

Systematic Innovation



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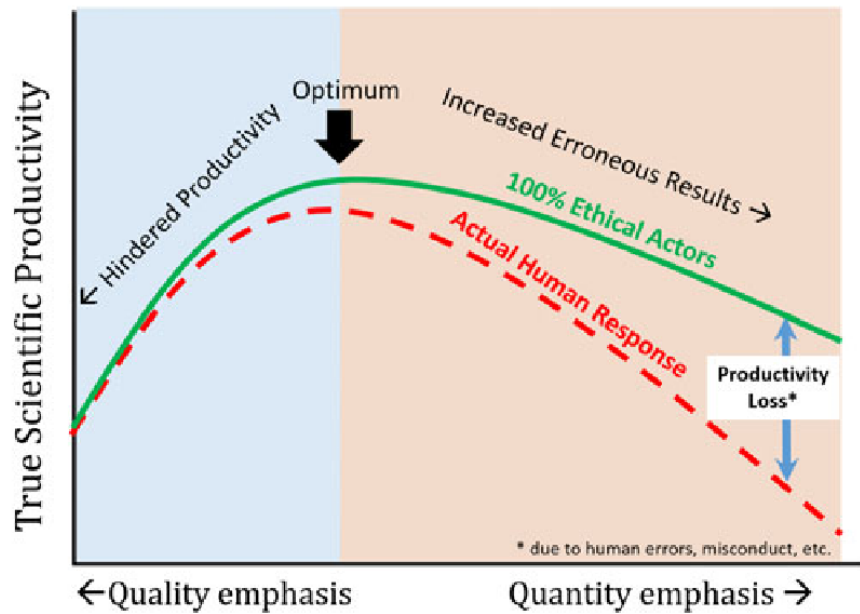
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Case Study: Perverse Incentives In Academia

"To achieve great things, two things are needed; a plan, and not quite enough time."
Leonard Bernstein



There's a crisis in the world of academia it seems. One borne of corruption. Or human nature. Or both. The above figure – taken from Reference 1 – highlights the apparent problem. The vertical axis of the plot describes 'true scientific progress'. The horizontal axis contains two parameters that affect the achievement of that progress: on the left hand side is quality, and on the right is quantity. The green-line indicates the theoretical relationship between these three parameters: too much emphasis on quality and productivity decreases; too much emphasis on quantity and productivity also decreases, with, in between – assuming we are able to get the balance between quality and quantity right – some kind of optimum productivity value.

The red-line below the green one then represents the reality: when we ask humans to increase the quantity of the output they produce, their actual productivity becomes progressively less than the theoretical level would otherwise suggest. The reasons for this shortfall include a greater propensity to error when we're encouraged to do things more quickly, and also, more seriously, when a system introduces incentives, there's a natural human tendency to distort the system by playing to the set targets. The primary thrust of the Reference 1 paper is that, by introducing crude incentives that seek to improve the quantity of output, we end up bringing the worst out of people. What gets measured gets done. And, the authors show, if the system measures the number of papers academics produce, surprise, surprise, the number and rate of production of papers will go up. But, unfortunately the longer people work with targets, the more their behavior will be distorted in the direction of the target. Thus, if the target was not a good reflection of the desired outcome of the system, the only net result is that the outcomes will suffer. Here the problem is all about the difference between measuring what is easy to measure and measuring what is important. If the academic system happens to choose 'easy' measures

like ‘number of papers produced per year’, then the actual desired outcome of quality papers will progressively suffer. As described in the paper, academia has been particularly prone to introducing a whole series of measures in recent times that have all been about measuring what is easy rather than what is important, and as a consequence, the whole system has found itself in some kind of horrible death-spiral:

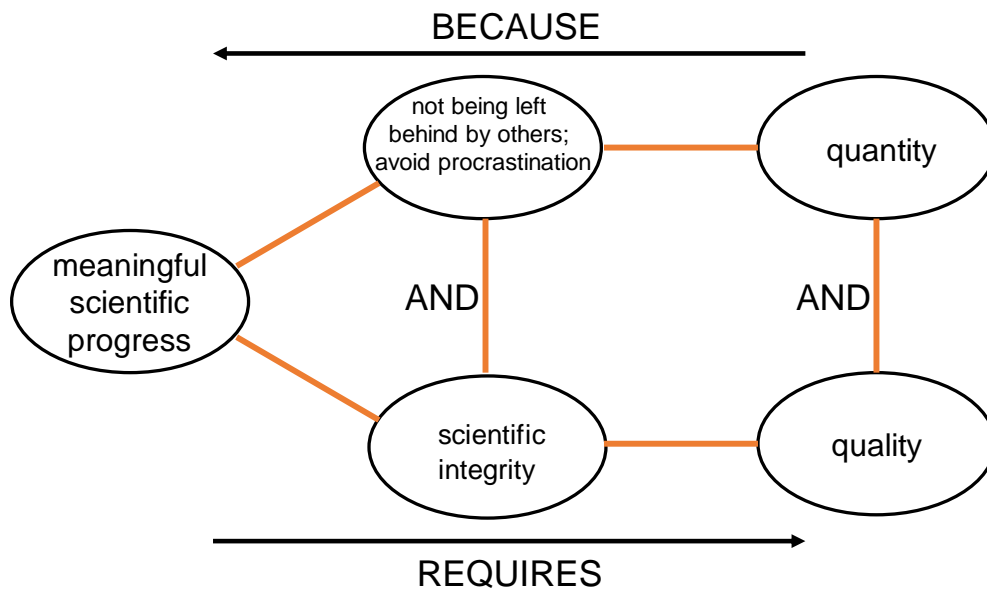
<i>Incentive</i>	<i>Intended effect</i>	<i>Actual effect</i>
“Researchers rewarded for increased number of publications.”	“Improve research productivity,” provide a means of evaluating performance.	“Avalanche of” substandard, “incremental papers”; poor methods and increase in false discovery rates leading to a “natural selection of bad science” (Smaldino and McElreath, 2016); reduced quality of peer review
“Researchers rewarded for increased number of citations.”	Reward quality work that influences others.	Extended reference lists to inflate citations; reviewers request citation of their work through peer review
“Researchers rewarded for increased grant funding.”	“Ensure that research programs are funded, promote growth, generate overhead.”	Increased time writing proposals and less time gathering and thinking about data. Overselling positive results and downplay of negative results.
Increase PhD student productivity	Higher school ranking and more prestige of program.	Lower standards and create oversupply of PhDs. Postdocs often required for entry-level academic positions, and PhDs hired for work MS students used to do.
Reduced teaching load for research-active faculty	Necessary to pursue additional competitive grants.	Increased demand for untenured, adjunct faculty to teach classes.
“Teachers rewarded for increased student evaluation scores.”	“Improved accountability; ensure customer satisfaction.”	Reduced course work, grade inflation.
“Teachers rewarded for increased student test scores.”	“Improve teacher effectiveness.”	“Teaching to the tests; emphasis on short-term learning.”
“Departments rewarded for increasing U.S. News ranking.”	“Stronger departments.”	Extensive efforts to reverse engineer, game, and cheat rankings.
“Departments rewarded for increasing numbers of BS, MS, and PhD degrees granted.”	“Promote efficiency; stop students from being trapped in degree programs; impress the state legislature.”	“Class sizes increase; entrance requirements” decrease; reduce graduation requirements.
“Departments rewarded for increasing student credit/contact hours (SCH).”	“The university’s teaching mission is fulfilled.”	“SCH-maximization games are played”: duplication of classes, competition for service courses.

The paper culminates, eventually in a plea for a removal of these kinds of simple-but-corrosive incentives and targets and a swing of the quantity-versus-quality pendulum back over to the quality end of the spectrum.

Like most sectors of human endeavor, this kind of pendulum-swing plea reveals a fundamental lack of understanding of how the world works. It assumes that we have to make trade-offs and compromises in life. And, of course, we do have to eventually make such compromises, but when we sit down with an explicit intention to design better solutions, we absolutely don’t have to live by the rules of trade-off and compromise. Design is about breaking the rules and finding better ones.

