Systematic Innovation

e-zine

Issue 266 May 2024

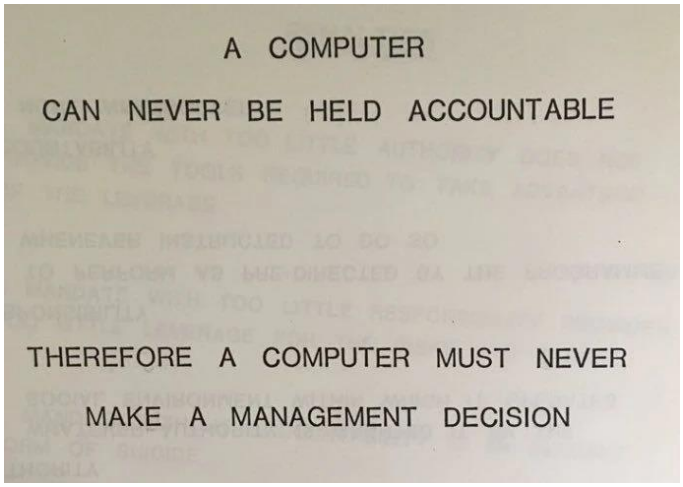
In this month's issue:

The Systematic Innovation e-zine is a monthly, subscription only, publication. Each month will feature articles and features aimed at advancing the state of the art in TRIZ and related problem-solving methodologies.

Our guarantee to the subscriber is that the material featured in the e-zine will not be published elsewhere for a period of at least 6 months after a new issue is released.

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

The Meta-Data Never Lies… Until It Does



In 1979, IBM – like all technology businesses – had a meeting about future technology, both hypothetical and real. Nothing about this was unusual, or at least, it wasn't back then. However, in 2024, we're now approaching what is purported to be some kind of technology zenith, an AI alignment point of no return, and Silicon Valley's "move fast, break stuff" methodology is finally catching up to us. Now, a single photograph from the IBM meeting's presentation packet has resurfaced after years of circulating the internet, ready for its moment nearly 45 years later.

Our book-of-the-month recommendation this month shows us that – good news – computers aren't accountable today. Their ubiquity, however, has created many situations where managers and users are no longer accountable for their decisions either. We are, to quote one of my favourite Indigo Girls songs, gluttons for our doom. The best of intentions unwittingly creating the worst of outcomes. Now with the turbocharging additional effect of AI. A world chock full of accountability sinks. The AI-driven 'invisible hand' not just gone mad but going madder at the speed of light.

At the same time, perhaps ironically, enterprises are discovering that an awfully large proportion of the work they task people with conducting can be done quicker, cheaper and far more effectively with AI solutions. Or almost. Per the already cliched expression, 'people won't be replaced by AIs, they will be replaced by people using AIs', its still the case that having a human in the loop 'somewhere' is useful. One of the fastest growing businesses on the planet right now offers clients AI-assisted Executive Assistants. Early evidence from clients suggests that one of these Assistants is replacing between 10 and 20 non-AI-equipped people (Reference 1). Tomorrow the ratio will likely be higher. The out-sourcing company, and their growing array of overwhelmed clients will no doubt be happier. Leaders and managers more than happy to cut headcount, save money and get higher quality output. What's not to like? This is classic contradiction solving, apparently breaking the most intractable of iron-triangles – faster, cheaper and better. Now, it would appear, through the magic of AI, managers can have all three.

If there's one sure thing in life, however, it is that there's no such thing as a free lunch. Solve one contradiction, and sooner or later the next one arrives. With AI involved, more likely sooner than later.

Just because the next problem arrives quickly, however, doesn't necessarily mean that AI will help us to solve it any more quickly. Instead, if we're not careful, it can slow the solving part down considerably. Which is perhaps my way of saying that the signs are already there that the AI world is heading into another Winter period. There is still no singularity.

We'll get to that in a few minutes. Meanwhile, the contradiction to be solved becomes clearer day by day. It looks something like this:

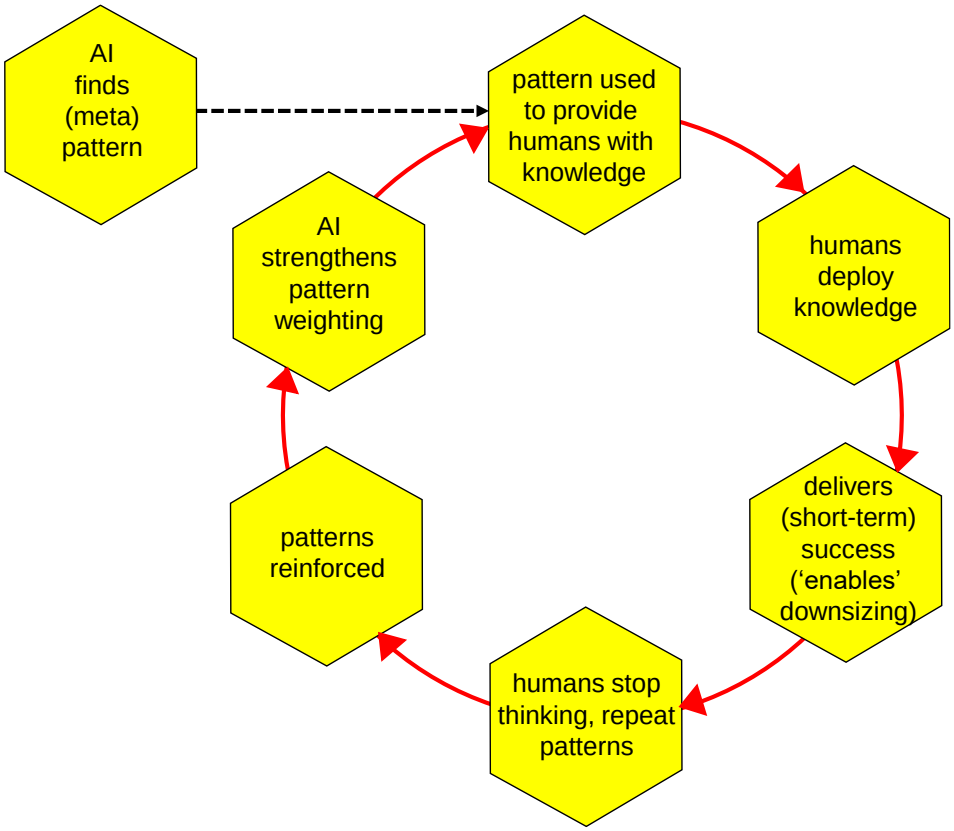


Figure 1: AI Gets 'Better', Human Gets Worse Vicious Cycle

The cycle starts (top left) when a human asks the A(G)I a question. The algorithm interrogates the available data, finds the relevant pattern and shares it with the user. The user deploys the shared knowledge, and usually discovers – to their time/cost-saving joy – that it delivers a useful outcome. It was likely a question we didn't much care about in the first place, so now we've obtained an answer that gets me a pat on the back, I'm likely to become more accepting of and dependent on the AI. The fact of my success with the AI recommendation in turn provides the AI with more data to analyse. This analysis strengthens the evidence that the pattern is valid. Which, now returning back to the top of the cycle, means the human places even more trust in what the algorithm says. Repeat that cycle a few dozen times and we head into the zone where the AI knows everything and the poor, overworked, undermotivated humans know nothing.

Still, not to worry, we've now got an AI that we can trust. It hasn't just perfected the basic patterns, it has found the previously invisible meta-patterns. Invisible to humans that is. That's why it is virtually lore in the AI world that the 'meta-data never lies'. Because humans can't visualise the meta data, they didn't know how to lie to cheat it. And so the algorithm is not just 'perfected' it increasingly represents reality.

In some warped way, to a lot of people (managers) this ultra-transparent, ever more accurate version of reality represents some kind of Utopian vision of the future.

Fortunately (or unfortunately, depending on your personal perspective) this will rapidly devolve into a somewhat nightmarish version of Utopia. One that the algorithm-owning totalitarianists might still like (Reference 2), because they'll have all the money, and money, while it might not buy happiness, sure helps alleviate most of the usual sources of unhappiness. Like not being able to afford to feed the family, or put a rented roof over their heads. Let's not go there, and instead think about why these 'perfected' algorithms aren't. And why the meta-data can very easily begin to lie.

Point one: complexity. The algorithms we've been talking about up to this point are based on situations that are either Simple or Complicated. As we've discussed multiple times elsewhere (Reference 3 should suffice for now for anyone wanting to dig deeper), while these types of situation are common in our highly segmented, highly specialised world, in the real world they are highly uncommon. A Complicated problem has a calculatable 'right' answer. Same as it ever was. AIs, like well-trained white-collar workers, know how to answer Simple or Complicated questions. Are there any malignant cells in this x-ray? Is the apple bruised? What should driver X's car insurance premium be? What's my optimal 5-city break itinerary? Did the student plagiarise their essay? What grade does the essay merit? What are the quarterly figures? What are the projections for next quarter?

