'Third Way'. One that says, 'let's not meet halfway, but rather somewhere else.'

Map the problem as a contradiction and very quickly it ought to open up a host of win-win re-design opportunities. Here's what that might look like for the nationalise-privatise story:

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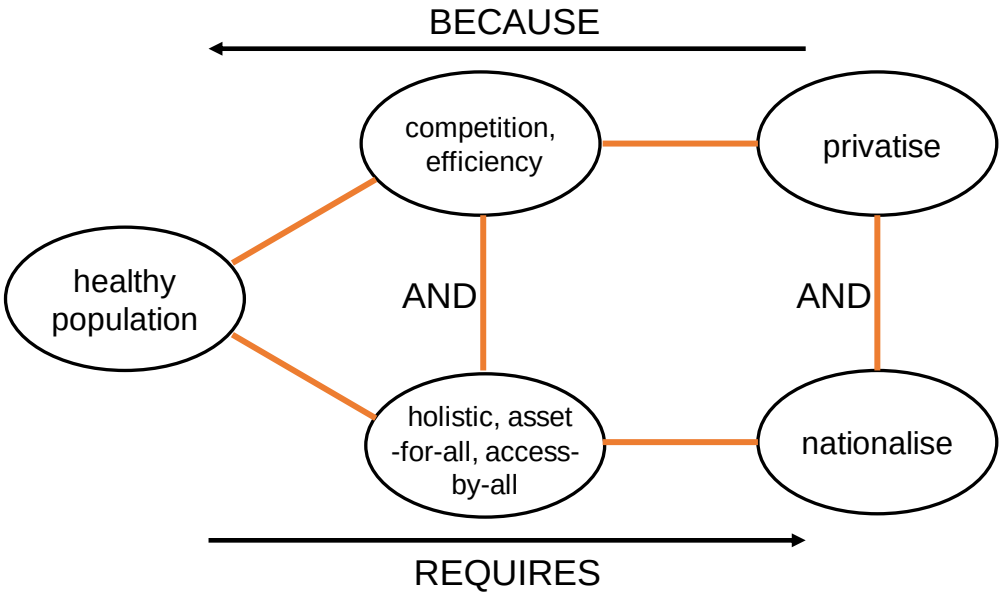


Figure 1: To Privatise Or Nationalise – Mapped As A Contradiction

Now, clearly, these kind of society-wise issue are massively complex and we shouldn't expect that we can distil it down to a single contradiction. That said, we know that if we can get matters down to the 'First Principles' level (see the following article), we give ourselves the best opportunity to make progress.

First Principles, when we're dealing with people, means recognizing that we do things for two reasons, the good one and the real one. This should tell us that, if we're going to try and map the Figure 1 story onto the Contradiction Matrix, it will be helpful to map it as two contradictions: one examining the tangible ('good reason') situation, and the other mapping the intangible ('real reason'). In this case, looking at the middle column of the Bubble Map, we get:

> Tangible:
> Market Demand versus Supply Cost – Principles 25, 13, 24, 4
>
> Intangible
> Meaning versus Competence – Principles 13, 19, 2, 23

So far so good. We're not the only people, the Matrix tells us, who've had to design a solution to these kinds of problem. The new challenge, now, is how we might meaningfully apply these abstract Principle solution suggestions to a problem as broad as nationalisation-versus-privatisation.

At the risk of offending every British reader ('don't touch our NHS'), I thought I'd try and describe an example system-level win-win solution that the Matrix might help us to design. Seeing Principle 13, The Other Way Around, appear in both the tangible and intangible problems, I thought I should start there. What to turn around the other way, though? That's what TRIZ can't tell us. Switch from top-down management to bottom-up? Switch from 'clinical evidence' to 'no clinical evidence'? Slightly more controversial perhaps, but as far as I can see, not entirely without merit since, for the most part, the whole 'clinical evidence' schtick is made-up crap anyway.

Here's another 'controversial' one: get people to get rid of the need for their role, rather than trying to preserve them. We know this works well in other industries, so why not the

NHS? As a pre-requisite, people need to be given the clear assurance that getting rid of roles doesn't mean they lose their job. Once that issue is out of the way, the eliminate-role first-principle turnaround transforms a vicious, lose-lose cycle into a win-win, virtuous one.

Here's a specific example:

Radiology. Clinical evidence tells us very clearly that computer algorithms are already considerably better at interpreting x-ray images than even the best radiologist. That statement can sound very threatening if you're a radiologist. You trained a long time to become a radiologist, so how can it possibly be that you're not as good as an algorithm? And so, with this realization, the downward spiral begins – radiologists try and pretend the finding doesn't exist (clinical evidence in *real* action!), they publish papers highlighting the dangers of computerised analysis to show the world how important radiologists are, and, in the background hidden from the public glare, they set up education programmes to ensure the next generation of radiologists compensate better for the failings of the current generation. The new generation of radiologists graduate, and the whole sorry tailspin starts another cycle. The moment you're trained to be an expert in a subject, you're inclined to protect those skills. Radiologists-create-more-radiologists. All the time this is happening, of course, patients continue to be unnecessarily harmed through mis-interpretation of their x-ray by the defensive radiologist. Everyone loses.

Contrast this with the following: the radiologists, instead of fighting the computer analysis algorithms, use their skills to make the algorithms better. They train the machines, instead of trying to dis-credit them. The patient immediately wins, because now they get a more accurate interpretation (the computer is already demonstrably better… clinical evidence), and know that the more time progresses, the better the algorithms will get. The radiologist's primary purpose is now to help the algorithms get better, such that they can focus on the more difficult diagnoses. They write papers on their findings, which get shared across the whole radiology profession, such that every hospital needs fewer and fewer radiologists. The radiologists are expected to educate fewer and fewer new radiologists, but those they do teach get taught in such a way that means they graduate with higher and higher levels of skill because now they're focusing on the stuff the computers can't do yet. Their work becomes more meaningful, and moreover, the system then allows them to retire early if they want, or retrain to build other skills, or do something else that interests them. The point being that we turn-around the 'preserve-radiologists-by-creating-more-radiologists' 'DNA' into 'create less radiologists' in a way that allows everyone, especially the radiologists, to win. The downward spiral becomes a virtuous one.

It will take a generation or two, but if we translate the same Principle 13, turn-around from preserving-the-role to build-the-capability-to-eliminate-the-role to every other part of the system, we all start to reap massive rewards from the get-go. People are now incentivised to get rid of the in-efficiency-creating work-arounds instead of protecting them, all the meaningless work gets transferred to computers, and all the meaningful work gets preserved and expanded.

The same applies to politicians. My personal Rule #1: anyone that wants to become a politician should not be allowed to become one. Anyone that is a politician has an obligation to work towards eliminating the need for more politicians. Design-in meaningful endeavor; design-out meaningless either/or debate. Every complex problem can indeed have a simple, effective solution if we capture the right problems (root contradictions) and work to solve them at the First Principle level…

First Principles First

"As to methods there may be a million and then some, but principles are few. The man who grasps principles can successfully select his own methods. The man who tries methods, ignoring principles, is sure to have trouble."
Harrington Emerson

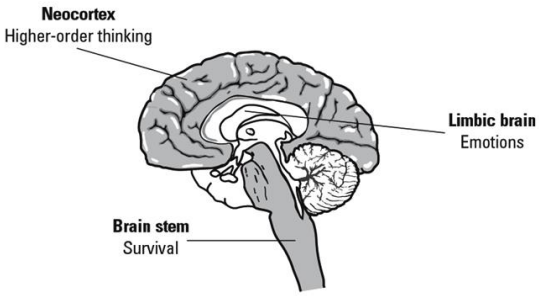
There's an aphorism we use a lot. 'For every complex problem there is an answer that is simple, clear and wrong'. These days we tend to modify it to, 'For every complex problem there are thousands of clear, simple, wrong answers.' Then we add, 'For every complex problem there is a clear, simple, right one. If we understand and affect the first principles.' As illustrated in the previous article.

The problem, very often, is working out just what these 'first principles' are. We make a start at cataloguing them here in this article.