The whole reason the academic sector has found itself having to grapple with a quality-quantity trade-off is because the world is moving faster and faster, and the academic community for the large part is not keeping up. More and more pioneering research is bypassing academia altogether because industry needs the answers faster than academia seems able to provide them.

If the academic world really sat down and thought about solving the problem, they’d do rather better than assuming quality and quantity were fundamentally locked together, and would instead look to design ways to achieve the best of both worlds. Anyone familiar with the TRIZ/SI world would know to start such a re-design process by formulating the contradiction. It would look something like this:



And as soon as we can re-frame the problem to show that quantity and quality form a physical contradiction (hence the reason for the parabolic-shape curve in the opening figure), we know we can quickly tap into the breakthrough solutions of other sectors of human endeavor. Like, for example, Leonard Bernstein and his quote at the very top of this article, where he encourages us to recognize that ‘some’ time pressure is often the best possible spark to producing great work.

Actually, I think that when we’re talking about these kinds of ‘human corruption’ problem, it’s often advisable to think about the contradiction as both a tangible one and a parallel intangible. People make decisions for two reasons, the good reason and the real reason. Similarly, people get stuck when trying to make those decisions by two things: the good contradiction and the real contradiction.

Looking at the above Bubble Map, I believe the good/real contradictions distil down to the following, expressed in terms of the available parameters in the new (version 3.0) Business Matrix:

Good Contradictions: (Design) Capability versus (Design) Time
 (Design) Capability versus (Design) Risk

Real Contradictions: Competence versus Trust
 Trust versus Ability To Measure

For the ‘good’ contradiction, the Matrix gives us the following Inventive Principles to work with: 23, 21, 3, 38, 24, 10, 9

For the ‘real’ contradictions, we get Principles: 5, 17, 4, 8, 31, 7, 36 and 10.

We could brainstorm our way through each of these Principles and derive a whole series of potential solution directions that will serve to shift the green curve in the upward direction. The best way to do this would be to bring the academic community into the ideation process, but I also see, looking at the top recommendation of the ‘good’ contradiction, that Principle 23, Feedback’ is going to be important. It immediately begs the question, ‘how do we measure the quality of the scientific output being produced?’

I'm also aware, before getting too far into this question, that when dealing with this kind of human-complexity problem, the only meaningful solutions are going to emerge by affecting the system at the 'first principles' level (Reference 2). Which in turn means firstly dealing with the 'real' contradictions and affecting matters at the human 'intangibles' first principles of ABC-M (Reference 3).

People – including academics (although I occasionally have my doubts!) – are all motivated to change when Autonomy, Belonging, Competence and Meaning all head in the right direction.

When we examine the current incentives used in the academic sector as described in the earlier table, and relate them to whether this 'ABC-M increases' rule is being observed, in every instance, Meaning always gets worse, and ABC get worse in the majority of cases.

This fact should offer up some important additional solution clues. First and foremost a need to scrap all of the current incentive measures and replacement with things that (Principle 8) counter the natural downward tendencies of human behavior.

This in turn, I think, means finding measures that focus on what's important (Principle 17) rather than what's easy. Here are a few suggestions:

- Objective measures of paper *quality* as are increasingly being used (Principle 5) in industry – e.g. Evolution Potential Trend jumps
- Research should really be about (Principle 36) step-change progress – industry is already way, way better at optimization than academia will ever be – so think about the Hero's Journey and 'ordeals' and hence 'contradictions solved' or 'contradictions revealed'
- In our ever-more connected world, solving problems gets easier and easier ('someone somewhere already solved your problem'), so (Principle 36 again) incentivize authors that reveal better questions
- Any paper that describes experiments and results that seek to demonstrate or show an 'optimum' for any given parameter should be (Principle 8) penalized, or better yet be rejected. Any subsequent paper that repeat the same optimization effort to confirm or challenge 'the optimum' should be awarded negative citation points – example: working with the K-12 education sector over the course of the last three years, we've become aware of much utterly-meaningless debate over the past thirty years about 'optimum class-size'. '25.4' was the conclusion of an early publication. This eventually provoked a small avalanche of other papers rejecting the finding. The whole lot of them should be put on a bonfire and burned because they all started from the wrong question. Class-size is a contradiction to be solved not a number to be optimized. The authors of the first paper in the sequence should be placed carefully on top of the bonfire for starting a wild-goose chase that has wasted hundreds of thousands of subsequent research hours. That's the (Principle 10) story that really needs to be told.
- (recognizing that all four of these solution directions are likely to make the academic community feel incompetent, and thus fail our ABC-M test, there's perhaps a need for a (Principle 31) time-out period where the new measurement system is acclimatized and everyone made aware of the new rules. That or sack everyone, 'drain the swamp', and start again. Given that the academic sector is (in theory at least) built on 'evidence', there should be (Principle 10) proof that all the genuinely productive scientific literature did precisely make trend jumps and/or solve contradictions. Notably, some of the biggest – and best known – academic-lead breakthroughs are attributable to accidents rather than design (think penicillin,

Teflon, x-rays, and a myriad others), situations where the accident cause the researcher to deviate away from the optimization path and run towards a vital contradiction – we expected X to happen, but instead Y happened.)

So much for designing an academic system built around first principles. My overall view is that academia's real role is becoming that of historian: the people that make sense of the world after the innovators have made the breakthroughs. Again, there is a wealth of evidence to prove this case. Shifting back to the tangible world and solving the quality-versus-quantity contradiction and looking at the suggested Inventive Principles as a cluster, the overall message seems to be that the main step-change the academic world needs to make is recognizing and treating the world they operate in as a complex one. No more evidence required. Complexity requires research strategies that are almost wholly different from those we see in operation in most universities. The whole community would, I think, do well to take a peek at our Book of the Month feature this month. Let's call that the final word. For now.

References

- 1) Edwards, M.A., Roy, S., 'Academic Research in the 21st Century: Maintaining Scientific Integrity in a Climate of Perverse Incentives and Hypercompetition,' Environmental Engineering Science, Volume 34, Number 1, 2017
<http://online.liebertpub.com/doi/pdf/10.1089/ees.2016.0223>
- 2) Systematic Innovation E-Zine, 'First Principles First', Issue 184, July 2017.
- 3) Systematic Innovation E-Zine, 'ABC-M Gets Better'?, Issue 163, October 2015.

Patent Invent-Beyond Templates

For some reason, we've had a surge of client requests for 'patent strengthening' workshops over the course of this year. From being a one-off activity, it seems there's something in the air in a number of organisations, dictating that the skill of designing-around, inventing-beyond or bulletproofing their IP has become an ongoing need. While I'm not a desperate fan of templates, experience tells us that when newcomers are starting the journey towards building a skill that will become a normal part of their everyday work, they can serve a useful transition tool. This article describes the short deck of template slides we've evolved over the course of working through these method-teaching workshops.