Here's where these kinds of situation exist on the Complexity Landscape Model:

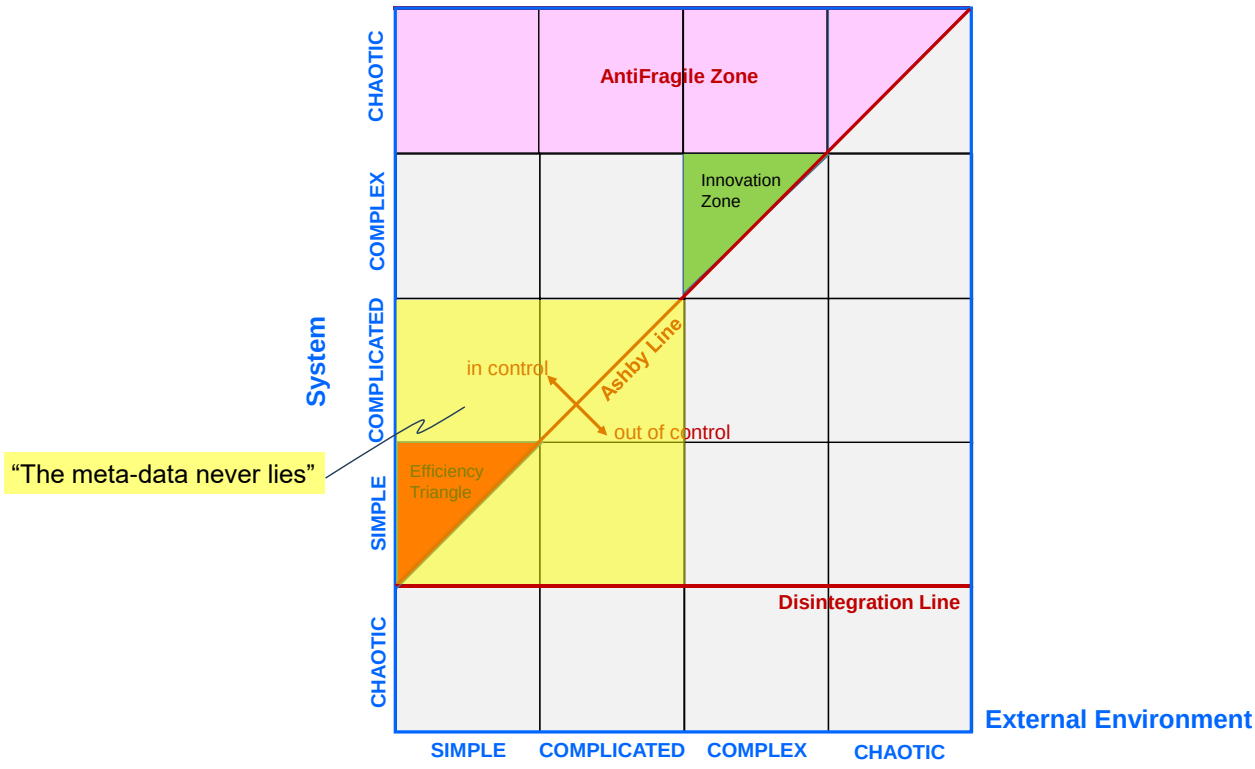


Figure 2: Complexity Landscape Model – Yellow 'Meta-Data Never Lies' Zone

Here, too, is where the meta-data indeed never lies. Given a big enough computer and a big enough set of training data, the algorithm will find that 'right' answer. According to the Landscape, however, the yellow 'right answer' zone is a relatively small proportion of a much bigger reality. Escaping from the Simple and Complicated worlds demands a far great level of algorithm sophistication, the biggest jump of which only starts when programmers begin to understand that there is no such thing as a 'right' answer any longer. The best that can be hoped for is an answer that is 'acceptable' at this given point in time, given the shifting sands of the surrounding context.

Point two: not only does the algorithm struggle with context – which, in theory at least, is expressed in the meta-data – the bigger issue is that along comes the innovator. The innovator is fundamentally the pattern-breaker. The chaos-loving, entropy-reducer. The moment the innovator sees everyone stuck inside a pattern, they know they've just found fertile ground for developing a novel solution that breaks that pattern. And, moreover, takes the intended customer to a step-change higher level of ideality. And, moreover again, turns the meta-data into a lie.

Innovators, in the context of Utopian ideals of a perfectly optimised world, are a real nuisance.

It won't be too long, I'm sure, before 'the algorithm' will be taught to identify these nuisances before they can start disrupting the already 'perfectly optimised' order in order to then prevent them from doing their thing. Come to think of it, those algorithms already exist.

It is several orders of magnitude easier to design them than the one that could automatically identify – nay, 'create' – the pattern breaks that would transcend the law-of-diminishing-return optimisation of current systems and allow us all to make the much needed leaps to better paradigms.

Perhaps creating this capability could be as easy as training a pattern-breaking AI with the pattern-breaking heuristics of successful innovators?

Which sounds rather like creating an AI 'trained' using a TRIZ/SI-based contradiction-solving LLM?

Life is never that simple, of course. But until it happens, we will all have to learn to live through the coming AI Winter. A Winter, moreover, in which the Figure 1 vicious cycle becomes progressively more and more vicious. Less thinking, less ability to think; more perfectly-optimised, perfectly-stuck algorithms; more entropy, more – to quote the Little Britain meme – 'Computer Says No'; more optimally paralysed on the peak of Mount Stupid.

References

1) https://humanloop.com/customer/athena.
2) Mann, D.L., 'TRIZ versus The Global Descent Into AI-Driven Totalitarianism', TRIZCON, 8 November 2023.
3) SIEZ, '(Woodstock And) The AntiFragile Zone', Issue 247, October 2022.

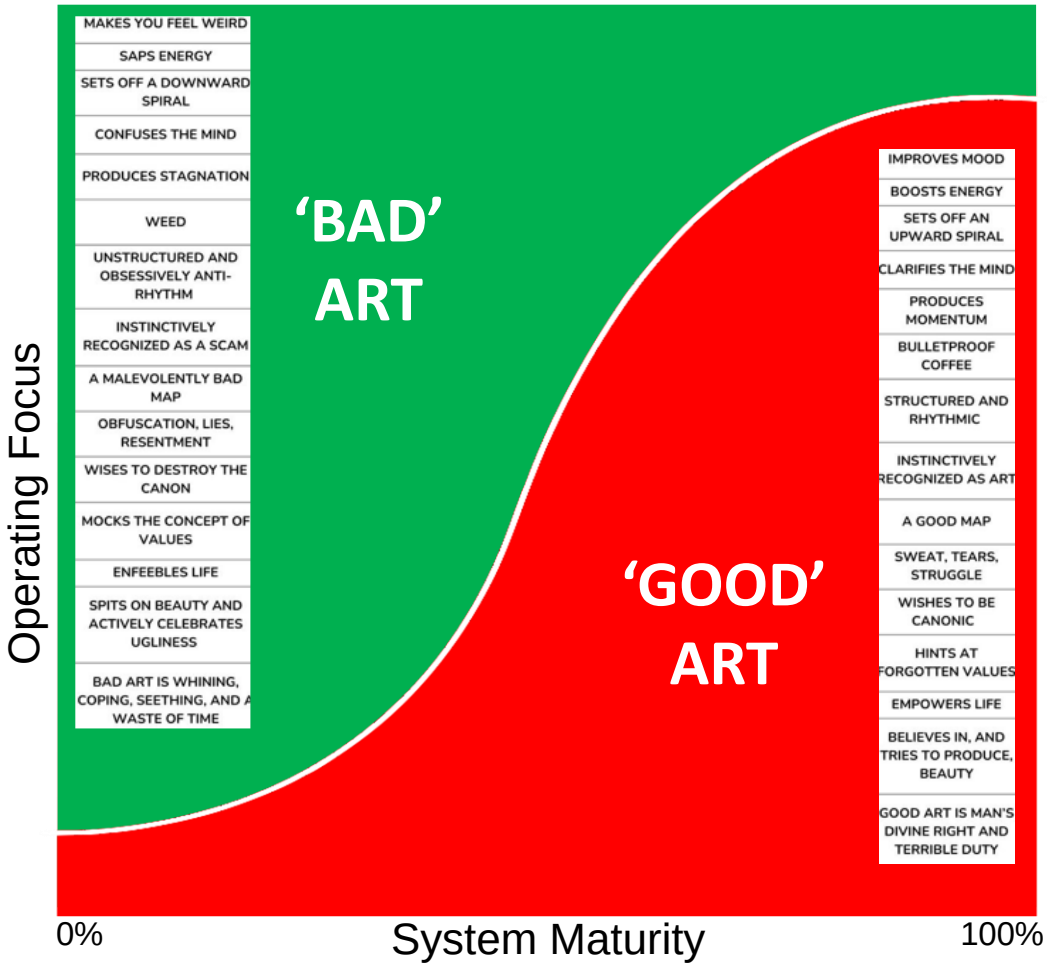
Good Art/Bad Art I

The world loves a fatuous argument. The best way to trigger one – as all the best click-bait seeking wannabee-gurus have learned – is to pose an either/or question. Preferably one with a moral or ethical dimension. That way you can guarantee there is no right answer. just lots of followers making ever more obtuse, more delusional claims for their side of the either/or fence.