Everything we come in to contact with is complex. If our job is to make successful step-change happen, the very best way to make sure it happens is to change things at the 'first principle' level. Customer constraints don't always allow us to do this, but it's incumbent upon us, I think, to always explore and try to affect change at the 'first principle' level. That way we don't spend our time 'pushing rivers' – we make the system 'emerge' in the way we desire it to emerge.

There are three levels of 'first principle' that we ought to have at the front of our minds when thinking about how best to create a successful step change: human, system and technological:

Human
Innovation in our context is a fundamentally deliberate act that starts as a thought in someone's brain. To all intents and purposes, therefore, 'first principles' starts in the brain. And specifically the limbic brain. Our limbic brain does all the 'why?' and 'how?' intangible stuff before our conscious (neocortex) brain has even started to get its act together.



'First principles' as far as our limbic brain is concerned means the ABC-M model we have talked about many times in the ezine. That's why it's everywhere in the tools and methods we bring to bear on any job. When Autonomy, Belonging, Competence and Meaning 'get better', good things happen.

Beyond that, when we start to think about what happens when we zoom-out and start looking at interactions between different brains, 'first principles' relates to the DNA in TrenDNA: Gravesian Thinking Styles and Generational Cycles. Strictly speaking, regarding the latter, the 'first principle' from which the 4-archetype model emerges is the transfer of influence from parent to child: the way your parents raised you, will influence how you raise your own children.

As far as Clare Graves' model is concerned, although he never (as far as I can tell) understood contradictions and s-curves, the 'first principle' underpinning the Thinking Style 'levels' is: we encounter certain contradictions in life, and if we successfully resolve those contradictions, our model of the world changes, and we 'add a new' gear into our mental gearbox. We can still access the other gears, but we can only be in one gear at any moment in time.

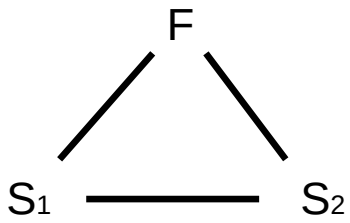
Everything else we see happening in society pretty much emerges from the ABC-M driver inside all of our heads, which then gets coupled with the Graves and Generation-Cycle models sitting in everyone else's heads.

System

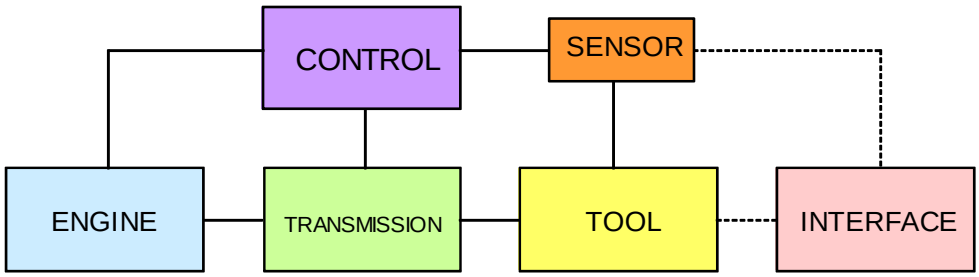
First principles as far as we need to concern ourselves when thinking about 'systems' effectively distil down to three things:

- Minimum system
- Minimum controllable system
- S-curves and discontinuous shift from one system to another

Minimum system – TRIZ did some hard work for us. The minimum system required to deliver a function (useful or otherwise – when stuff goes wrong, there was a 'system' that made it go wrong) requires a minimum 'two substances plus a field':

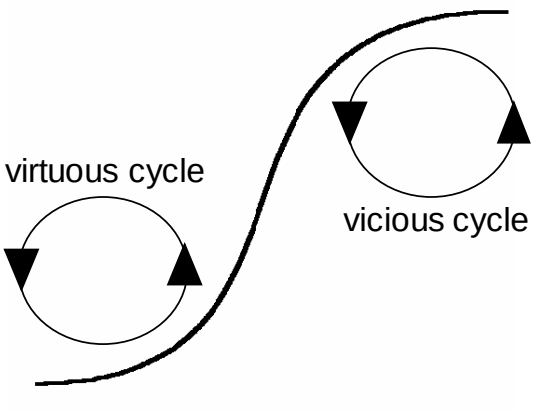


Minimum controllable system – the hard work this time was a combination of the TRIZ 'Law of System Completeness' and Stafford Beer's 'cybernetics'. The minimum controllable system must contain these six elements:



The model is also recursive ('turtles all the way'), meaning that every sub-system within a system also has to contain the requisite six elements.

S-Curves – the reason we're in the business we're in is because of the universality of the s-curve. All systems hit limits; when they hit those limits, the only way to improve the system is to change the system. Which means jumping to a new s-curve. The 'limit' is a contradiction. The contradiction comes from a 'vicious cycle'. The shape of the s-curve is driven by the dynamics of a minimum of two cycles: a 'virtuous cycle' to drive the upward trajectory, and the 'vicious' one that prevents the system from improving forever:



Technology

At a technical level, 'first principles' essentially means 'laws of physics', but even then the word 'law' needs to be used with some caution. 'Laws based on our current assumptions' is probably more accurate. Few clients like it when you take it upon yourself to challenge 'the laws of physics', but I've been involved in several projects that have successfully done just that: we challenged the assumptions and found ways in which they were wrong. The 'laws' fall into two categories: classical physics that deals with the observable world (classical mechanics), and atomic physics that deals with the interactions between elementary and sub atomic particles (quantum mechanics). Fundamental change at the technological level pretty much comes down to challenging one or more of these 'truths':

Ampere's Law

> The line integral of the magnetic flux around a closed curve is proportional to the algebraic sum of electric currents flowing through that closed curve; or, in differential form curl *B* = *J.*

Archimedes' Principle

> A body that is submerged in a fluid is buoyed up by a force equal in magnitude to the weight of the fluid that is displaced, and directed upward along a line through the center of gravity of the displaced fluid.

Avogadro's Hypothesis (1811)

> Equal volumes of all gases at the same temperature and pressure contain equal numbers of molecules. It is, in fact, only true for ideal gases.

Bernoulli's Equation

> In an irrotational fluid, the sum of the static pressure, the weight of the fluid per unit mass times the height, and half the density times the velocity squared is constant throughout the fluid.

Boyle's Law (1662); Mariotte's law (1676)

> The product of the pressure and the volume of an ideal gas at constant temperature is a constant.

Bragg's Law (1912)

When a beam of *X*-rays strikes a crystal surface in which the layers of atoms or ions are regularly separated, the maximum intensity of the reflected ray occurs when the complement of the angle of incidence, *theta*, the wavelength of the *X*-rays, *lambda*, and the distance between layers of atoms or ions, *d*, are related by the equation 2 *d* sin *theta* = *n lambda*,

Causality Principle

The principle that cause must always preceed effect. More formally, if an event *A* ("the cause") somehow influences an event *B* ("the effect") which occurs later in time, then event *B* cannot in turn have an influence on event *A*. That is, event *B* must occur at a later time *t* than event *A*, and further, all frames must agree upon this ordering.

Charles' Law (1787)

The volume of an ideal gas at constant pressure is proportional to the thermodynamic temperature of that gas.

Complementarity Principle

The principle that a given system cannot exhibit both wave-like behavior and particle-like behavior at the same time. That is, certain experiments will reveal the wave-like nature of a system, and certain experiments will reveal the particle-like nature of a system, but no experiment will reveal both simultaneously.

Conservation Laws

Conservation of mass-energy
The total mass-energy of a closed system remains constant.
Conservation of electric charge
The total electric charge of a closed system remains constant.
Conservation of linear momentum
The total linear momentum of a closed system remains constant.
Conservation of angular momentum
The total angular momentum of a closed system remains constant.

There are several other laws that deal with particle physics, such as conservation of baryon number, of strangeness, etc., which are conserved in some fundamental interactions (such as the electromagnetic interaction) but not others (such as the weak interaction).

Coulomb's Law

The primary law for electrostatics, analogous to Newton's law of universal gravitation. It states that the force between two point charges is proportional to the algebraic product of their respective charges as well as proportional to the inverse square of the distance between

Curie-Weiss Law

the susceptibility of a paramagnetic substance is related to its thermodynamic temperature *T* by the equation KHI = C/T - W, where W is the Weiss constant.