There are three basic jobs that the templates are intended to address:

- 1) Finding good solutions
- 2) Modelling and designing-around target patents
- 3) Bulletproofing patents

Finding Good Solutions

There are two primary situations in which we might find ourselves needing to find existing 'good' solutions (Reference 1): one that we are looking for an existing solution that we can build upon; two that we are looking to find good 'technical alternatives' to a solution we already have. There's only really one template needed to assist in meeting either of these needs. Basis for the template and the good solution finding strategy is the three-part search construction illustrated in Figure 1 (and described in more detail in Reference 2):

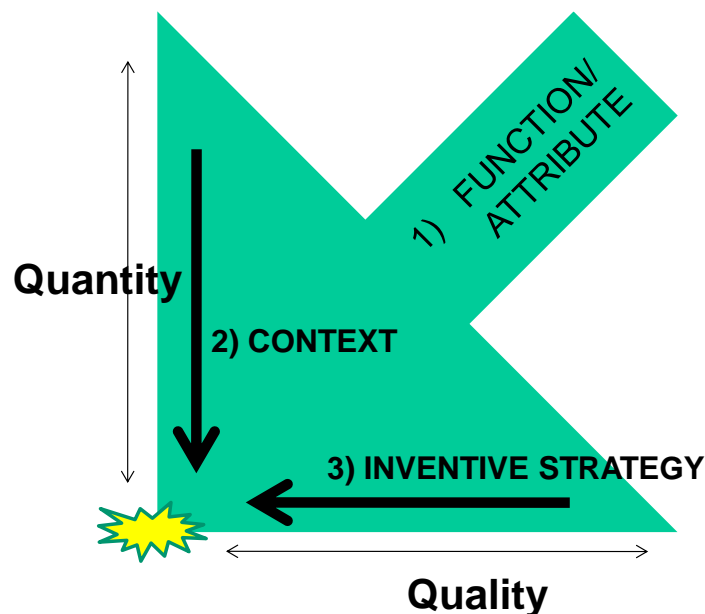


Figure 1: 'Good' Patent Search Strategy

The first part of this search is all about escaping from within one's own domain to find equivalent solutions in others. This is classic, 'someone, somewhere has already solved your problem' TRIZ territory. It is based on the premise that Functions and Attributes are the things that 'customers' want. Customers want holes not drills, and so if we wish to

escape from our traditional drill-bit manufacture business, we need to reveal other hole-making solutions that might exist out there.

The second aspect of the search controls for the quantity of hits we're going to receive. What we're trying to achieve here are inputs that will constrain what we find according to conditions relevant to our specific context. If, for example, I'm only interested in making holes in human teeth, then I might use 'tooth' (and relevant synonyms) as a constraining word. Better yet, I might constrain the search to look for certain values of strength or hardness similar to that of teeth and use that condition to constrain my search. Ditto for things like the relevant size or shape of hole that I might be interested in, or temperature limit that I must remain below.

The final part of the search, then, is all about controlling for the quality of solution that I might uncover. This is the TRIZ specific part of the search, the part that recognizes the difference between the 97% of patents that generate no value and the 3% that do. Specifically, what we're looking to include here are words relating to the resolution of conflicts and contradictions. Words like 'self', 'dynamic', 'asymmetry', and 'resonance'. Words, in other words, that relate to the presence of the sorts of word found in the Inventive Principles or Trends of Evolution.

Taken all together, the eventual patent-search template sheet looks like this:

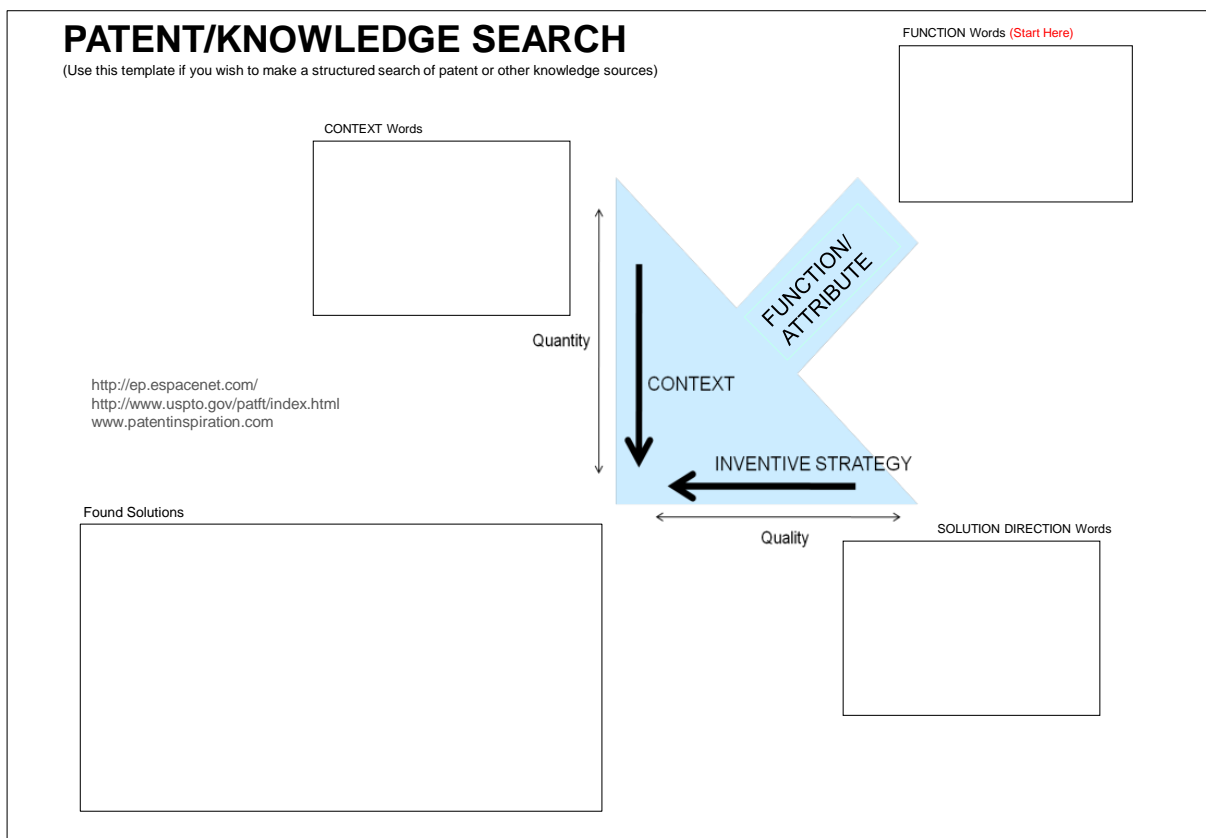


Figure 2: IP Template 1: Solution Finder

Modelling & Designing Around

Having located a good target patent, the next job is to translate the patent lawyer's language into something that we can begin deploying TRIZ/SI tools on. This means constructing Function and Attribute Analysis (FAA) models. We need to do this job for each of the independent Claims found within the target patent. For each of these Claims, the template sheet is the same:

What Is The Current System? (construct a FAA model for each of the independent claims)

Patent No. Claim No.

Nouns:
represent the components described in the Claim

Verbs:
represent the relationships between the components described in the Claim

→

Adjectives:
represent any descriptive text relating to the components described in the Claim

Example:

```

graph LR
    gas[] -- moves --> piston["]
  
```

Figure 3: Independent Claim FAA Model Template

Now, having unraveled what the independent Claims are describing, we get to the creative part of the design-around process: looking for strategies that will mean we no longer infringe on the Claim. This in turn means, crudely, that we need to alter the FAA model by utilising one or more of the strategies summarized on the left-hand side of the design-around template sheet:

Design Around Strategies (ultimately, only one will be necessary, but here a comprehensive search for options is desirable)

Patent No. Claim No.

Possible Strategies:

- take something away
- substitute something
- remove a connection
- change a connection
- connect something to something else;
- change an attribute
- remove a process step
- change process sequence

Most design around strategies will create a negative impact on the efficacy of the patented solution. The right-hand column is where we register these negative impacts...

strategy	solution	yes, but...

Figure 4: Design-Around Options Template Sheet

In the large majority of cases – and certainly if the target patent has been drafted well – whatever we need to do to design-around the Claims will create a ‘yes, but’ negative side-effect. In effect what we are doing when we identify a design-around strategy is to create an artificial contradiction. Solving this contradiction, then, is the final step in the process from ‘design-around’ to ‘invent-beyond’. We may be perfectly happy ‘designing around’ and ending up with an inferior solution. What TRIZ/SI tells us, of course, is that, this would adversely impact the commercial success of our solution. In most situations, we would wish to not only make sure we don’t infringe on the target patent, but at the same time also create a solution which is more ideal. The template sheet for solving Contradictions should be familiar to anyone that has attended one of our standard SI workshops. We’re in standard Contradiction Matrix territory now – we take each of the artificial contradictions from the Figure 4 sheet and transpose them into the top row of this template. Then we translate the specific to the generic (i.e. Matrix Parameters), we then look up the generic solutions (‘Inventive Principles’), then do the creative work to translate these generic strategies into specific solution clues...