At the risk of falling into the clickbait trap set by wannabee-guru, @oldbooksguy, I recently got caught up in the aftermath of his fifteen fatuous dimensions of 'good art' post. It wasn't a pretty sight.

My immediate thought after scanning his fifteen definitions of good art was the Talking Heads song, Heaven, the chorus of which goes, *"Oh, Heaven, Heaven is a place, A place where nothing, Nothing ever happens."* Which is kind of like my shortcut way of saying if that's what good art is, give me bad art any day of the week. Or almost.

My second thought was triggered by the red and green backgrounds given to the fifteen good and bad art definitions, respectively. The thought was, 'he's got them the wrong way around'. All the definitions of 'good art' seemed to coincide with the way, Operationally Excellent, Red-World people would define it. All the definitions of 'bad art' seemed to coincide with the way Innovation-driven Green World would define 'good art'. Something like this:



Anyone that follows me on Twitter will know that I've got an annoying habit of drawing lots of these Red/Green S-Curve pictures. They're my way of highlighting a certain type of either/or contradiction. A type that gets solved not so much by separation in time, space or interface, but by level of system maturity. The more mature a system becomes, the more it comes to define good art – in this example – as stuff that is efficient, controlled and soothing, and less challenging, wild or discomforting. Both extremes, crucially, are necessary…

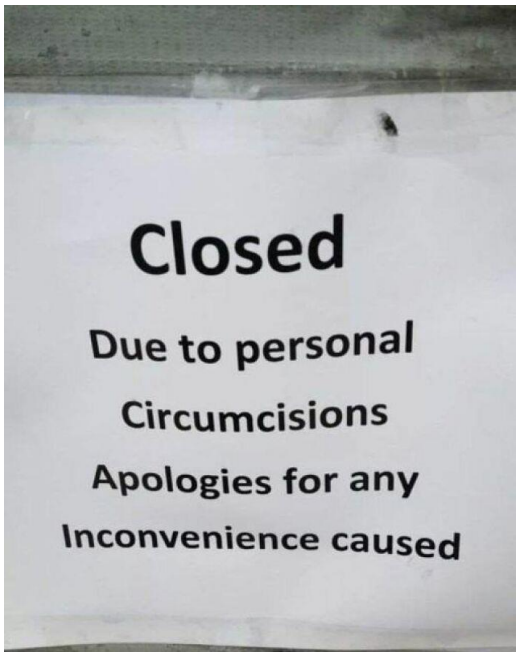
…sometimes more than others maybe… you might like to skip forward to Part II of this story, in the Generations section of the ezine…

Not So Funny – 40 Inventive (Slightly Disturbing Sign) Principles

Semiotics is the study of the use of symbolic communication. Semiotics can include signs, logos, gestures and other linguistic and non-linguistic communication methods. Some of which are more effective than others. Some merely communicate what needs to be communicated. Others manage to encourage viewers to read between the lines. And others seem to have a completely different meaning to the one we think they mean. The challenge involves reverse engineering the original creativity to work out which is which…

Principle 1, Segmentation

Principle 2, Taking Out/Separation



Principle 3, Local Quality

Leeds. I knew it.

Principle 4, Asymmetry

Sounds a bit one-sided?

SYSTEMATIC INNOVATION

Principle 5, Merging

Principle 6, Universality

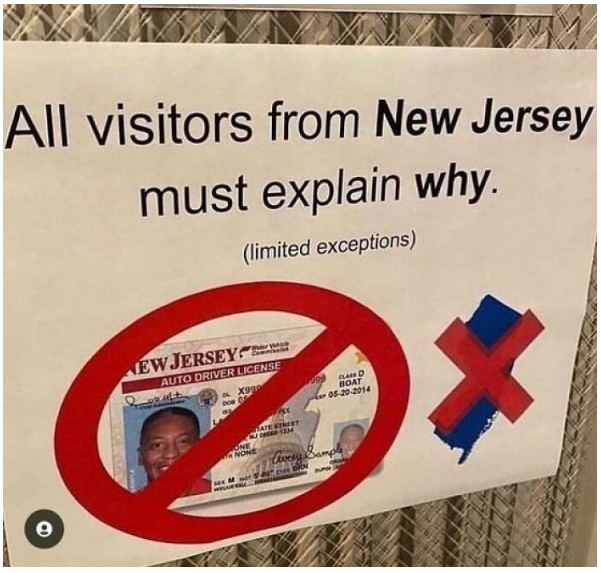
Principle 7, Nested Doll

Principle 8, Anti-Weight

Principle 9, Prior Counteraction

Principle 10, Preliminary Action

Principle 11, Beforehand Cushioning

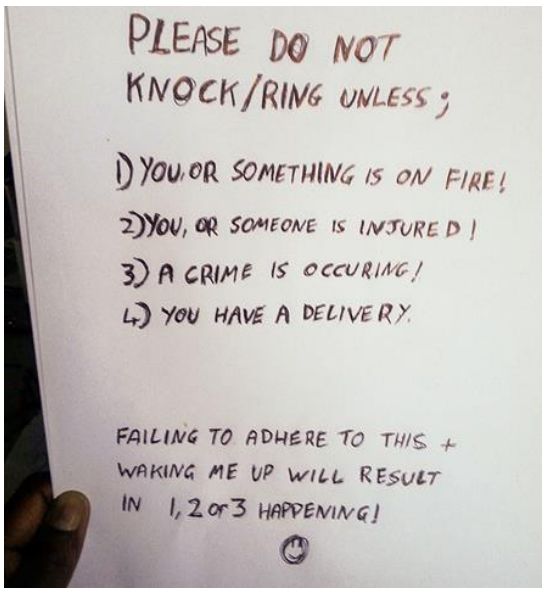


SYSTEM ATIC INNOVAT ION

Principle 12, Equipotentiality

Principle 13, The Other Way Around

Principle 14, Spheroidality

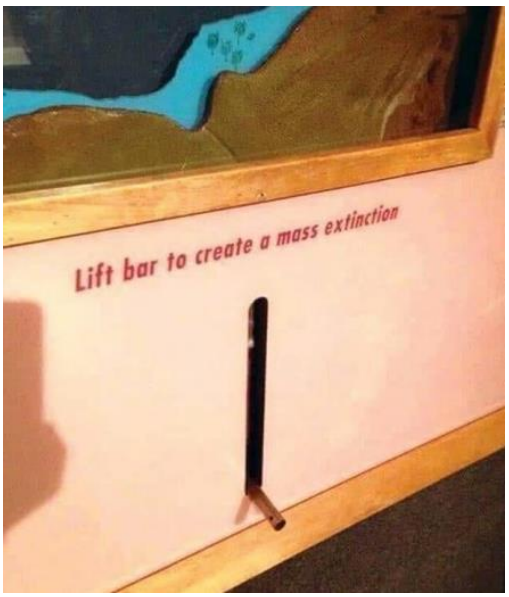


Principle 15, Dynamisation

Ikea furniture… tcch.