Dalton's Law of partial pressures

The total pressure of a mixture of ideal gases is equal to the sum of the partial pressures of its components; that is, the sum of the pressures that each component would exert if it were present alone and occupied the same volume as the mixture.

Doppler Effect

Waves emitted by a moving object as received by an observer will be blueshifted (compressed) if approaching, redshifted (elongated) if receding. It occurs both in sound as well as electromagnetic phenomena.

Dulong-Petit Law (1819)

The molar heat capacity is approximately equal to the three times the ideal gas constant.

Einstein Field Equation

The cornerstone of Einstein's general theory of relativity, relating the gravitational tensor G to the stress-energy tensor T by the simple equation G = 8 *pi* T.

Einstein's Mass-Energy Equation

The energy E of a particle is equal to its mass M times the square of the speed of light c, giving rise to the best known physics equation in the Universe:
$E = M c^2$.

Faraday's Law

The line integral of the electric field around a closed curve is proportional to the instantaneous time rate of change of the magnetic flux through a surface bounded by that closed curve; in differential form curl *E* = -d*B*/d*t*, where here d/d*t* represents partial differentiation.

Faraday's Laws of electrolysis

Faraday's first law of electrolysis
The amount of chemical change during electrolysis is proportional to the charge passed.
Faraday's second law of electrolysis
The charge *Q* required to deposit or liberate a mass *m* is proportional to the charge *z* of the ion, the mass, and inversely proportional to the relative ionic mass *M*; mathematically *Q* = *F m z* / *M*,
Faraday's first law of electromagnetic induction
An electromotive force is induced in a conductor when the magnetic field surrounding it changes.
Faraday's second law of electromagnetic induction
The magnitude of the electromotive force is proportional to the rate of change of the field.
Faraday's third law of electromagnetic induction
The sense of the induced electromotive force depends on the direction of the rate of the change of the field.

Gauss' Law

The electric flux through a closed surface is proportional to the algebraic sum of electric charges contained within that closed surface; in differential form div *E* = *rho*, where *rho* is the charge density.

Gauss' Law for magnetic fields

The magnetic flux through a closed surface is zero; no magnetic charges exist; in differential form
div *B* = 0.

Hall Effect

When charged particles flow through a tube which has both an electric field and a magnetic field (perpendicular to the electric field) present in it, only certain velocities

of the charged particles are preferred, and will make it un-deviated through the tube; the rest will be deflected into the sides.

Hooke's Law

The stress applied to any solid is proportional to the strain it produces within the elastic limit for that solid. The constant of that proportionality is the Young modulus of elasticity for that substance.

Ideal Gas Law

An equation which sums up the ideal gas laws in one simple equation $P\,V = n\,R\,T$,

Joule's Laws

Joule's first law

The heat Q produced when a current I flows through a resistance R for a specified time t is given by $Q = I^2\,R\,t$.

Lambert's Laws

Lambert's first law

The illuminance on a surface illuminated by light falling on it perpendicularly from a point source is proportional to the inverse square of the distance between the surface and the source.

Lambert's second law

If the rays meet the surface at an angle, then the illuminance is proportional to the cosine of the angle with the normal.

Lambert's third law

The luminous intensity of light decreases exponentially with distance as it travels through an absorbing medium.

Laplace Equation

For steady-state heat conduction in one dimension, the temperature distribution is the solution to Laplace's equation, which states that the second derivative of temperature with respect to displacement is zero.

Lenz's Law (1835)

An induced electric current always flows in such a direction that it opposes the change producing it.

Murphy's Law (1942)

If anything can go wrong, it will.

Newton's Law of universal gravitation

Two bodies attract each other with equal and opposite forces; the magnitude of this force is proportional to the product of the two masses and is also proportional to the inverse square of the distance between the centers of mass of the two bodies; $F = (G\,m\,M/r^2)$ e, where m and M are the masses of the two bodies, r is the distance between. the two, and e is a unit vector directed from the test mass to the second.

Newton's Laws of motion

Newton's first law of motion: A body continues in its state of constant velocity (which may be zero) unless it is acted upon by an external force.

Newton's second law of motion: For an unbalanced force acting on a body, the acceleration produced is proportional to the force impressed; the constant of proportionality is the inertial mass of the body.

Newton's third law of motion: In a system where no external forces are present, every action force is always opposed by an equal and opposite reaction force.

Ohm's Law (1827)
: The ratio of the potential difference between the ends of a conductor to the current flowing through it is constant; the constant of proportionality is called the resistance, and is different for different materials.

Peter Principle
: In a hierarchy, every employee tends to rise to his level of incompetence.

Planck Equation
: The quantum mechanical equation relating the energy of a photon E to its frequency nu: $E = h\ nu$.

Reflection Law, Snell's Law
: For a wavefront intersecting a reflecting surface, the angle of incidence is equal to the angle of reflection, in the same plane defined by the ray of incidence and the normal.

Refraction Law
: For a wavefront traveling through a boundary between two media, the first with a refractive index of n_1, and the other with one of n_2, the angle of incidence *theta* is related to the angle of refraction *phi* by $n_1 \sin theta = n_2 \sin phi$.

Stefan-Boltzmann Law
: The radiated power P (rate of emission of electromagnetic energy) of a hot body is proportional to the radiating surface area, A, and the fourth power of the thermodynamic temperature, T. The constant of proportionality is the Stefan-Boltzmann constant. Mathematically $P = e\ sigma\ A\ T^4$,.where the efficiency rating e is called the emissivity of the object.

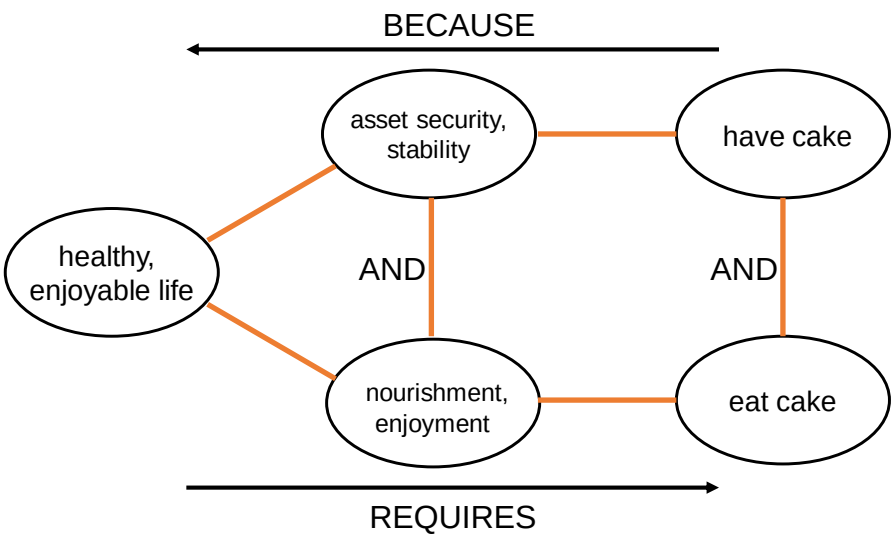
Thermodynamic Laws
: *First law of thermodynamics*
The change in internal energy of a system is the sum of the heat transferred to or from the system and the work done on or by the system.
Second law of thermodynamics
The entropy -- a measure of the unavailability of a system's energy to do useful work -- of a closed system tends to increase with time.
Third law of thermodynamics
For changes involving only perfect crystalline solids at absolute zero, the change of the total entropy is zero.
Zeroth law of thermodynamics
If two bodies are each in thermal equilibrium with a third body, then all three bodies are in thermal equilibrium with each other.

Not So Funny – Can You Have Your Cake And Eat It?