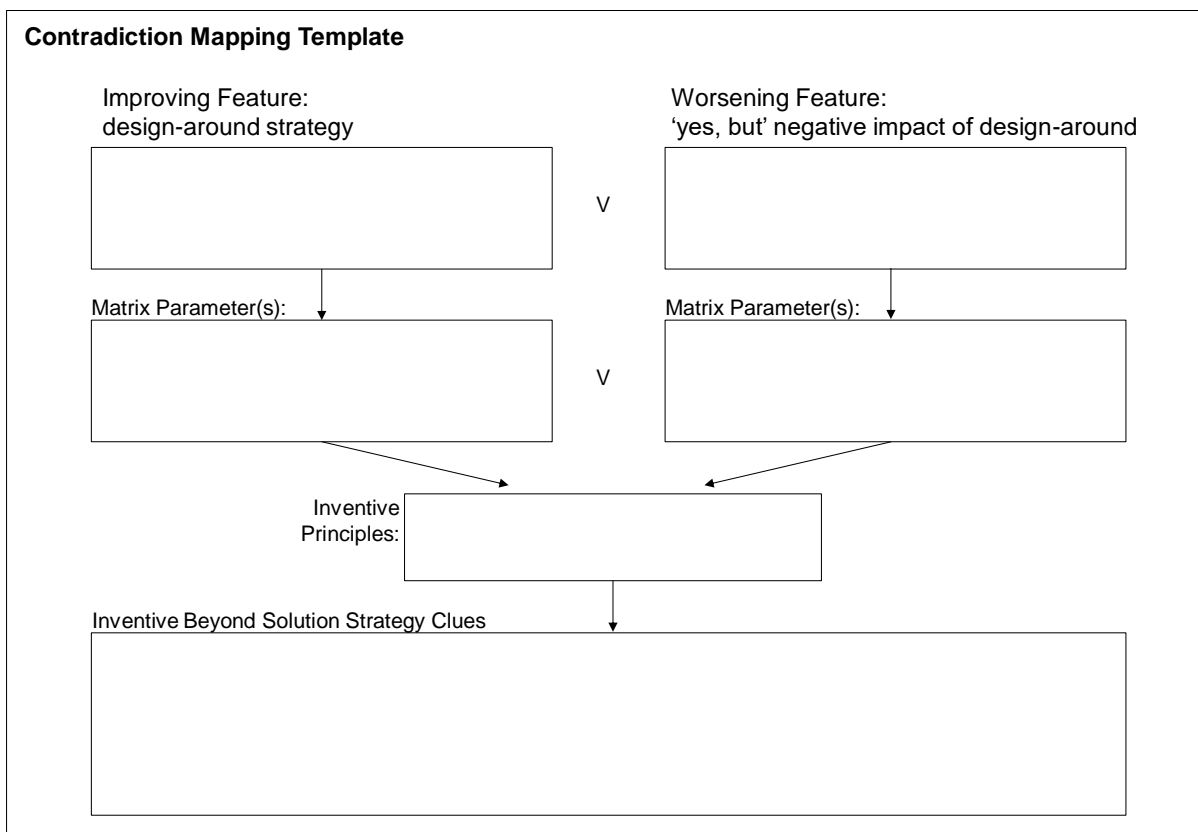


Figure 5: Design-Around-To-Invent-Beyond Contradiction Resolution Template Sheet

Hopefully, one or more of these ‘invent-beyond’ solution clues becomes the basis for the Independent Claims of a potential new invention. This time, one we can own. Now the final job is to bullet-proof this new solution so that no-one can do to us what we’ve just done to them.

Bullet-Proofing

This job is all about anticipating all of the future evolution jumps that the TRIZ/SI Trends of Evolution tell us will form the basis of future successful solutions. The full bullet-proofing job requires us to examine both the overall system and all of the individual components and process steps that form a part of our intended new Independent Claims, and we should examine each of the Trends of Evolution that are relevant to the system or

Not So Funny – Missing

August 8 was International Cat Day. This was my favourite Tweet of that day. Inventive Principle 12 in action...



It made me wonder if there were any other Inventive Principles to be found in the sad, traumatic world of missing pets. It turns out there were. Here's Principle 5...



And then a very cunning Principle 7...



Here's an unexpected Principle 38...



miser bisson, Flickr

...and how about a Principle 39 to counter-balance...



A Principle 2...



Principle 33?



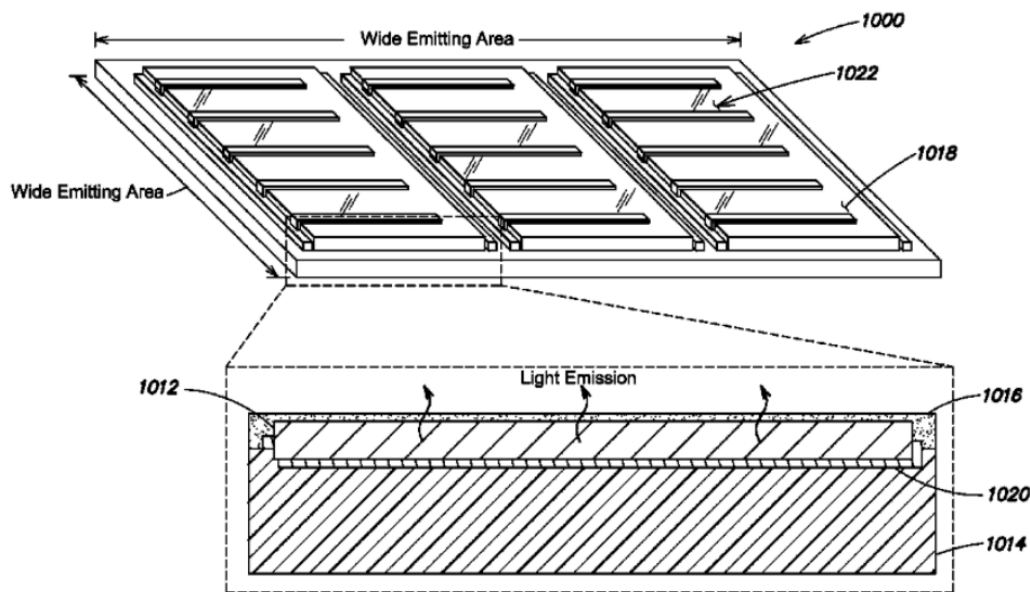
Almost my favourite. Hello Principle 6. Maybe.
Special thanks to the three good Samaritans that responded.



And my actual favourite. More cats. Inverted commas. Principle 35...



Patent of the Month – Phonon-Recycling LEDs



Patent of the month this month takes us to a trio of inventors at MIT. US9,722,144 was granted on August 1. Two reasons for being attracted to the invention: one, it comes with a high degree of counter-intuition, two it delivers a solution with >100% efficiency... and yet still complies with all of the Laws of Physics. Here's what the inventors have to say about the problem being addressed:

In theory, a light-emitting diode (LED) may emit optical power higher than the driving electrical power, with the difference between the optical power and electrical power drawn from lattice heat. In other words, an LED's wall-plug efficiency .eta., which is the ratio of optical output power to electrical input power, that is greater than 100%. This phenomenon is known as electro-luminescent cooling, electro-luminescence refrigeration, opto-thermionic cooling, the operation of a "Thermischer Konverter," and thermo-photonic cooling.

In an electro-luminescently cooled LED, electrons and holes are first excited by small forward bias voltage V , which may be small enough that $qV < \omega$, where q is the charge of an electron and ω is the energy of the emitted photon. The total amount of electrical work supplied per excitation is the product of the electron's charge q and the bias voltage V ; when qV is zero, the device is in thermodynamic equilibrium. Upon excitation, some of the electrons and holes relax by radiative recombination and generate photons that exit the LED.