Principle 16, Slightly-More/Slightly-Less

Principle 17, Another Dimension



SYSTEM ATIC INNOVAT ION

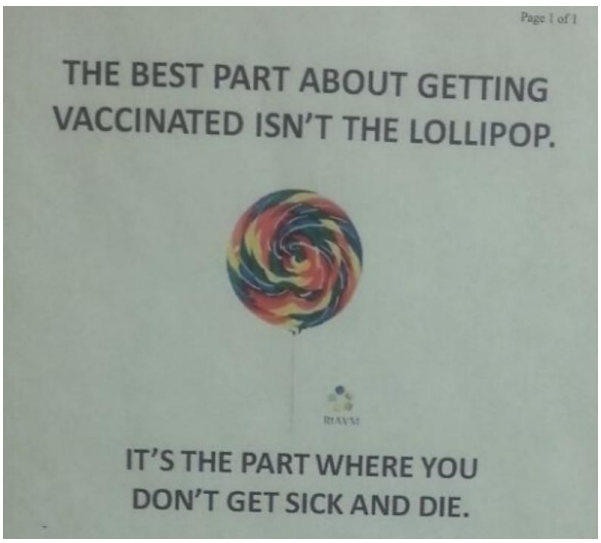
Principle 18, Vibration

Principle 19. Periodic Action

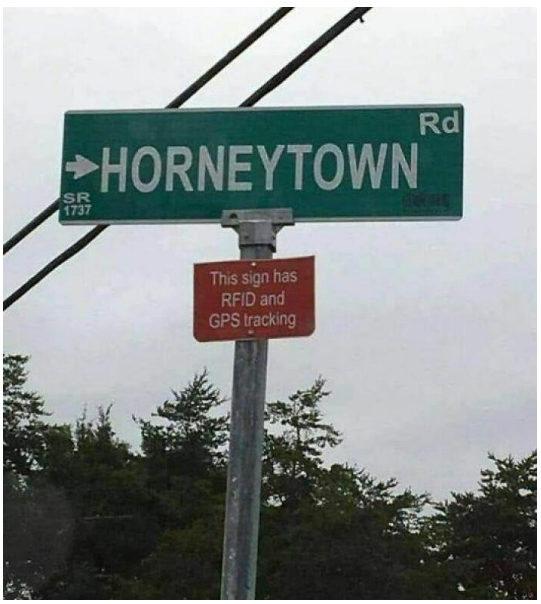
Principle 20, Continuity Of Useful Action

Principle 21, Skipping

Principle 22, Blessing-In-Disguise



Principle 23, Feedback



SYSTEM ATIC INNOVAT ION

Principle 24, Intermediary

Principle 25, Self- Service

Principle 26, Copying

Principle 27, Cheap Disposable

Principle 28, Mechanics Substitution ('Another Sense')

Principle 29, Pneumatics & Hydraulics

SYSTEMATIC INNOVATION

Principle 30, Flexible Shells & Thin Films

Do not go gentle into that good night,
Rage, rage against the dying of the light...

Principle 31, Holes (‘Pauses’)

Principle 32, Colour Changes

Principle 33, Homogeneity

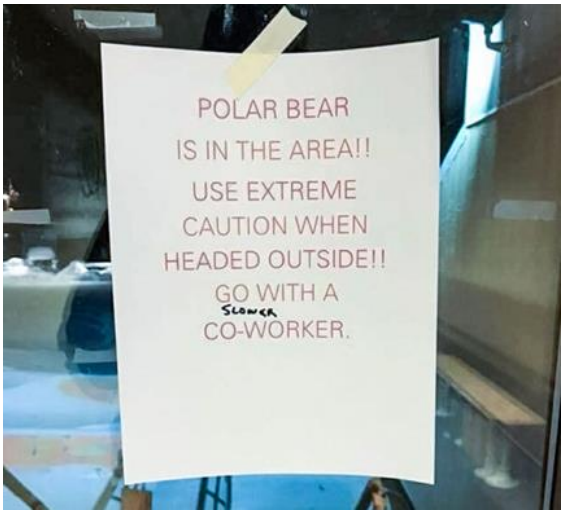
Principle 34, Discarding & Recovering

Principle 35, Parameter Changes

SYSTEM ATIC INNOVAT ION

Principle 36, Phase Transition

Principle 37, Relative Change



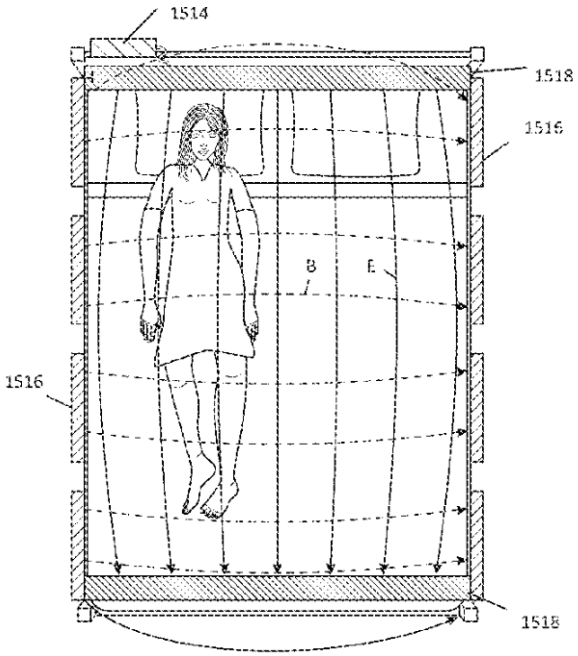
Principle 38, Enriched Atmosphere

FOR THE LOVE OF ALL THAT'S HOLY - WHAT ARE YOU WARNING US AGAINST

Principle 39, Calmed Atmosphere

Principle 40, Composite

Patent of the Month – Therapeutic Systems (Using Magnetic & Electric Fields)

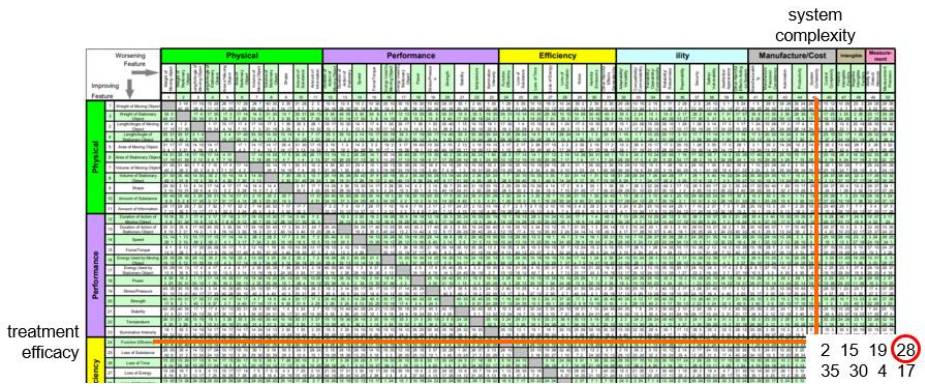


No prizes for guessing the Inventive Principle underpinning this month's Patent of the Month award winning solution. Another clear illustration of the 'field always wins' axiom, and the advantages of moving electrons rather than atoms. Enter US11,980,768, granted to a quintet of inventors at The University of Iowa on 17 May. Here's what the inventors have to say about the problem about to acquire a 'field' solution:

Existing therapies for chronic diseases, such as but not limited diabetes, cancer, neurological and immune diseases, have significant challenges. For example, existing therapies may only treat symptoms of the disease, may be invasive, and/or may have relatively low patient adherence.

By way of a non-limiting example, many diabetic patients have failed to achieve a healthy glycemic range and have a significantly greater risk of premature death in spite of the medications that are available to manage the disease. Patients may fail to adhere to their therapy because of the complexity of the dosing regimen for their prescribed medication, the discomfort of testing and insulin injections, and drug intolerability. Conventional diabetic care and the cost of treating complications resulting from poorly-managed diabetes is very costly.

A relatively simple problem, then, to map onto the Contradiction Matrix. At the macro-level, we want to improve medical treatment efficacy and we're unable to because of various complexity related issues. Here's what that looks like in the Matrix:



Good to see the presence of the ‘switch to a field’ Principle, 28, in the list. Here’s how the inventors have used it, twice, along with a healthy smattering of Principles 2 and 17. As described in the main Claim of the patent:

A system for delivering a therapy to a patient on a surface of a bed, comprising: a magnetic system configured to provide a magnetic field in a first direction over the surface of the bed; and an electric field system configured to provide an electric field in a second direction over the surface of the bed, the second direction being non-parallel to the first direction, wherein the electric field system includes at least a first electrode and at least a second electrode configured to be positioned on opposing first and second sides of the bed, both the first electrode and the second electrode are plate-shaped electrodes configured to be positioned substantially parallel to each other to provide the electric field with uniformity between the plate-shaped electrodes and over the surface of the bed, and with approximately linear electric field vectors in the second direction from the first side of the bed to the second side of the bed.