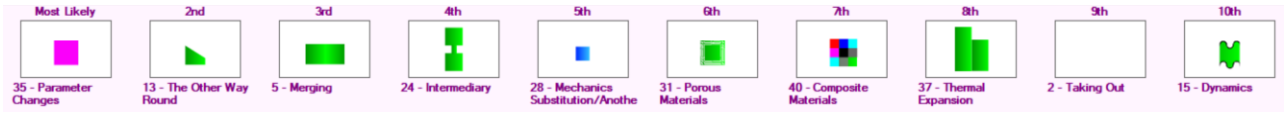
More politics. If that's what we can call the increasingly farcical Brexit story. Enter Donald Tusk, in the blue-and-yellow corner to argue the case for the EU. Here's what he announced to the Community at large and the UK 'negotiators' this month:

"To all who believe in it, I propose a simple experiment. Buy a cake, eat it, and see if it is still there on the plate. The brutal truth is that Brexit will be a loss for all of us. There will be no cakes on the table. For anyone. There will be only salt and vinegar."

See what I mean about the problem of Socratic thinking? No imagination. Of course we can have our cake and eat it. Like this…



It's not rocket science.
Neither is looking this up in the Contradiction Matrix to see how others have successfully solved the problem before us…



Which, in turn, should fairly swiftly take us to some breakthrough solutions:

Principle 35, Parameter Changes – virtual cake; shift to a virtual EU, a al The Matrix.

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Principle 13, Other Way Around – cake regurgitation; let the other countries all leave the EU and the UK stays in.

Principle 5, Merging – stay in the EU; everyone takes turns to make or share their cake

Principle 24, Intermediary – acquire a cake-factory; stay in the EU, operate all political relations through the Isle of Man(n)

Principle 28, Mechanics Substitution, a cake version of ‘Le Whiff’ – all the best bits of the chocolate without the calories. Stay in (a field-based) EU.

Principle 31, Holes – aerate the cake-mix better. Stay in the EU, dig more Tunnels. Ideally bypassing France.

Principle 40, Composite – include positive and negative calorie ingredients into the cake (celery and pineapple), stay in the EU, the perfect blend of different nationalities and cultures (and the French)

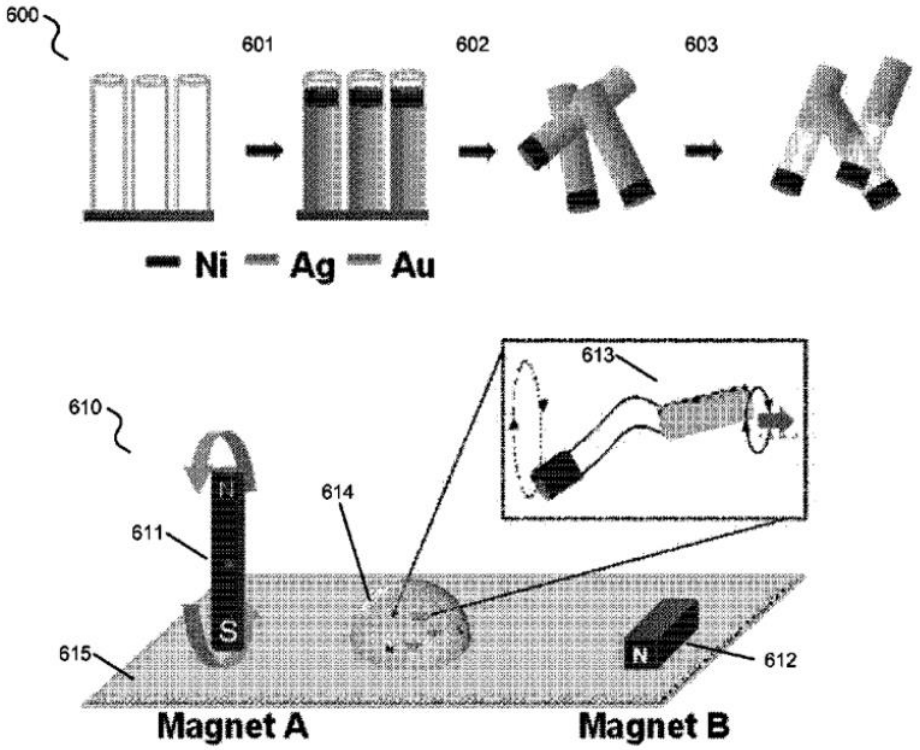
Principle 37, Relative Change, Thermal Expansion – roast the French, then stay in the EU.

Principle 2, Taking Out – take out the calorific components; take out the French.

Principle 15, Dynamics – eat cake only when hungry, make new cake when not hungry; stay in the EU except for the twelve sessions where parliament is forced to up sticks and move to Strasbourg to satisfy French egos. Or, have everyone rotate the country they live in every six months, so we all get to experience all the different types of cake. Apart from France.

This politics lark, it’s really easy when you have the right tools.

Patent of the Month – Nanowire Motor

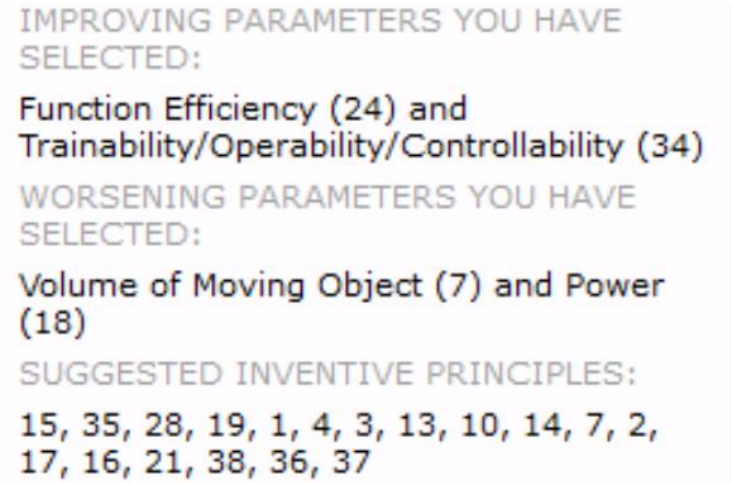


We delve down into the micro-scale world for our patent of the month this month, and another lovely looking patent from the University of California, this time in San Diego. US 9,698,708 was granted on Independence Day. The inventor is Professor Joseph Wang of the self-named Wang Lab. Research in the Lab falls within the field of nano-bioelectronics, focusing mostly on the design of wearable biosensors and nano- and micromotors for drug delivery and microchip diagnostics. The Wang group's work on nano- and micromotors have advanced the field significantly towards the dream of autonomous machines capable of navigating the circulation to deliver drugs or test for the presence of disease biomarkers (à la *Fantastic Voyage*). Their previous designs have demonstrated the feasibility of nano- and micromotors that rely on local chemical fuel or ultrasound or magnetic actuation to travel rapidly and carry cargo (unlike the vast majority of the field until recently focused on peroxide-driven machines). Excitingly, they have introduced the first water-driven micromotor, in which water reacts with aluminum to produce hydrogen microbubbles, which move efficiently in human serum. Recent contributions to fuel-free nanomotors include the development of magnetically guided ultrasound-powered nanowires capable of towing cargo and, now, thanks to this latest patent grant, of magnetically-powered flexible nanowire motors capable of high-speed propulsion. Here's what the patent document background description has to say about the problem the invention solves:

Micro/nano-scale propulsion in fluids can be challenging due to the absence of the inertial forces exploited by biological organisms on macroscopic scales. The difficulties are summarized by E. M. Purcell's "scallop theorem", which states that a reciprocal motion (a deformation with time-reversal symmetry) cannot lead to any net propulsion at low Reynolds numbers. The Reynolds number, Re=.rho.UL/.mu., measures the relative importance of inertial to viscous forces, where .rho. and .mu. are the density and shear viscosity of the fluid, while U and L are the characteristic velocity and length scales of the self-propelling body. Natural microorganisms can inhabit a world where Re.about.10.sup.-5 (e.g., flagellated bacteria) to 10.sup.-2 (e.g., spermatozoa), and they achieve

their propulsion by propagating traveling waves along their flagella (or rotating them) to break the time-reversibility requirement, and hence escape the constraints of the scallop theorem. Yet, there is a formidable challenge in engineering nanoscale, complex objects and systems capable of locomotion in fluids, which can be due to the combination of low Reynolds numbers and Brownian motion. Overcoming the challenges and limitations of micro/nano-scale propulsion in fluids can hold important implications.