The observation of light emission with photon energy ω in excess of the electrical input energy per electron qV is readily accessible in LEDs at a variety of wavelengths. At these operating points, the electron population is pumped by a combination of electrical work and Peltier heat originating in the semiconductor's lattice; this thermo-electric heat exchange is non-uniformly distributed throughout the device. This phenomenon has been experimentally observed in a SiC emitter and connected physically to the Peltier effect. Nevertheless, net cooling, or equivalently electro-luminescence with wall-plug efficiency greater than unity, has eluded direct observation until recently.

Early measurements of light emission from semiconductor diodes were followed closely by theoretical developments. Beginning in 1957, a body of literature theoretically establishing the basic thermodynamic consistency of electro-luminescent cooling and exploring its limits began to emerge. In 1964, experimental results demonstrated that a GaAs diode could produce electro-luminescence with an average photon energy 3% greater than qV . Still, net cooling was not

achieved due to competing non-radiative recombination processes, which led to a conclusion that a high value of η_{ext} was required for direct experimental observation of net electro-luminescent cooling.

More recently, several modeling and design efforts have aimed to raise the external quantum efficiency η_{ext} toward unity by maximizing the fraction of recombination that is radiative and employing photon recycling to improve photon extraction. More recent attempts to observe electro-luminescent cooling experimentally with a wall-plug efficiency η_{wp} near 100% have focused on the regime in which qV is equal to at least 50% of the material bandgap. As qV is lowered well below E_g , the electron and hole populations decrease exponentially following a Boltzmann distribution with decreasing chemical potential. Since an excited electron in a direct bandgap semiconductor may relax either by recombining with a hole and emitting a photon, or alternatively by scattering into a state associated with a lattice imperfection and emitting phonons, small forward bias voltages $qV \ll E_g$ may be precluded by a requirement for high external quantum efficiency η_{ext} .

Complicated stuff, but effectively a conflict exists between the desire to increase illumination from the LED, but without increasing the electrical power input. A nice easy one to map on to the Contradiction Matrix:

IMPROVING PARAMETERS YOU HAVE SELECTED:
Illumination Intensity (23)
WORSENING PARAMETERS YOU HAVE SELECTED:
Power (18)
SUGGESTED INVENTIVE PRINCIPLES:
35, 25, 19, 28, 17, 2, 14, 4

And here's how the MIT team have solved the problem:

Contrary to conventional wisdom, which holds that light-emitting diodes (LEDs) should be cooled to increase efficiency, the LEDs disclosed herein are heated [Principle 35] to increase efficiency. Heating an LED operating at low forward bias voltage can be accomplished by injecting phonons generated by non-radiative recombination back into the LED's semiconductor lattice [Principle 28]. This raises the temperature of the LED's active region, resulting in thermally assisted injection of holes and carriers into the LED's active region. This phonon recycling or thermo-electric pumping process can be promoted by heating the LED with an external source (e.g., exhaust gases or waste heat from other electrical components [Principle 25]). It can also be achieved via internal heat generation, e.g., by thermally insulating the LED's diode structure to prevent (rather than promote) heat dissipation. In other words, trapping heat generated by the LED within the LED increases LED efficiency under certain bias conditions.

Principle 35 solutions are very common, but at the same time the Principle often confuses TRIZ users. The name of the Principle would be better stated as 'Change a parameter to such an extent that a non-linear shift is created'. So, in this invention, on the one hand we may say, that the inventors have merely 'changed temperature' (Principle 35D) to solve the problem, but on the other, the inventive step that we see is that the temperature change creates a change in the properties of the diode that is very non-linear – to the extent that we get the opposite of what we ought to expect.

Okay, it's still a complicated solution, but that shouldn't stop us from admiring a team that sets out to achieve a solution beyond the conventional definition of ideal. If you want to know more, and don't like ploughing through patent literature, there's a much more readable paper describing some of the key research findings behind the invention, check out:

http://www.rle.mit.edu/sclaser/documents/SanthanamThermoelectricallyPumped_000.pdf

And now, assuming this research gets to find a commercial application, look for a step-change in LED design and solid-state-cooling technologies:

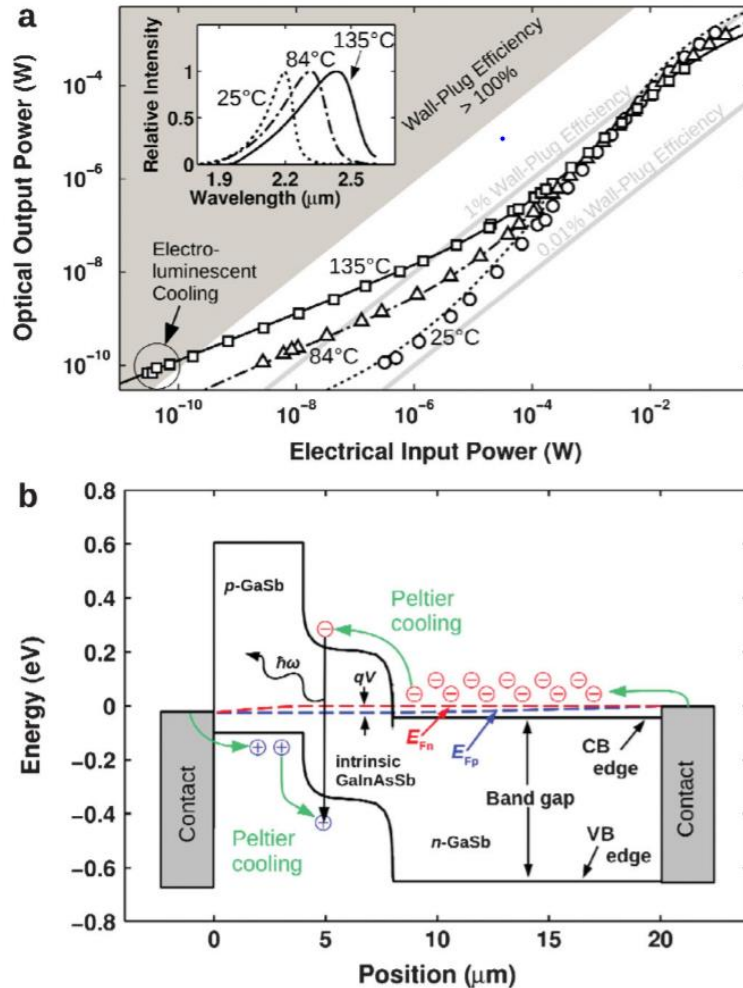
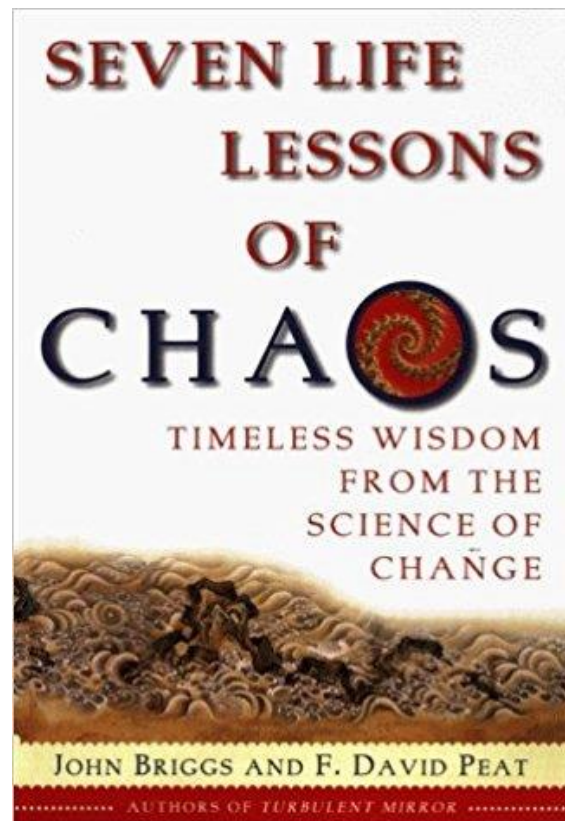


FIG. 1 (color). (a) LED output optical power versus input electrical power. The inset shows the experimental temperature dependence of the emission spectrum for a typical device. The lines denote the results of a numerical model. The discrete markers denote experimental data. (b) Band diagram at 26 mV forward bias. Peltier heat exchange occurs at various positions within the device. When a small forward bias is applied, most of the energy required to inject electrons and holes into the InGaAsSb active region is drawn from the lattice and the device operates as a heat pump. (CB, conduction band; VB, valence band.)