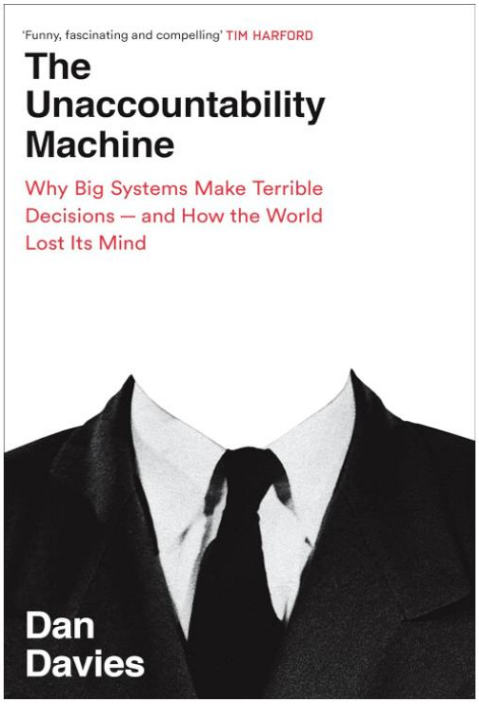
Lest you be wondering, elsewhere in the disclosure, they also talk about the use of pulsations (Principle 19) and moving the fields (Principle 15). They also reveal the underlying reason for the field-generated efficacy:

Many diseases are caused by an imbalance of free radicals. Free radicals, including reactive oxygen species (ROS) and reactive nitrogen species (RNS), have been implicated in the pathogenesis of a wide range of chronic diseases. The majority of free radicals are produced in the mitochondria as a result of cellular respiration. Free radicals are also generated in other cellular compartments by various enzymes and biological processes. Although free radicals were once thought to be destructive to the cell, there is a growing body of evidence demonstrating that free radicals act as signaling molecules, transmitting crucial information that contributes to the health state of the cell. The therapy protocol disclosed herein has been shown, through experiment, to increase free radicals (e.g. ROS). It has also been shown, through experiment, that at least some of the therapeutic benefits of the therapy are mediated by free radicals (e.g. ROS). Therefore, the present subject matter is believed to provide an effective therapy for diabetes and cancer, as well as for other diseases and conditions such as but not limited to neurological and immune related disorders (e.g. inflammation), and retinovascular disease. The present subject matter is also believed to provide therapeutic benefits against the aging process.

…which sounds like a different illustration of Principle 2.

Meanwhile, I’m still slightly amazed that in 2024 (well, strictly speaking 2021 – when the application was first filed) it has been possible to obtain such a broad ranging patent – point non-parallel magnetic and electric fields at a patient and cure them. If it wasn’t for the fact that it was a piece of University research, I might be tempted to call it quackery. Instead, I’m wondering how soon we’ll begin to see these kinds of solution at home?

Best of the Month – The Unaccountability Machine



During the process of setting up our DangerMouth conversation with the rather erudite Jolly Contrarian (https://www.dangermouth.org/episode-19-we-fought-the-law-and-the-law-won/), he pointed us in the Direction of the just-published book, The Unaccountability Machine by Dan Davies. It sounded like our sort of thing. Two weeks later, we now *know* it is our sort of thing. This is a great book. The subtitle indicates its scope: "Why Big Systems Make Terrible Decisions and How the World Lost Its Mind". The book asks why mistakes and crises never seem to be anybody's fault – it's always 'the system'. Davies uses the concept of the 'accountability sink' mentioned in the first article at the top of this month's ezine. An accountability sink is a policy or set of rules that prevent individuals from making or changing decisions and thus being accountable for them. He writes: "For an accountability sink to function, it has to break a link; it has to stop feedback from the person affected by the decision from affecting the operation of the system. The decision has to be fully determined by the policy, which means that it cannot be affected by any information that wasn't anticipated." The book also makes it clear that the more leadership teams out-source work to smart consultants (see our review of The Big Con from Issue 252), and the more that gets delegated to machine-learning automation, the more accountability sinks we will experience. Think Horizon. Or other examples discussed in the aforementioned Meta-Data article. Davies book, however, also shares plenty of non-automated examples. Citing, for example, Gill Kernick's wonderful book on the Grenfell disaster (and others), Catastrophe and Systemic Change.

Best of all, the book draws heavily on Stafford Beer's cybernetics, providing the public service of digesting all of his writings and making them accessible enough that maybe more than a dozen people on the planet have any idea what the great man was talking about. Cybernetics was of course concerned with using the flow of information and enabling feedback. Decisions about how to make decisions are part of the system. Hence the often-quoted principle that "the purpose of a system is what it does" – and not what it says it does. The book has several chapters describing how systems operate, including

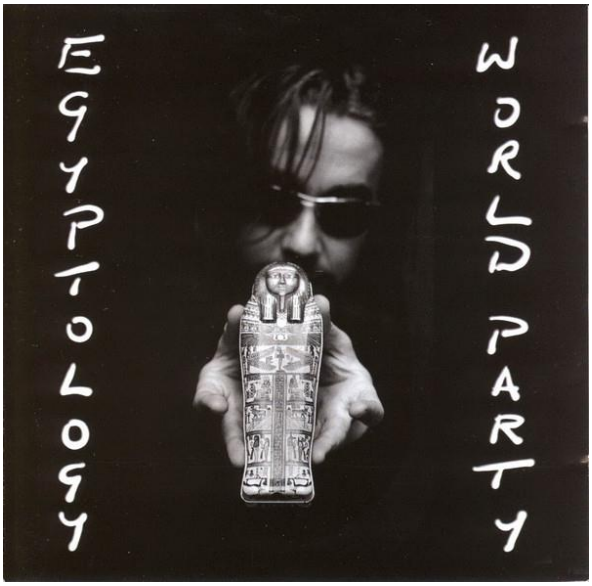
how to conceptualise a ‘system’ in the complex, messy real world. Davies observes that this requires a representation that is “both rigorous and representative of reality.” The selection of categories and relationships in a system is a property of the choices about description and classification made by the analyst rather than inherent reality. He describes – using plentiful examples – how systems so often malfunction because the people in charge didn’t understand what a system actually was.

Davies being an economist, it shouldn’t surprise that the book makes several forays into the dismal science, specifically diagnosing the strengths but also malfunctions of economics. He writes: “Economics has been a major engine of information attenuation for the control system. Adopting the economic mode of thinking reduces the cognitive demands placed on our ruling classes by telling them there are a lot of things they don’t have to bother thinking about. … when decisions are made that have disastrous long-term consequences as a result of relatively trivial short-term cash savings, the pathology is often directly related to something that seemed like a good idea to an economist.” There’s an interesting section on ‘markets as computing fabric’, a ‘magic calculating machine’. It’s a fruitful way of thinking about collective economic outcomes. It’s also a way of demonstrating the fallacy of trying to analyse complex systems from a top-down perspective. Tiny top-down errors – like eliminating bits of data that seem inconvenient – can and will sooner or later transform themselves into enormous errors. ‘Shocks’ as the dismal scientists like to say. Not to mention the parallel fantasy of thinking that using expedience as a means of deciding what to measure and what not to measure is a smart thing to do. Here, over several sections, Davies insightfully concludes, “numbers are collected for a purpose and it’s often surprisingly hard to use them for any other purpose.” Not to mention all the more important numbers that no-one thought to collect in the first place. Bad data plus outsourced algorithm-building plus systems-blind leadership begets a world-size minefield of accountability sinks. And misery for all that have to deal with them. Either as customers or ‘operatives’ stuck within the systems neither they nor anyone else seems to understand are systems.

The book ends by returning to system dysfunction – ‘morbidity’. From the toxic idea of shareholder value maximisation to the fentanyl crisis in the US, from the collapse of public infrastructure networks to the adverse effects of private equity (which Brett Christophers has dissected forensically in his book), economic and financial systems need a redesign. Davies suggests one step that he thinks would have a big impact: make these investors liable for company debts. Oh, and make sure the economists are not in charge: “Every decision-making system set up as a maximiser needs to have a higher-level system watching over it.” Turtles all the way. Thanks, Stafford. And thanks Dan Davies for making some of Beer’s obtuse language infinitely more approachable.

With a following wind, The Unaccountability Machine might just trigger a Beerian Viable System Model revival. We need more leaders – in companies and in politics – that understand systems, even if just the profound implications of the innocuous sounding but nevertheless profound, ‘the purpose of a system is what it does’ sound-bite. I suspect the world won’t get that any time soon. Largely thanks to the plethora of accountability-sinks we’ve all conspired to accidentally accept. Slippery slopes about to turn into slippery cliffs if we’re not careful. Time to wake up. Time to read the rather splendid Unaccountability Machine and time to all start putting on our system-goggles.

Wow In Music – Rolling Off A Log



There aren't many artists I've had the privilege to go see live that I come away thinking, 'here's someone that oozes music from every pore'. Prince was one. Jeff Buckley was another. Even the things that weren't musical were music. Nils Frahm maybe? The only other person I can think of is Karl Wallinger, a man who produced some of my favourite songs of the 1990s, and several of my most frequently played albums. When Karl sadly passed away in March of this year, I knew I had to find a World Party track to feature in this section of the ezine. For a while it was going to be Put The Message In The Box. Then What Is Love All About (the slightly off-kilter Arkeology career compilation version). Then Ship Of Fools. Then Is It Like Today? Then This World. Then Way Down. Then – definitely – the utterly beautiful, Always. You get the point. I could've pretty much chosen anything Karl put his Beatle-influenced genius hand to. In the end, I stayed with his under-appreciated fourth album, Egyptology, and the even more under-appreciated gem that is Rolling Off A Log.