At the macro-level, the basic contradiction relates to parallel needs to have a prime mover that is so small there is insufficient space for fuel. Here's how we might map that problem on to the Contradiction Matrix:



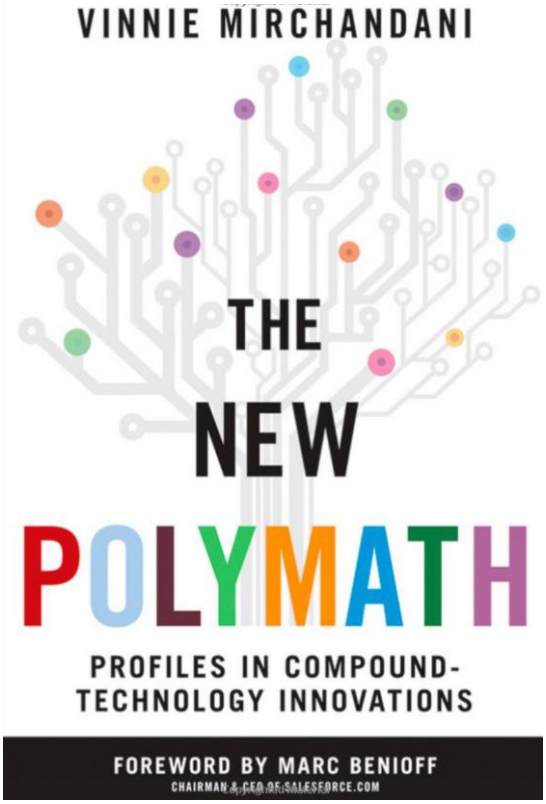
And here's a description of the main inventive steps contained in the solution:

…a nanostructure is configured as a nanowire diode formed of two or more segments [Principles 1, 15] *of different electrically conducting materials* [Principle 3]*. A container contains a fluid surrounding the nanostructure* [Principle 35a]*. A mechanism produces an electric field in the fluid* [Principle 28]*, such that the electric field drives the nanostructure to locomote in the fluid…*

… the system can include a mechanism for producing an electric field that includes electrodes and an AC signal source coupled to the electrodes. The system can include an electric field that can be an alternating electric field [Principle 19]*, such as a uniform alternating electric field or a non-uniform* [Principle 3] *alternating electric field.*

As the S-Field tool within TRIZ tells us, every system requires a source of energy ('field'), what Professor Wang's invention shows us is that the 'field' doesn't have to be contained on-board the system (the classical-TRIZ community will probably admire the deployment of a field that is magnetic!) Plus, of course, it's a very elegant and highly practical solution to an important problem. That's one of the reasons we keep a close eye on the new work emerging from the Lab and its practical deployment. For example, they have shown that micromachines are capable of capturing and transporting cancer cells in biological media, which allow rapid, sensitive detection of circulating tumor cells in blood to improve the accuracy of cancer staging. In addition, their incorporation of tubular micromotors into a microchip enabled quantification of a specific protein, and has lead to on-chip immunoassays with no external power requirement.

Best of the Month – The New Polymath



A Polymath the Greek word for Renaissance Man is one who excels in many disciplines, a lot like the #-shaped person profile we discussed in last month's ezine. This book is one of the sparks behind that article. It has its flaws, but if you like the 'drinking from a firehose' kind of management text book, you'll probably get along just fine. From Leonardo da Vinci to Benjamin Franklin, we have relied on Polymaths to innovate and find creative solutions to the problems of the day. How would these Renaissance men and women manage our current technology bounty? Which disciplines would they choose to focus on? Would they work on the architecture of next–generation green cities, or focus on nanotechnology?

As our challenges have grown exponentially we need to bring together da Vinci, Franklin, and many more. The New Polymath is an enterprise that excels in multiple technologies infotech, cleantech, healthtech, and other tech and leverages multiple talent pools to create new medicine, new energy, and new algorithms.

Author Vinnie Mirchandani shares his varied experience as a technology adviser and market watcher to explain in business language the diversity of today's technology palette and to profile a wide range of innovations at:

- Large multinationals such as GE and BP
- Fast–growing, midsized companies like Cognizant and salesforce.com
- The cleantech industry in China, farms in Ireland, and the back roads of Rwanda

This book categorizes eleven "building blocks" for the New Polymath to leverage in its (very brave, more than slightly contrived) R–E–N–A–I–S–S–A–N–C–E framework,

including next–generation analytics (a bit dated since the 2010 publication date of the book!), cloud computing (ditto), sustainability, and social networks. The author profiles over a hundred innovators and demonstrates how they use these building blocks to solve both their individual day–to–day issues and the "Grand Challenges" the world faces.

Brimming with examples from a variety of industries, countries, and business processes, the book will inspire you to groom your own New Polymath tools, processes, and ecosystem of innovation ideas. And, as with so many management texts, if you already know some TRIZ/SI, you'll be able to pick out the (many) flaws in Mirchandani's thesis and turn them into some highly productive new directions. It's all about the contradiction, y'all.

Conference Report – ICSI, Beijing

It was a small but select crew of TRIZ/SI academics and practitioners that convened at the prestigious Tsinghua University in Beijing earlier this month. Lots of familiar faces among the crowd, and not so many new ones. The main absence was industry. I'm not sure whether this was due to a growing rivalry with the world of MATRIZ now that the Chinese Government has apparently mandated broad-scale use of TRIZ, but safe to say that Sergei Ikovenko, who was actually in China during the week of the conference, somehow conspired not to be present. Yet again the various different factions of our small, cult-like world seem intent on *not* using the tools and methods we tell others to use to solve our own contradictions. If you didn't laugh about it, you'd probably cry.

That said, there was a decent array of papers on display, enough to fill a whole day with three sessions running in parallel. As ever, the quality was patchy, but there was definitely the occasional case-study nugget. The main problem seems to be a gap between industry and academia. It's a gap that isn't getting any smaller. Hence, we get lovely case studies that make some quite spectacular improvements on manufacturing processes, but then fall down when we learn that industry hasn't adopted them because they are too busy running the processes they've already got in place. On one hand it's madness, on the other, it's surely also a case of academics (and the students they inflict the case study problems on) selecting the wrong problems to work on. If you can't deploy – or even test – the solutions you come up with, what's the point in doing them? If we actually applied TRIZ/SI to the problem, we might see a bit more Principle 13 in play – find the situations where the answers can be deployed before we start working on the problem. The problem – if we use TRIZ/SI – is the easy bit.

As far as the 'if we use TRIZ' comment is concerned, the key word as far as several of the papers being presented were concerned is 'if'. Yet again, we saw a significant number of 'case studies' that were quite evidently ones in which the solution had appeared before any TRIZ had been used. There's nothing wrong with taking an elegant answer and using

it as an ‘illustration’ of the process, but, please, be honest about it. Especially if the answer you’re presenting is not such a good one. And there were definitely a few of those on show; cases where the audience could quickly see that if the author had actually used TRIZ/SI, they would’ve derived a very different, much stronger solution.

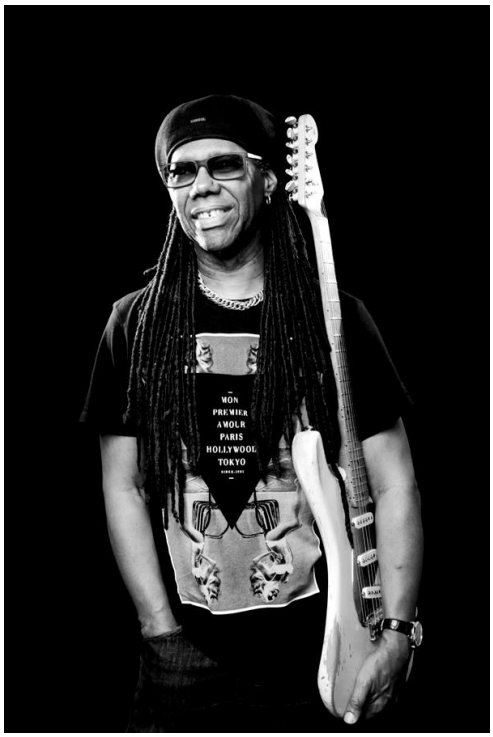
I wonder whether this is why industry increasingly stays away from these kinds of event. If they’re really using TRIZ and producing elegant solutions, there’s no incentive to tell the rest of the world how they did it. If they’re using TRIZ and not producing elegant solutions, there’s very definitely no incentive to tell a community of harsh critics. Every TRIZ person, it seems, can very easily find themselves in a pissing contest with all the other ‘experts’. No matter how good your solution is, you’re presenting it to an audience that is already thinking about how much better they would have made it.