Best of the Month – Seven Life Lessons Of Chaos



Here's a book I didn't think I'd find. For what seems like an age, we've been on the lookout for a good (i.e. 'recommendable') book on complexity and chaos. In theory, there's lots to choose from. In practice, what we usually end up with are lots of abstract and largely empty theory, lots of pretty picture examples of 'look how complex this is', and not a lot of practical advice. And then, out of the blue appears this little gem. From 1999 if you can believe it. Co-authored by a strange pairing of a physicist and a professor of literature. It shouldn't work, but somehow it works amazingly well. The book is both readable and practical. And, perhaps most amazing of all, given the fact that it's close on eighteen years old, it feels very leading edge. Which is another way of saying that it demonstrates how little practical progress the chaos-theory world appears to have made so far this Century.

Admittedly, when I initially looked at the seven chapter headings relating to the titular 'seven life lessons', I wasn't filled with a lot of confidence:

- Be Creative: engage with chaos to find imaginative new solutions and live more dynamically
- Use Butterfly Power: Let chaos grow local efforts into global results
- Go with the Flow: Use chaos to work collectively with others
- Explore What's Between: Discover life's rich subtleties and avoid the traps of stereotypes.
- See The Art of the World: Appreciate the beauty of life's chaos.
- Live Within Time: Utilise time's hidden depths.
- Rejoin the whole: Realise our fractal connectedness to each other and the world.

I needn't have worried. The book is full of practical, real-life examples of chaos and complexity in action. From Václav Havel and the short 1978 'greengrocer' article that ultimately triggered the 'velvet revolution' in Czechoslovakia (Lesson 2: Using Butterfly

Power) through to Christopher Alexander and 'the quality without name' in architecture, from fractal-Beethoven to the complex mechanics of cancerous cells, the whole book makes for an awe invoking tour through a parallel universe. Everything we know is wrong; everything we take for granted means something else when we see it through the eyes of complex systems.

Here's the foreword, adapted from The Complete Works of Chuang Tzu:

The next day the two came to see Taoist Master, Hu Tzu again, and when they had left the room, the shaman said to Lieh Tzu, "Your master is never the same! I have no way to physiognomize him! If he will try to steady himself, then I will come and examine him again."

Lieh Tzu went in and reported this to Hu Tzu.

Hu Tzu said, "Just now I appeared to him as the Great Vastness Where Nothing Wins Out. He probably saw in me the Workings of the Balanced Breaths. Where the swirling waves gather there is an abyss; where the still waters gather there is an abyss; where the running waters gather there is an abyss. The abyss has nine names and I have shown him three. Try bringing him again."

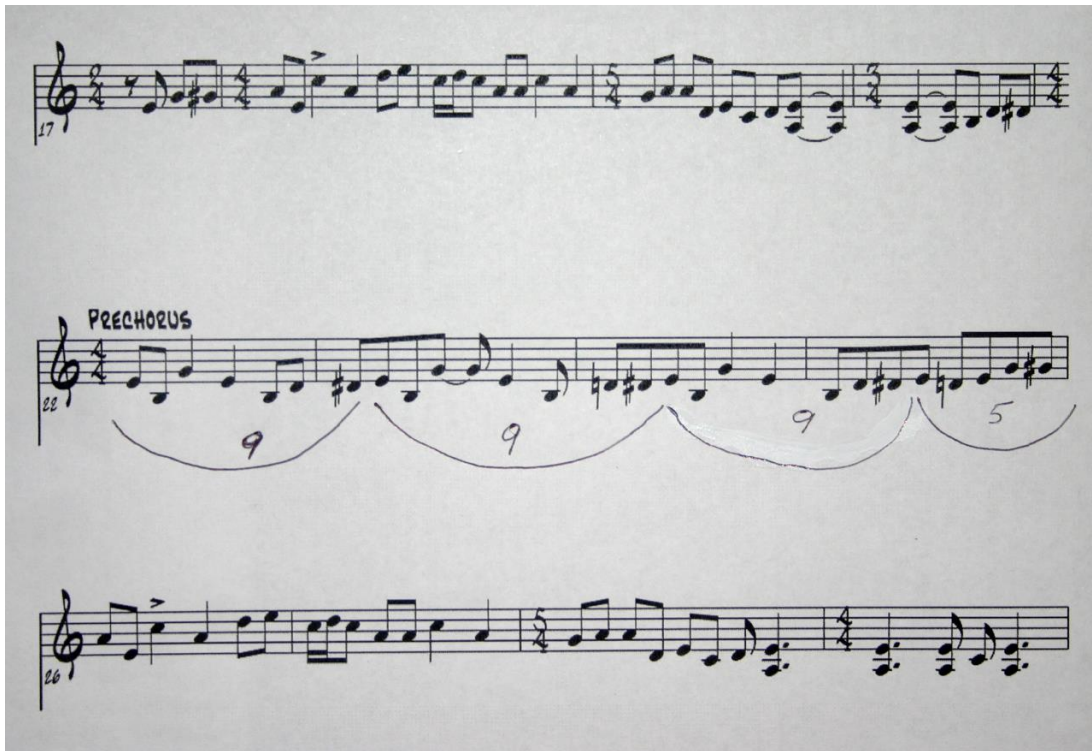
The next day the two came to see Hu Tzu again, but before the shaman had even come to a halt before Hu Tzu, his wits left him and he fled.

"Run after him!" said Hu Tzu, but though Lieh Tzu ran after him, he could not catch up. Returning, he reported to Hu Tzu, "He's vanished! He's disappeared! I couldn't catch up with him."

Hu Tzu said, "Just now I appeared to him as Not Yet Emerged from My Source. I came at him empty, wriggling and turning, not knowing anything about 'who' or 'what,' now dipping and bending, now flowing in waves - that's why he ran away."

But we needn't run.
Poetry. Pure poetry.

Wow In Music – Black Dog



“Well we can’t count from where you stopped because your vocals might be different. Your voice might go on half a beat and we’re gonna be fucked.”
John Bonham to Robert Plant

On the one hand the opening track from Led Zeppelin’s all-time classic album, ‘IV’, Black Dog, sounds to be straight-ahead rock music. But then somehow, when you try and tap along or play Jimmy Page’s guitar part, something doesn’t seem right.... to the extent that, the more you listen the more you wonder whether the drums and guitars even playing the same song?

Progressive rock was famous for its traffic-light stops and starts, but Led Zeppelin generally eschewed that approach, deploying shifts of time-signature and tempo, along with a movement of the placement of rhythmic emphasis (pulses) and varying degrees of syncopation within the same song without drawing too much attention to these elements, none of which is easy to pull off, not when there are four of you and you are mostly recording live and in real time. And “Black Dog” exemplifies Zeppelin at their peak in this regard.

In fact, the beginning of the end of the musical logics that propelled Zeppelin were foreshadowed by an unfortunate development: “Stairway To Heaven” with its daft lyrics and its blatant signalling of unprompted time-shifts that neither meld successfully nor create a delightful sudden change of gear (as in “Heartbreaker”). One gets the feeling, I do anyway, that this is the first track in their career when they are in fact *killing time*.