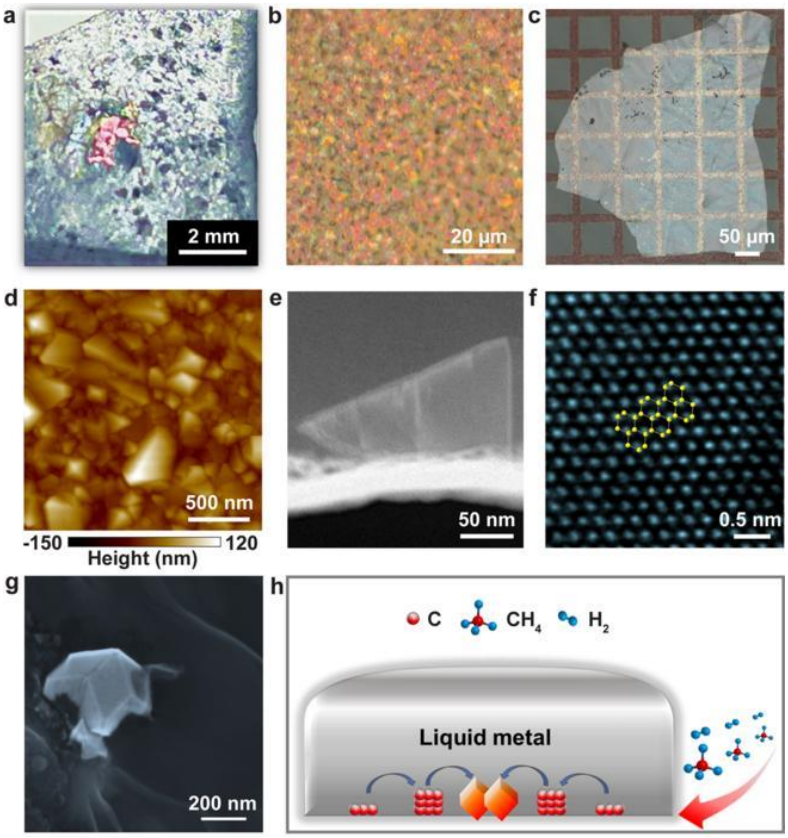
The song starts with a swirl of Johann Strauss-meets-Van Dyke Parks post-waltz strings, then a gentle brush of drum, and then an oboe – not the first instrument we tend to expect on any kind of 'pop' record (Principle 35) – picks up the melody. Then, after around 45 seconds, the boss lets rip with one of his most hopeful-yet-bleak lyrics. The vocal and the oboe intertwining all the time through the first two verses and choruses, over the top of the string, drum, McCartneyesque 'lead-bass' gumbo. Karl playing all the instruments apart from the drums. Then a (Principle 19) gear-change into the Middle-8-that-isn't, the voice rising to a (Principle 38) scream. Then back down again to an 'asleep inside' mantra, and then a (Principle 37) distorted guitar solo, then a chorus of Karls outdoing the Beach Boys. And then… relax. Principle 40 Rollercoaster ride over.

So many fought the wars
And what was that all for?
They said between good and evil
Well, I think they lied a little
We live in a prison, somewhat of our own design
Grab the key, unlock the door
Then you'll know what life is for

Former Waterboys bandmate, Mike Scott paid tribute on X to Wallinger: “Travel on well my old friend. You are one of the finest musicians I’ve ever known.”

RIP, Karl Wallinger

Investments – Ambient Pressure Diamond Manufacture



Growth of diamond in liquid metal alloy under 1 atmosphere pressure. (a) A photo showing the as-grown diamond on the solidified liquid metal surface. (b) An optical image of the as-grown continuous diamond film on the solidified liquid metal surface. (c) An optical image of the as-transferred diamond film on a Quantifoil holey amorphous carbon film coated Cu TEM grid. (d) An atomic force microscopy topographic image of the as-transferred diamond film on the Cu TEM grid. (e) A cross-section TEM image of an as-grown single diamond particle on the solidified liquid metal surface. (f) An atomic resolution TEM image of the as-grown diamond. (g) A scanning electron microscopy image showing a grown diamond (partially) submerged in the solidified liquid metal. (h) Scheme showing the diffusion of carbon that leads to the growth of diamond at the bottom surface of the liquid metal.

Did you know that 99% of synthetic diamonds are currently produced using high-pressure and high-temperature (HPHT) methods? A prevailing paradigm is that diamonds can only be grown using liquid metal catalysts in the gigapascal pressure range (typically 5-6 GPa, where 1 GPa is about 10,000 atm), and typically within the temperature range of 1300-1600 °C. However, the diamonds produced using HPHT are always limited to sizes of approximately one cubic centimetre due to the components involved. That is – achieving such high pressures can only be done at a relatively small length scale. Discovering alternative methods to make diamonds in liquid metal under milder conditions (particularly at lower pressure) is an intriguing basic science challenge that if achieved could revolutionise diamond manufacturing. Could the prevailing paradigm be challenged?

A team of researchers led by Director Rod RUOFF at the Center for Multidimensional Carbon Materials (CMCM) within the Institute for Basic Science (IBS), including graduate students at the Ulsan National Institute of Science and Technology (UNIST), have grown diamonds under conditions of 1 atmosphere pressure and at 1025 °C using a liquid metal alloy composed of gallium, iron, nickel, and silicon, thus breaking the existing paradigm. The discovery of this new growth method opens many possibilities for further basic science studies and for scaling up the growth of diamonds in new ways.

SYSTEM ATIC INNOVAT ION

Director Ruoff, who is also a UNIST Distinguished Professor notes, "This pioneering breakthrough was the result of human ingenuity, unremitting efforts, and the concerted cooperation of many collaborators." Researchers led by Ruoff conducted a series of experiments, involving several hundred parameter adjustments and a variety of experimental approaches before they finally succeeded in growing diamonds using a 'home-built' cold-wall vacuum system.

Ruoff notes "We had been running our parametric studies in a large chamber (named RSR-A with an interior volume of 100 litres) and our search for parameters that would yield growth of diamond was slowed due to the time needed to pump out air (about 3 minutes), purge with inert gas (90 minutes), followed by pumping down again to vacuum level (3 minutes) so that the chamber could then be filled with 1 atmosphere pressure of quite pure hydrogen/methane mixture (again 90 minutes); that is over 3 hours before the experiment could be started! I asked Dr. Won Kyung SEONG to design & build a much smaller chamber to greatly reduce the time needed to start (and finish!) the experiment with the liquid metal exposed to the mixture of methane and hydrogen." Seong adds, "Our new homebuilt system (named RSR-S, with an interior volume of only 9 litres) can be pumped out, purged, pumped out, and filled with methane/hydrogen mixture, in a total time of 15 minutes. Parametric studies were greatly accelerated, and this helped us discover the parameters for which diamond grows in the liquid metal!"

Yan GONG, UNIST graduate student and first author, explains "One day with the RSR-S system when I ran the experiment and then cooled down the graphite crucible to solidify the liquid metal, and removed the solidified liquid metal piece, I noticed a 'rainbow pattern' spread over a few millimetres on the bottom surface of this piece. We found out that the rainbow colours were due to diamonds. This allowed us to identify parameters that favoured the reproducible growth of diamond."

The initial formation occurs without the need for diamond or other seed particles commonly used in conventional HPHT and chemical vapor deposition synthesis methods. Once formed, the diamond particles merge to form a film, which can be easily detached and transferred to other substrates, for further studies and potential applications.

The synchrotron two-dimensional X-ray diffraction measurements confirmed that the synthesized diamond film has a very high purity of the diamond phase. Another intriguing aspect is the presence of silicon-vacancy colour centres in the diamond structure, as an intense zero-phonon line at 738.5 nm in the photoluminescence spectrum excited by using a 532 nm laser was found.

Coauthor Dr. Meihui WANG notes, "This synthesised diamond with silicon-vacancy colour centres may find applications in magnetic sensing and quantum computing."

The research team delved deeply into possible mechanisms for diamonds to nucleate and grow under these new conditions. High-resolution transmission electron microscope (TEM) imaging on cross-sections of the samples showed about 30-40 nm thick amorphous subsurface region in the solidified liquid metal that was directly in contact with the diamonds. Coauthor Dr. Myeonggi CHOE notes, "Approximately 27 percent of atoms that were present at the top surface of this amorphous region were carbon atoms, with the carbon concentration decreasing with depth."

Ruoff elaborates, "The presence of such a high concentration of carbon 'dissolved' in a gallium-rich alloy could be unexpected, as carbon is reported to be not soluble in gallium. This may explain why this region is amorphous -- while all other regions of the solidified

liquid metal are crystalline. This sub-surface region is where our diamonds nucleate and grow and we thus focused on it."

Researchers exposed the Ga-Fe-Ni-Si liquid metal to the methane/hydrogen for short periods of time to try to understand the early growth stage -- well prior to the formation of a continuous diamond film. They then analysed the concentrations of carbon in the subsurface regions using time-of-flight secondary ion mass spectrometry depth profiling. After a 10-minute run, no diamond particles were evident but there were ~65 at% carbon atoms present in the region where the diamond typically grows. Diamond particles began to be found after a 15-minute run, and there was a lower subsurface C atom concentration of ~27 at%.