That said, I have to humbly say that our very first entry into the Global Competition on Systematic Innovation resulted in us coming away as joint winners. So maybe I’m being a bit too skeptical with my comments. Competitions can easily create a downward spiral of lowering standards due to fear of being criticized. Maybe GCSI has now, at its 7th attempt, managed to create a virtuous cycle… to the extent that I’m already nervous about daring to have the SI team make another entry next year… and how’s that for another contradiction to solve?

Darrell picking up the GCSI Platinum award on behalf of co-entrant, Kobus Cilliers at the University of Buckingham

How’s this for another contradiction: there was only one person from Korea attending the conference. His view was that Samsung and Korean industry has reached a point of saturation with TRIZ and is now on the look-out for the next big thing. I’ll leave readers to incubate on that one. You have until the 9th Conference to get your answer ready. I’ll look forward to hearing your thoughts in Taiwan next year.

Wow In Music – ‘The Hitmaker’



Aah, Nile Rodgers. Nile Rodgers and his 1959 Fender Stratocaster (‘The Hitmaker’). A man behind some of the biggest hit records of the last 40 years. Sometimes as a composer, sometimes producer, but always the man with the golden touch when it comes to guitar playing. A man that, when interviewed, often describes himself as ‘just a guitar player’. Here’s one of those interviews:

‘A great example of what I mean by “just being a guitar player” is in ‘Lose Yourself To Dance’ by Daft Punk,’ replies Nile. ‘When they first played the track for me, it didn’t have a guitar part, of course. The part that I added kept the same voice leading through all the chord changes.’

Investigate this tune if you don’t know the part he’s referring to: delivered in his signature high-register, rapidly-strummed style, Nile’s guitar part contains a melody within (Principle 7) the extended chords that harmonises with the groove (Principle 5). It’s an infectious, maddeningly catchy part that completely makes the song.

‘That’s what I mean about being “just” a guitar player,’ explains Nile. ‘You go in and you do what they tell you to do, but you add your own technique to it. All of a sudden, that thing that you did, they can’t live without! The simple chords are the basis of the song, but once you put your lick to it – a lick that makes the song special – and then you take that lick away again, all of a sudden, the song isn’t doing that thing any more. Even though it’s the same chords.’

When asked, ‘what is funky guitar playing, and how do we master it? Niles replies: ‘I try to accentuate the important part of any groove,’ he tells us, picking up the famous Fender Stratocaster. ‘Typically I play sixteenth notes with my right hand. If I didn’t hold down any notes, you would hear this…’ Demonstrating his effortless syncopated picking style, Nile mutes the strings, leaving us with a toneless metallic click that reveals the slinky rhythm behind the up- and downstrokes. He continues, ‘To me, my style of funk is based on

playing groups of three strings at a time and not playing too much information on the first stroke (Principle 2). That way, on the second stroke that follows it (Principle 19), I can invert (Principle 13) and make it sound almost like a Clavinet or another keyboard instrument.' (Principle 35)

As an example, Nile plays through what is probably the most famous song in his immense catalogue: Chic's eternal 'Good Times'. That three-downstrokes-plus-eighths line, which you've heard a million times before, somehow manages to sound incredibly fresh when he plays it to us in this little backstage room at London's Olympia… He explains, 'I don't play 'Good Times' like most guitar players. I could just play those high three strings with precision, but I like to play all six, a full 13 chord, even though you don't hear the lower three. Even though you see me fingering all six strings, I'm muting the low strings (Principle 3), especially because I'm on the seventh fret and you know there's a big harmonic there (Principle 18). I'm basically playing a triad on the higher strings. But what makes it funky is the tonality of the chord. I'm just playing the motion that is defining the voice, and that's what makes it sound funky and cool to me.'

He stops playing, laughs and says: 'It just hit me this morning that what I am is the right hand of a piano player (Principle 17) – a frustrated piano player, actually, because I only have six strings (Principle 2). That's what I do! When you're watching a band's guitar player play a song, look at his right hand. Once they've learned the song, they play it the same way from then on, but a piano player would do something different, maybe in a different octave. I'll always try and do something interesting. But that's not how most people play.'

Asked how he got into playing with such economy, Nile lays the blame squarely at the feet of a jazz icon. 'When I was learning to play funk as a pretty young guy, I was going to Miles Davis concerts,' he says. 'Miles would say things like, "You know man, it's ain't the notes you play, it's the notes you don't play" (Principle 31). He was telling us to play sparingly but make it hip – I guess, anyway… Who knows what Miles meant? Ha ha! But I'd hear that stuff as a kid and take it to heart. I don't always want to beat people up by playing all the time. It's fun though, I love doing it.'

Here, Nile grabs the Strat and breaks into a fast-fingered rock solo. Even unamplified, it sounds amazing. 'I love playing with guys that play like that,' he says, 'although I notice that unless I'm careful, we can both sound bad, because it's like playing doubles in tennis or something. I like to be part of a team. When I started I was like that, I was a soloist and it was all about me and the guitar. I couldn't wait to go, whooo! I come from the hippie days, so I wanted to be Jimi Hendrix and we'd feed back everywhere. Every now and then, you'll come to a Chic show and I won't play with my teeth – I stopped doing that – but I'll do a trick and play the guitar over my head…'

The Hitmaker

He leans forward to emphasise his closing point, one which guitarists of all stripes would do well to heed. ‘Music is such an individual thing: the more you learn it, the smarter you get,’ he explains. ‘Every musician who listens to me knows I’m telling you the truth: the smarter you get, the more you want to show people how smart you are, and you actually think that that means more to them. And every now and then it does: you get Eddie Van Halen playing the solo in ‘Beat It’ by Michael Jackson, and it means a lot. A whole lot! But you don’t want to hear a whole Michael Jackson album like that. You want to hear it on ‘Beat It’. So, it’s about learning the art of balance.’

Final words of wisdom? ‘The people who come to hear my music, they come to dance and have a good time. They want to hear musicians who interpret the music well, but it’s really about the crowd, and I’m so happy that I’ve learned to care about other people in my music. I’m learning more as I get older, and as I learn more on the guitar at the age of 62 than I did when I was 16, the compositions get a little more interesting – and a little less selfish!’

Pretty cool, right? Lots of parallels with the world of the innovator, I think. Let’s take a deeper dive on one of my favourite Nile Rodgers songs, Upside-Down by Diana Ross…

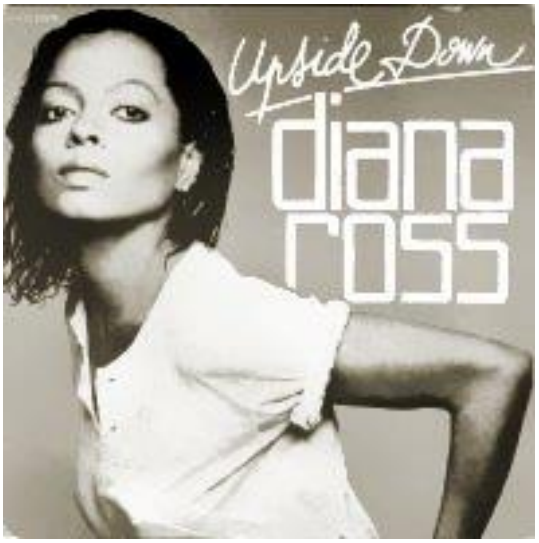
“UPSIDE DOWN,” with DIANA ROSS (*DIANA*, 1980): Rodgers and Chic cohort Bernard Edwards took a personal approach in the recording of their first project with this Motown legend, meeting with her for days to map out themes for the album. The results speak for themselves, as Ross’ 11th album became the best-selling studio project of her lengthy career. *Diana* reached No. 2 on the Billboard album charts on the strength of a pair of Top 10 singles, including this chart-topper. Billboard would rank “Upside Down” No. 62 in its list of greatest songs of all time. Chic served as Ross’ backing band, with Rodgers — in a move that echoed the band’s 1979 hit “Good Times” — somehow drawing this deeply funky sound out of a string section.