But generally, they were innovators, albeit with a strong desire to imitate, learn from, compete ambitiously with the best. Zeppelin were also of course nostalgically (nostalgia: an illness that Led Zep combined with modernism, never more so than on “Black Dog”) drawn back to places and times that preceded their births – the blues. But anyone who thinks that this is merely standardized routine 12/32-bar repetition has rather missed the

dropped beats, the odd meters, the changes in tempo, the vocal/guitar inflection, cadences and intonations that can make subtle or shocking transformations of feel: those elastic moveable pulses.

So, notice how on “Black Dog” the gaps between the end of the last vocal line in each verse gets shorter each time (Principle 3), before the band crashes the silence, as the song progresses. And this *is* progressive rock, if that term means anything. It is progressive for three reasons: (i) it aggressively refuses the norm of the pop/rock song by obsessive messing with one’s sense of time; (ii) this means you have to listen to it (i.e. regressive listening is not an option); (iii) the song itself progresses, getting more complex and also more emotional as it takes flight and then – of course – crashes.

And, if we now look at “Black Dog”, composed and recorded (mostly live – the overdubs are largely Page’s synthetic-sounding hyper-treated guitar parts) when Zep were at the height of their powers, we hear a group that can perform a track with 98 times changes (Principle 15!), absent sheet music or a conductor. Not only that but amongst these strict changes in time signature (including the tense and extremely funky simultaneous use of two different ones) the song hides syncopation on a grand scale. Listen to the “oh baby pretty baby” sections and focus on the pick-up on the snare drum before the main backbeat, and how Bonham is always following Page – not Jones, his bassist, which would be the norm – Jones had to watch Bonzo’s kick drum, to keep up, or rather to keep just behind.

“Black Dog,” so brilliantly analyzed by Erik Davis in his book detailing the IV album, changes time-signatures, tempo, syncopation and pulsing, throughout the song: from the verse/vocal part stolen from Fleetwood Mac’s “Oh Well” to the twisting riff. But, of course, the most striking surprise, surely one of the most shocking moments in rock history, occurs when Page and Jones go into a riff in 5:4 time and Bonham play across them in 4:4 time. Thus reaching a point of connection every three 9s plus a 5 beats – see chart at top of the article.

The story goes that originally John Bonham tried playing 8th notes, in keeping with the 5:4 time, but that he either lacked the technical ability to do this or that the effect sounded too much like The Mahavishnu Orchestra! In any case they toyed, they experimented, they played and they were willing to play this game: ignore *la langue* (the rules of rock) and make a new utterance (*parole*) – 4s over 5s until it resolves, then repeat the joke. For this accidental joke, one of the funkiest musical japes I have heard, did apparently reduce the four of them to laughter, the first time they played it, in rehearsal. But these kid’s giggles, you can hear them stifling the raucous laughter that is to follow, is surely not ironic or a poking of fun at the audience: it was that of highly skilled musicians who just pulled off a new trick, barely having the time to think of the intention behind it (if such there was), collective or otherwise.

The thing is, they kept playing, through the tension of the 5/4 toe-curling and the mind-scrunching concentration it takes at first to play the drums and not listen to the guitars too much, and the same goes of course for the bass/guitar. And then someone, or all of them, saw the brilliance of what they had done (progressive rock in all but name but it sounds like a straight blues rock throwaway) and they did this intentionally. They intended to play with the mistake and then they intended to keep it.

Because it was good.

You know it already, but if you want to remind yourself of the Principle 37 trick, check it out here: <https://hooksanalysis.files.wordpress.com/2009/10/black-dog-2.mp3>

Investments – Dirty-Aluminium Biofuel Catalyst



A researcher at Queen's University Belfast has discovered a way to convert dirty aluminium foil into a biofuel catalyst, which could help to solve global waste and energy problems.

In the UK alone, around 20,000 tonnes of aluminium foil packaging is wasted each year - enough to stretch to the moon and back. Most of this is landfilled or incinerated as it's usually contaminated by grease and oils, which can damage recycling equipment. However, Ahmed Osman, an Early Career Researcher from Queen's University's School of Chemistry and Chemical Engineering, has worked with engineers at the university to create an innovative crystallisation method, which obtains 100% pure single crystals of aluminium salts from the contaminated foil. This is the starting material for the preparation of alumina catalyst.

Usually, to produce this type of alumina it would have to come from bauxite ore, which is mined in countries such as West Africa, the West Indies and Australia, causing huge environmental damage.

Osman, who took on the project under the University's Sustainable Energy, Pioneering Research Programme, has created a solution which is much more environmentally-friendly, effective and cheaper than the commercial catalyst which is currently available on the market for the production of dimethyl ether -- a biofuel which is regarded as the most promising of the 21st century. Osman says making the catalyst from aluminium foil cost about £120/kg while the commercial alumina catalyst comes in at around £305/kg. Its unique thermal, chemical and mechanical stability means it can also be used as an absorbent, in electronic device fabrication, as a cutting tool material or as an alternative for surgical material for implants.

The ground-breaking research has been published in Nature Scientific Reports. Osman commented: "I have always been inspired by Chemistry and I believe that catalysis especially can make the world a better place. One day I took a walk through our

laboratories at Queen's and found lots of Aluminium foil waste so I did a little digging and after speaking to my colleagues, I ran my experiment and was astonished by the ultrapure single crystals -- I didn't expect it to be 100% pure.

"At Queen's, our scientists and engineers often work hand in hand on common challenging problems for the society. By using our joint expertise, we have been able to tackle the issue of sustainable development and come up with a research solution which lies in an area between chemistry and chemical engineering.

"This breakthrough is significant as not only is the alumina purer than its commercial counterpart, it could also reduce the amount of aluminium foil going to landfill while also sidestepping the environmental damage associated with mining bauxite."

Osman is hoping to continue his research into how these catalysts can be further improved and explore the opportunities for commercialisation of biofuel production or use the modified alumina catalyst in the catalytic converters in natural gas vehicles.

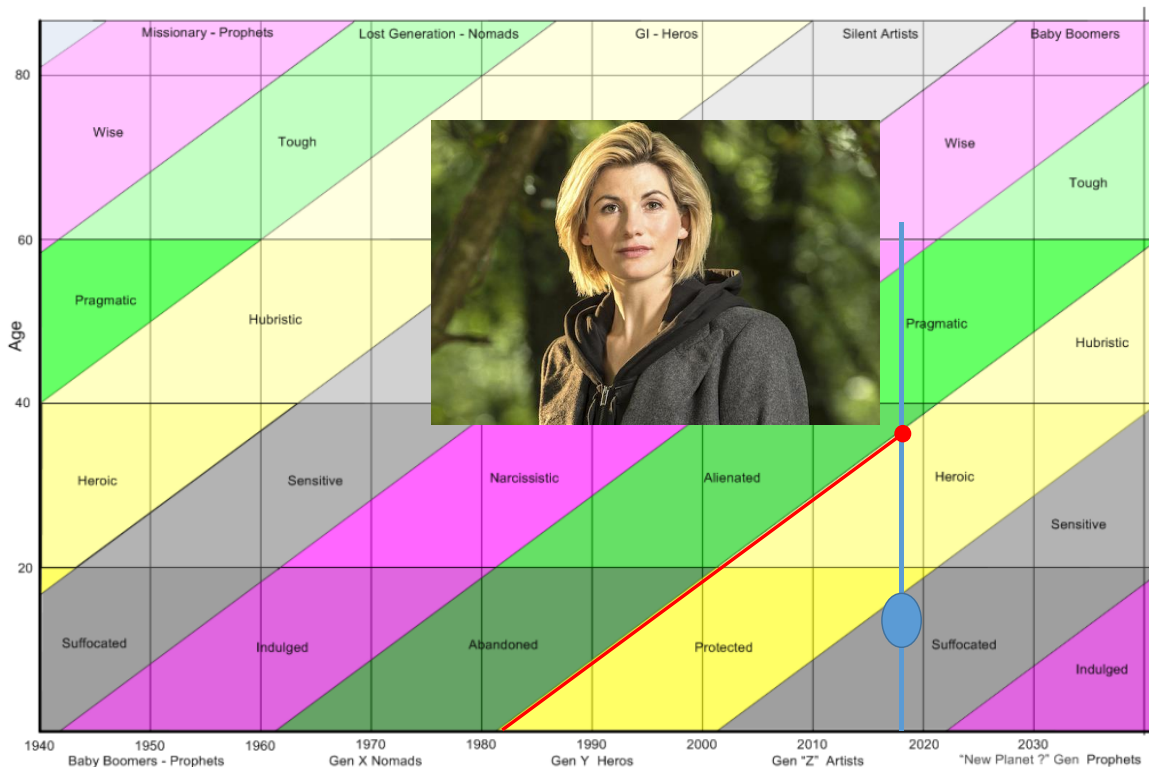
Read more:

Ahmed I. Osman, Jehad K. Abu-Dahrieh, Mathew McLaren, Fathima Laffir, Peter Nockemann, David Rooney. **A Facile Green Synthetic Route for the Preparation of Highly Active γ -Al₂O₃ from Aluminum Foil Waste.** *Scientific Reports*, 2017; 7 (1) DOI: [10.1038/s41598-017-03839-x](https://doi.org/10.1038/s41598-017-03839-x)

Generational Cycles – Dr Who XIII



It was a big enough announcement that it made the national news in the UK on all of the Channels. The new Dr Who was revealed to be Jodie Whittaker. The switch represents one of the bravest of the Doctor's regenerations. One might even say Heroic, since Ms Whittaker is indeed the first of the Hero Generation to be offered the part. If it's a sea-change in casting, it's also highly prescient in terms of the recognition that the programme's core audience – teenagers – will also have undergone a generational shift by the time the new series appears on our TV screens in 2018:



Jodie Whittaker: Hero Doctor for an Artist generation. Genius.

Biology – *Dischidia rafflesiana*



Imagine. You're a plant. You need to spread and create other plants. The further you grow away you get from your root system, the more difficult it is to get water to the new bits. Not to mention the possibility that there might not even be soil in places other than where your roots are currently positioned. What to do?

The *Dischidia* plant, which can send out shoots over two metres away from its roots, makes strange little pouch-like structures from pairs of leaves that fold in on themselves and become watertight. #when fully formed, they look like fat pickles. Ants are then invited to come and live in the pouches. They protect the plant from aphids and other small lifeforms, while the *Dischidia* gives the ants shelter. In addition to protecting the plant, the ants bring poop and detritus into the water-tight pouches. After a while, the plant sends roots into the pouch to absorb the anty-flavored goodness that has accumulated.

All in all it's a pretty remarkable evolutionary journey featuring multiple solved conflicts. The modified leaf (Principle 30) pouch is a good example of Principle 31, Holes (perhaps with a bit of Principles 35 and 14 built in for good measure). The ant-y synergy is a good illustration of Principle 24, Intermediary. Inserting a new root into the poop-filled pouch is then a good example of Principle 7, Nested Doll. Making positive use of the poop and detritus represents is a classic illustration of Principle 25B, Self-Service ('make use of waste substances').

Here's what the conflicts being solved look like when mapped on to the Contradiction Matrix:

IMPROVING PARAMETERS YOU HAVE
SELECTED:

Productivity (44)

WORSENING PARAMETERS YOU HAVE
SELECTED:

**Length/Angle of Stationary Object (4) and
Amount of Substance (10) and
Safety/Vulnerability (38)**

SUGGESTED INVENTIVE PRINCIPLES:

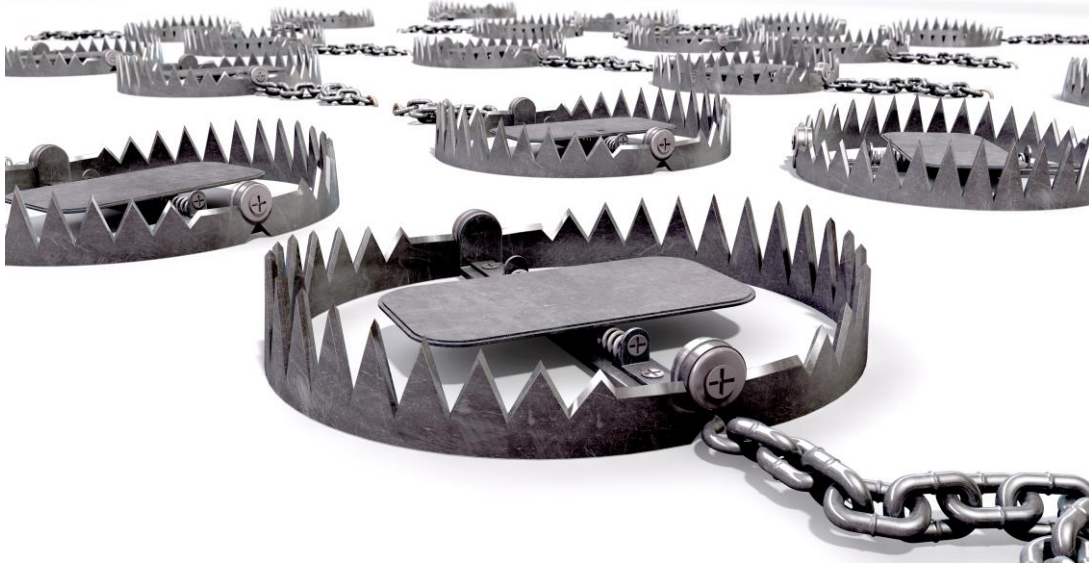
**3, 35, 1, 19, 14, 10, 7, 39, 17, 2, 25, 18,
9, 31, 24, 30, 13, 8, 5**

Simple when you know how.

Short Thort

"I hate endings. Just detest them. Beginnings are definitely the most exciting, middles are perplexing and endings are a disaster. ... The temptation towards resolution, towards wrapping up the package, seems to me a terrible trap. Why not be more honest with the moment? The most authentic endings are the ones which are already revolving towards another beginning. That's genius."

Sam Shepard (RIP)



"And if you can find any way out of our culture, then that's a trap too. Just wanting to get out of the trap reinforces the trap."

Chuck Palahniuk, Invisible Monsters

News

TRIZmeta

We are happy to announce that our forthcoming 'TRIZmeta' game will be a featured chapter in the TRIZ Games book, due for completion towards the end of this year. Creating a TRIZ-based game has been on the SI jobs-list for nearly fifteen years now. The challenge in creating a good game – the contradiction that needed to be solved in other words – is how to create a game where players are encouraged to break the rules of the game. With TRIZmeta we finally think we solved the contradiction: as the name suggests, you solve it by making a game that sits above other games. If anyone is interested in beta-testing TRIZmeta, drop us a line.

IMechE TRIZ

2017's last UK public '21st Century TRIZ' workshop is confirmed for 21 November. The event will take place at IMechE HQ in the centre of London. Book here:

<http://www.imeche.org/training-qualifications/training-details/21st-century-triz>

Complexis2018

Darrell will be presenting a paper at the 3rd International Conference on Complexity, Future Information Systems & Risk. Not that it played any role in the decision to attend,

but it is probably worth mentioning that the event next year takes place in Madeira. 20-21 March are the dates. <http://www.complexis.org/ConferenceVenue.aspx> is the URL.

US

Darrell's next four 2017 trips to the US are now all fully booked. The first trip of 2018 will be the week of 22-26 January. This week is also booked. The week immediately before is still a blank, so if anyone wants him to come and do something with you, please contact him directly.

New Projects

This month's new projects from around the Network:

- Education – SI workshops
- IT – Design-Thinking & TRIZ Workshops
- Electronics – Patent Bulletproofing Project
- IT – IP Development Project
- Fintech – PanSensic Study
- Emergency Services – Problem-Solving Workshops
- Technology – Innovation Leadership Mentoring Programme
- FMCG – SI Workshops
- Healthcare – PanSensic Study
- Recruitment – Innovation Strategy Project