Ruoff explains, "The concentration of subsurface carbon atoms is so high at around 10 minutes that this time exposure is close to or at supersaturation, leading to the nucleation of diamonds either at 10 minutes or sometime between 10 and 15 minutes. The growth of diamond particles is expected to occur very rapidly after nucleation, at some time between about 10 minutes and 15 minutes."

The team also discovered that silicon plays a critical role in this new growth of diamond. The size of the grown diamonds becomes smaller and their density higher as the concentration of silicon in the alloy was increased from the optimal value. Diamonds could not be grown at all without the addition of silicon, which suggests that silicon may be involved in the initial nucleation of diamond.

This was supported by the various theoretical calculations conducted to uncover the factors that may be responsible for the growth of diamonds in this new liquid metal environment. Researchers found that silicon promotes the formation and stabilization of certain carbon clusters by predominantly forming sp3 bonds like carbon. It is thought that small carbon clusters containing Si atoms might serve as the 'pre-nuclei', which can then grow further to nucleate a diamond. It is predicted that the likely size range for an initial nucleus is around 20 to 50 C atoms.

Ruoff states, "Our discovery of nucleation and growth of diamond in this liquid metal is fascinating and offers many exciting opportunities for more basic science. We are now exploring when nucleation, and thus the rapid subsequent growth of diamond, happens. Also 'temperature drop' experiments where we first achieve supersaturation of carbon and other needed elements, followed by rapidly lowering the temperature to trigger nucleation -- are some studies that seem promising to us."

The team discovered their growth method offers significant flexibility in the composition of liquid metals. Researcher Dr. Da LUO remarks, "Our optimized growth was achieved using the gallium/nickel/iron/silicon liquid alloy. However, we also found that high-quality diamond can be grown by substituting nickel with cobalt or by replacing gallium with a gallium-indium mixture."

Ruoff concludes, "Diamond might be grown in a wide variety of relatively low melting point liquid metal alloys such as containing one or more of indium, tin, lead, bismuth, gallium, and potentially antimony and tellurium -- and including in the molten alloy other elements such as manganese, iron, nickel, cobalt and so on as catalysts, and others as dopants that yield colour centres. And there is a wide range of carbon precursors available besides methane (various gases, and also solid carbons). New designs and methods for introducing carbon atoms and/or small carbon clusters into liquid metals for diamond growth will surely be important, and the creativity and technical ingenuity of the worldwide research community seem likely to me, based on our discovery, to rapidly lead to other

related approaches and experimental configurations. There are numerous intriguing avenues to explore!"

Read more:
Gong, Y., Luo, D., Choe, M. et al. Growth of diamond in liquid metal at 1 atm pressure. Nature, 2024 DOI: 10.1038/s41586-024-07339-7

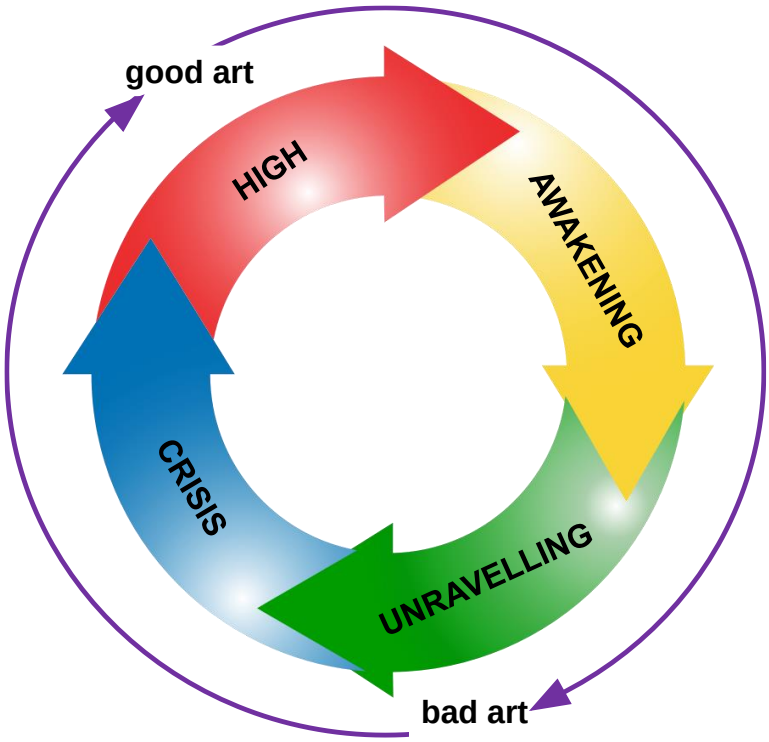
Generational Cycles – Good Art/Bad Art II

What does artist Ai WeiWei's 'Dropping of a Han Dynasty Urn' and Tracy Emin's 'Bed' have in common? Number one, they were very controversial, and provoked collective 'this isn't art' outrage from the art world. Number two, they both tick a lot of boxes in the 'Bad Art' definition described in the second article earlier in this issue of the ezine. Number three, they both appeared in the second half of the 1990s. Alongside other controversial artists like Damien Hirst and Chris Ofili.

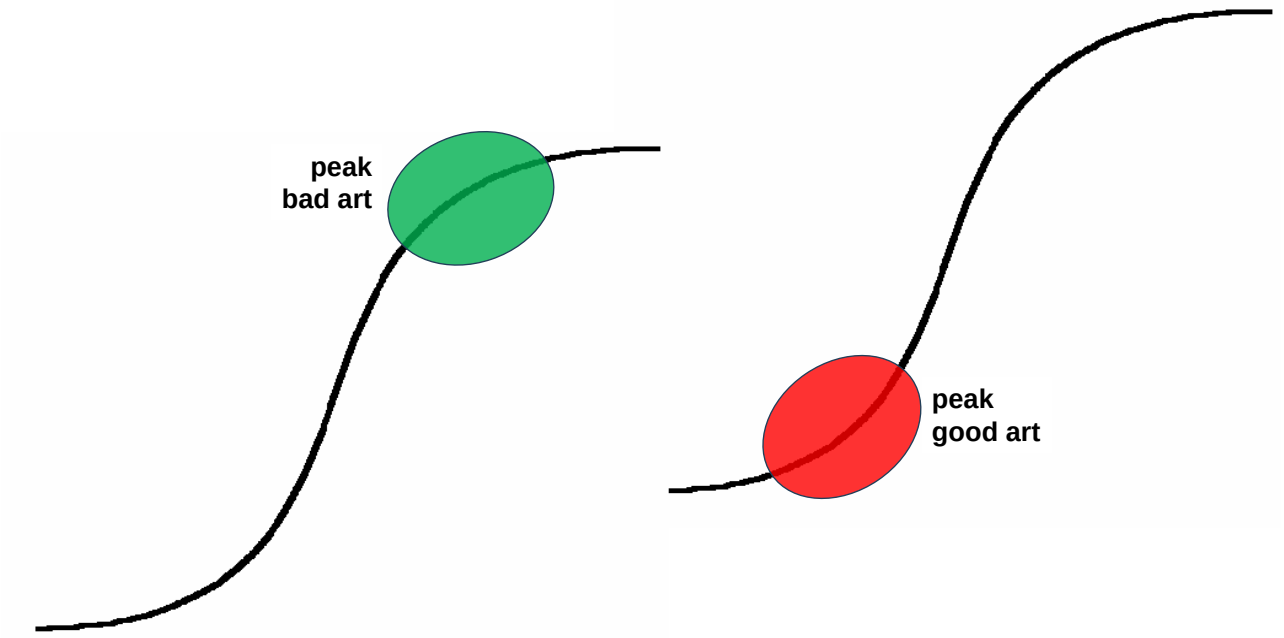
If we look back through history in search of other pieces of controversy-sparking 'bad' art, a fairly stark pattern begins to emerge. A pattern showing periods where a lot of this kind of genre-breaking 'bad art' appears, and other periods where virtually none of it appears. The period prior to the mid-90s when it last appeared was triggered by Marcel Duchamp's 'Fountain' from 1917, and probably peaked with Balthus' 'The Guitar Lesson' (1934) and Picasso's now-classic 'Guernica' from 1937.

Popular and famous paintings across the globe are mostly susceptible to getting hit by controversy. And vice-versa. Some paintings become popular for a controversial reason. Controversy is a very subjective thing. Subjective, however, in a manner that has many similarities with the underlying premise of the Strauss/Howe generational cycles model that 'events happen at random, but society's reaction to those events is very definitely not. Bad art appears at random, but society's reaction to it is definitely not. Sometimes it gets ignored, and sometimes it makes the front page of the newspapers and ends up changing the way in which we see art. Changes the way we define art. Sometimes, bad art becomes the new good art. And vice versa.