NILE RODGERS: We came from the old school analog recording business, where you had to use every trick at your disposal. Strings were not traditionally funky, and they were all classically trained musicians. If you look at all of the Chic records, most of our players came from the New York Philharmonic. They were some of the best players in the city. But, you’re right, they weren’t necessarily the funkiest players in the city — although we tried to get that out of them. So, what we would do to help aid in their interpretation of the groove is, sometimes we would actually use what we called gates (Principle 2) to trigger their sound. Basically, they would play what I had written on the page, but you would only hear that music start and stop when another instrument is playing a trigger, or a gate, to open up the sound. So, for instance, when you hear those strings parts on “Upside Down,” well, string players can’t play that — at least not tight. And they certainly can’t play it for six or seven minutes! Basically, what I have them playing is half notes (Principle 1), and I’m having them key off (long-time Chic drummer) Tony Thompson’s drum high hat (Principle 5). We used all of those kind of tricks to get those strings sounding funky and tight and grooving with us, so that it sounds like a band and a unit — as opposed to sweetening. The strings never felt like a sound that we just put on top of the records. They are a part of the groove, as well.

“Upside Down” was a gripping gateway to *diana*. All it took were two sixteenth notes on the hi hat doubled by Rodgers’ guitar (Principle 5) to trigger the groove. The rhythm was undeniably CHIC, but with a slight twist. “The way Nile and Bernard slipped those half measures (Principle 1) and chromatic progressions (Principle 17) in there was so creative,” notes Sandra St. Victor. Compared to “Good times / these are the good times”,

the opening chant was a mouthful. The syllables accentuated the rhythm with a punchy gait. Thornton explains, “That staccato sound—‘upside down you’re turning me, you’re giving love instinctively’—became our signature through that time. I think that when Michelle and I started singing with Alfa and Luci, the style of the CHIC vocals changed a little bit so by the time we got to *diana*, it was a case of me as a male singer singing higher than I normally sing and the girls singing alto along with my voice. That staccato sound is what we lent to Diana on that vocal part.”

Rodgers doubled the melody underneath the vocals on the closing vamp. He carries out the melody after the last round of vocals. Philip Bailey notes how his guitar solos complement, rather than upstage, the track. “He’s not jammin’ all over the doggone track, playing stuff to impress him and a lot of other musicians. He’s not trying to see how fast and how slick he can play ... and in doing that, he ends up impressing the musicians.” John Oates concurs, adding, “For Nile, it’s not about the flashy solos or how many notes per measure that he can play. Nile is really like a harmonic drummer. Human beings have the ability to play on the beat, ahead of the beat, or behind the beat. Nile has the unique ability to play perfectly in time slightly behind the beat.”



Investments – Roman Concrete

I live near the sea. A few years ago, a storm washed away some of the jetty. The council repaired it. Four years later the area was cordoned off because the repair was eroding at an apparently precipitous rate. I think my taxes paid for the repair.

Ancient Romans built concrete sea walls that have withstood pounding ocean waves for more than 2,000 years. Now, an international team has discovered a clue to the concrete's longevity: a rare mineral forms during chemical reactions between the concrete and seawater that strengthen the material.

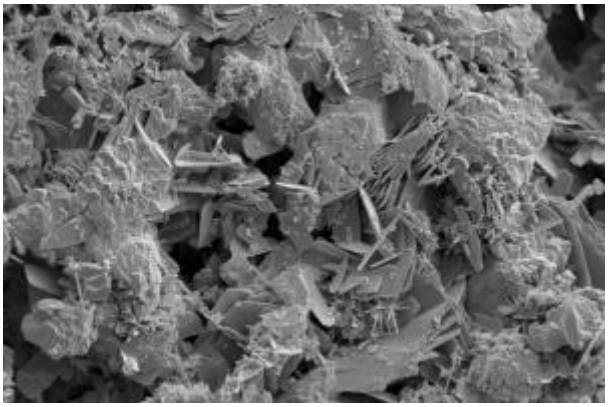
Structural engineers might be able to use these insights to make stronger, more-sustainable concrete, says team leader Marie Jackson, a geologist at the University of Utah in Salt Lake City. She and her colleagues reported their findings on 3 July in *American Mineralogist*.

Modern concrete uses a paste of water and Portland cement, a fine powder made mostly of limestone and clay, to hold together small rocks. But it degrades within decades, especially in harsh marine environments. Instead of Portland cement, the Roman concrete used a mix of volcanic ash and lime to bind rock fragments. The Roman scholar Pliny the Elder described underwater concrete structures that become "a single stone mass, impregnable to the waves and every day stronger." This piqued Jackson's interest. "For me the question was, how does this material become a rock?" she says.

In earlier work, Jackson and colleagues reported some of the unusual chemistry of Roman concrete, such as the presence of a rare mineral known as aluminium tobermorite. For the

new study, the scientists took samples of Roman harbour concrete to the Advanced Light Source, an X-ray synchrotron at Lawrence Berkeley National Laboratory in Berkeley, California, and mapped out the location of minerals in the samples.

The researchers found a silicate mineral called phillipsite, which is common in volcanic rocks, with crystals of aluminium tobermorite growing from it. Tobermorite seems to have grown from the phillipsite when seawater washed through the concrete, turning it more alkaline. “It's a very rare occurrence in the Earth,” Jackson says. Such crystallization has only been seen in places such as the Surtsey volcano in Iceland. As tobermorite grows, it may strengthen the concrete because its long, plate-like crystals allow the material to flex rather than shatter when stressed.



Applying ancient knowledge

Modern concrete-makers could learn from the ancient Romans’ knowledge, says Nele De Belie, a materials engineer at Ghent University in Belgium. She and her colleagues have used materials such as fly ash, produced during the burning of coal, to give concrete ‘self-healing’ properties, whereby the material closes up cracks after they form. Fly ash is similar to the volcanic ash that Romans used in their mix.

Jackson has been working to recreate the Romans’ concrete recipe in the lab. She is also a consultant for a cement company in Nevada that is using volcanic ash from the western United States to formulate such concrete.

“I’m not saying this would be the concrete that would be used in everyday infra-structure,” she says. “But for materials like sea walls, we could formulate mixtures with lime and volcanic ash materials in the way that the Romans did.” The Romans may have got their ideas from studying how ash from volcanic eruptions crystallized into durable rock, Jackson says. My next step is to introduce her to Torridge District Council.

Read more in Nature, doi:10.1038/nature.2017.22231

Generational Cycles – Imagine

Let's play Spot The Baby-Boomer. Specifically those born in the 'cusper' period between 1961 and 1964. Some fell on the Boomer side of the fence, some ended up Xers. One way to spot the difference is look to see if the wear 'Old Guys Rule' apparel (see Issue 138). The other is to play John Lennon's 1971 hit-record, Imagine and watch what happens.

Baby-Boomers will automatically go misty-eyed and start singing along. If there are two Boomers, they'll look at each other as they each mime the perfectly-remembered words. They'll smile at each other. Nostalgia rules. A small tear begins to appear in the corner of their eyes. It could've – should've – turned out so differently…

Imagine there's no countries
It isn't hard to do
Nothing to kill or die for
And no religion, too
Imagine all the people
Living life in peace... You...

You may say I'm a dreamer
But I'm not the only one
I hope someday you'll join us
And the world will be as one

Nomads, on the other hand, are more likely to reach for the off button. Bloody hippies. Bloody fur-coat. Bloody mansion. Bloody white piano. 'Imagine no possessions' my arse. Bloody hypocrite with your naïve utopian bullshit. Strawberry Fields Forever, ha. You sell-out. You embarrassment. You has-been. Don't ever darken my door again.

Biology – Jewel Wasp

Female parastic wasp injects venom in fly pupa host

Amid the incredible diversity of living things on our planet, there is a common theme. Organisms need to acquire new genes, or change the functions of existing genes, in order to adapt and survive.

How does that happen?

A common view is that genes duplicate, with one of the copies picking up a new function while the other copy continues to function as before.

However, by studying tiny parasitic Jewel Wasps and their rapidly changing venom repertoires, the Werren Lab at the University of Rochester has uncovered a different process that may be widespread in other species as well.

The process involves co-opting single copy genes to take on new functions. In some cases, these genes appear to continue their previous function as well, in other parts of the wasp's anatomy besides the venom gland. The findings are published in the latest issue of *Current Biology*.

"It is almost as if they are now moonlighting," says John (Jack) Werren, professor of biology. "They've got a day job, and then take on a night job as well. Over time, if the night job works out, they may give up the day job and evolve as a venom specialist. However, in other cases we have found that they stop moonlighting as venom genes but appear to retain their day job."

How is a gene co-opted? And what determines which job (or combination of jobs) it performs? In the case of Jewel Wasps, the process called gene regulation is key. As the researchers explain, the rapid turnover in venom genes is accomplished mostly by changes in regulatory regions adjacent to the genes.

These regulatory regions control how the genes are expressed -- that is, whether the genes are turned "on" or "off" in different tissues. When a gene is turned on, it provides

instructions for manufacturing proteins. When it's turned off, it provides no such instructions.

"Co-option of single copy genes can be a more rapid mechanism for adapting to a new environment because it does not require the gene to be duplicated first," notes one of the paper's authors, "In essence, these wasps are recycling their genes for new functions."

The group studied four closely related species of Jewel Wasps. The wasps lay their eggs on the pupae of other insects, after first injecting the pupae with venoms that manipulate the metabolism of the host in ways that make the environment more conducive to their developing young.

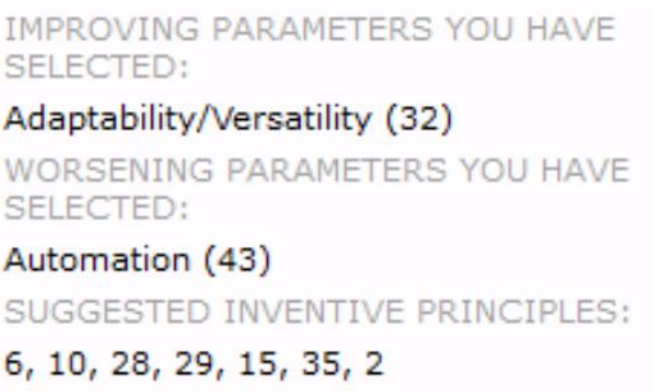
Using transcriptome and proteome sequencing, the researchers found that more than half of the venom components in the parasitic wasps resulted from single copy genes that had been co-opted without being duplicated. The composition of the venoms can change quickly, allowing the wasps to adapt to different hosts. For example, even closely related species can differ by up to 40 percent of their venom repertoire.

The group proposes that co-option of single copy genes for new function is not just restricted to parasitoid venoms. Co-option may be common in nature, particularly when organisms are evolving rapidly to changing environments.

With regards to parasitoid venoms, there may be an added benefit, says Werren. "The great diversity of parasitoid venoms and abundance of these species (estimates run as high as 600,000 parasitoid species on earth), combined with the fact that parasitoid venoms have evolved to manipulate metabolic processes, suggests that they are potentially an immense untapped cornucopia for drug discovery."

From our contradiction-solving case study perspective the 'co-option of single copy genes' sounds kind of like the Principle 41 'Change Function' solution we suggested several eons ago. More pragmatically, what it's all about is somewhat akin to a combination of 'universality' (Principle 6), 'moon-lighting' (Prior Action – Principle 10), switching (Principle 15) and add in a short dose of gene separation (Principle 2). So much for the jewel wasp venom 'solution', but what's the problem that is being solved?

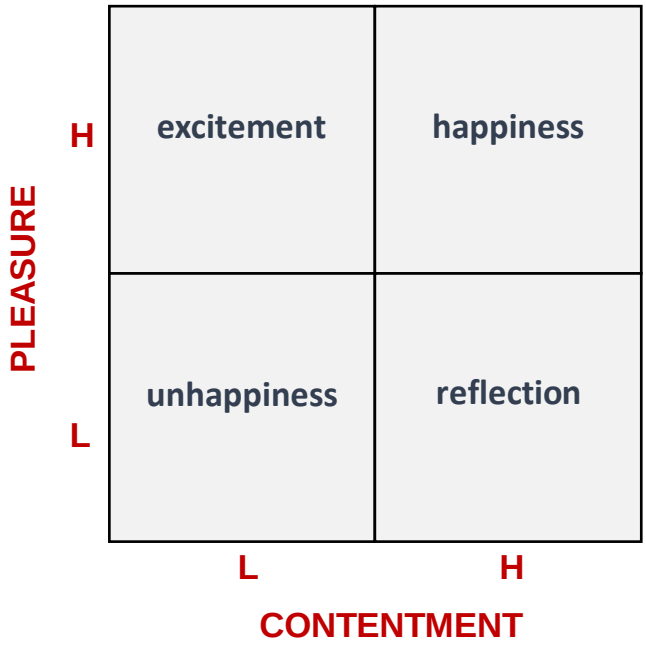
We think it looks something like this: the wasp venom needs to be able to rapidly adapt and evolve to meet different circumstances and stay ahead of the evolutionary arms-race parasites find themselves in, but… there's a need for reliable, repeatable cell creation processes for 'normal' growth and reproduction. Which very likely looks something like this when mapped onto the Contradiction Matrix:



Looks like a pretty good match.

Short Thort

"Only a fool can be happy. For happiness consists of two contradictory elements: contentment and pleasure. Enjoy pleasure and you have no contentment; be content and you have no pleasure. For this reason happiness is conceivable only for those who enjoy themselves without thinking that they will always want more and thus be discontented, or for those who are content without thinking that they have no pleasure. Whoever reflects can never be happy, unless he is a fanatic and thus blinded…thus exercising control over his intelligence with his feelings, instead of the other way round"
Marcellus Emants, A Posthumous Confession



News

Masters In Structured Innovation
The University Of Buckingham is proud to announce the formal launch of the new MSI degree programme. Prospective students are now able to see details of the curriculum and even sign up to join the programme. Kobus Cilliers, part SI-Network, part University will be the person you'll be speaking to as quickly as possible after you contact the University.
Find details here: https://www.buckingham.ac.uk/business/msc/structured-innovation

India
It looks like Darrell will have three more trips to India this year in September, October and November. Bangalore, Pune and Guwahati (a first!) are the currently scheduled stop-off places, but there's still scope to add one or two more. There's a strong likelihood that we'll be conducting at least one open programme on Design-Thinking-&-TRIZ (probably in Pune), more details next month. In the meantime, contact Darrell directly if you want him to build you into his itinerary.

USA
It also looks like Darrell will be sneaking another short trip to the US into September's diary. If you're in or around Michigan, get in touch to see if he might be able to head in your direction for a day or two.

ApolloSigma
This is our in-house patent quality measurement tool. We're in the process of re-building it to make it resilient enough to begin offering as a product rather than a service. We're currently looking for (brave) Beta customers. Get in contact with Darrell in the first instance if you're interested in participating. Probably from the end of August onwards.

Congratulations
Congratulations to Lanise Block, the first of this year's Minneapolis-based SI Certification programme to complete her three projects and receive our Level 3 'Specialist' Certificate. Lanise's three projects are in the education sector and offer up some lovely insights and solutions to the Achievement Gap problem. Amazing stuff.

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

IT – Design-Thinking & TRIZ Workshops
Automotive – Technology Evolution Workshop
Electronics – Patent Bulletproofing Project
FMCG – PanSensic study
Fashion – Design-Thinking Culture-Building Programme
Recruitment – PanSensic Study
FMCG – PanSensic Study
Chemical – SI Workshops
Government – Graduate Skill Enhancement Programme
Electronics – Leadership Innovation-Mentoring Programme
Financial Services – PanSensic Study