The question is, when does this genre-shifting bad art arrive?
Answer: here –



Or, put into S-Curve terms, here –

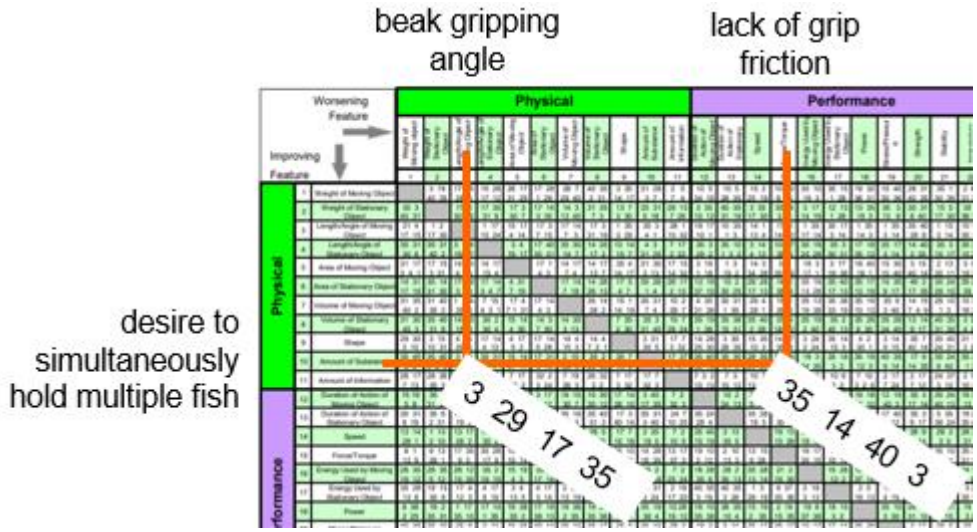


The ‘good’ness of art, in other words, depends where we are in the saeculum.

Biology – Puffin Beak

Anyone who spends time in a Puffin colony during the height of chick-rearing will inevitably ponder the question, ‘just how does a Puffin bring back all those fish in its beak?’ Apart from Puffins, only some tern species occasionally pull off the feat of returning to the colony with several fish in their beak. Terns have no special tricks up their beaks for hanging on to one fish after another. By contrast, the Puffin’s beak is highly adapted for keeping a ‘velcro’ grip on items caught successively underwater.

The basic problem to be overcome is that the desire to hold onto lots of fish is hindered, first, by the wedge-angle of the top and bottom halves of the beak (think scissor blades), and, second, by the difficulty of supplying enough gripping force to overcome the slippery nature of the prey. Here’s what those two conflicts look like when mapped onto the Contradiction Matrix:



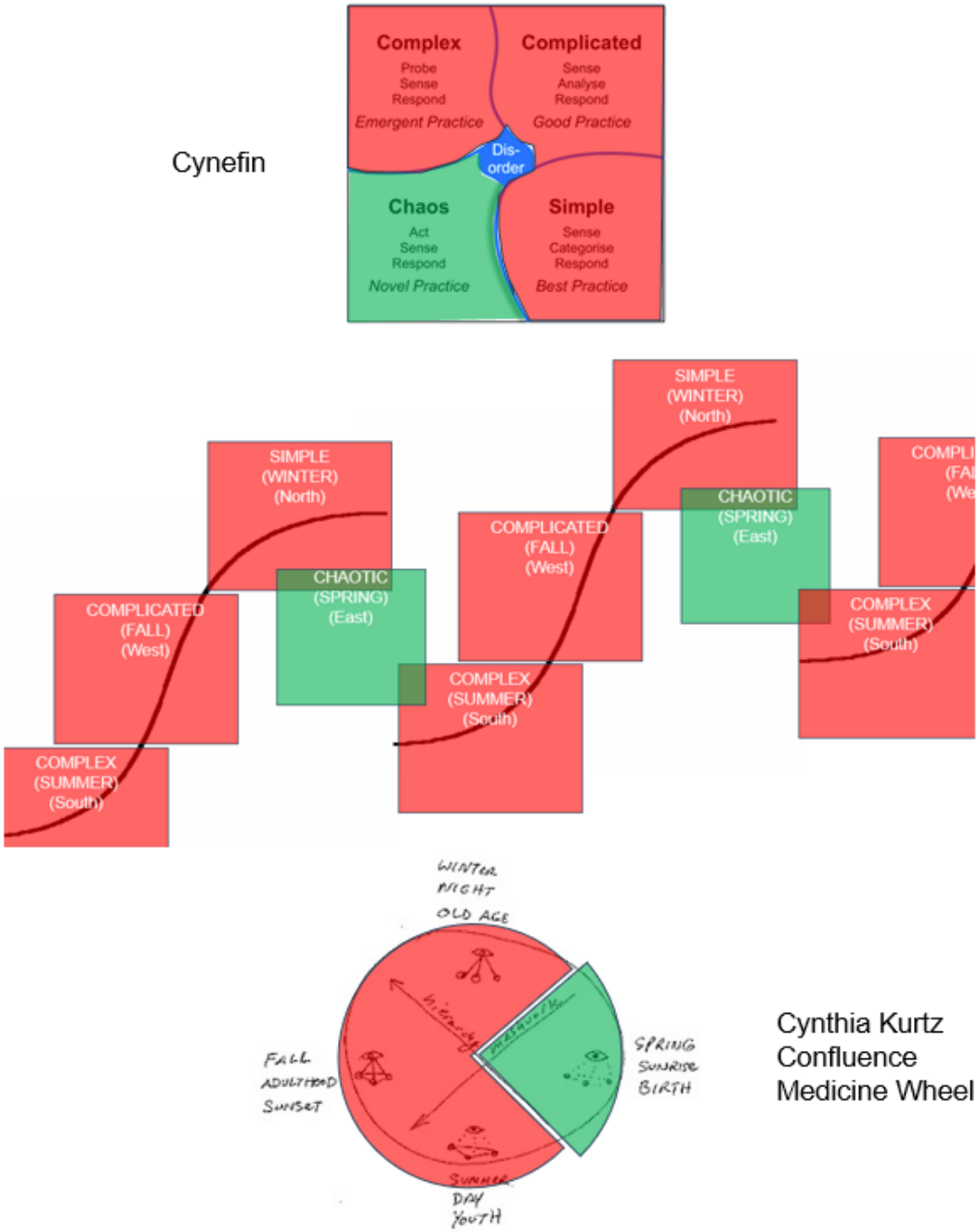
A close-up look at the inside of the Puffin’s beak swiftly reveals a pair of solutions. The most immediately obvious being a multitude of (Principle 17) backward facing (Principle 3) spines on the roof of the mouth and on the tongue. These spines lock one fish in place as the hunter goes for another. Secondly, the lower mandible also has a (Principle 35)

flexible hinge where it meets the skull (the yellow bit) , which helps wedge already-caught items against the palate when the beak opens to seize another one. You can imagine the Puffin charging through a shoal of sand-eels or sprats taking one after another.

The record for a single beakful of fish is held by a Norwegian Puffin. It brought in a meal consisting of 80 capelins.

Easy when you know how.

Short Thort



"The medicine wheel represents the circle of all life.
When you sit in the wheel and evoke the sacred, all life comes to sit in council.
The human, only one member of the web of life,
can use the ceremony of the wheel to restore contact with all the relations of life.
The animal relations, plant relations, stone people, spirit relations,
all things come to sit in council.
Our connections with the world are thus restored
and the healing of the Earth begins anew."
Stephen Harrod Buhner

News

SI Website

Hopefully, everyone has had a chance to look at the shiny new SI website. Several have expressed concern that access to the archive of past ezines and other papers has disappeared. Rest assured this is a temporary phenomenon. We took the website re-design as an opportunity to re-structure the archive to make it easier to navigate… which – naturally! – made it more difficult to create. We're almost there, and the full archive should be available in the next few weeks. In the meantime, if anyone is desperate to access a particular issue, please let us know, and we'll send you an electronic copy as soon as possible.

ICSI Workshop

In addition to his keynote address ('Seeing Around Corners: Using TRIZ & AI To Spot Industry Inflection Points Before They Happen'), Darrell has been invited to provide a one day SI/AI workshop at this year's International Systematic Innovation conference. The first thing this means is that he will now be physically at Bursa Technical University in Turkey; the second is that his instructions are to stay away from theory and focus on pragmatic, newcomer-friendly reality. The title of the workshop is '10x Faster, Cheaper, Better – The Promise Of AI-Powered Innovation'. It will take place on Friday 23 August. More details can be found at: https://i-sim.org/icsi2024/

DangerMouth

If you've not tried our weekly podcast yet, you should keep an eye out for a growing stream of high-profile guests. Top lawyers, multi-album recording artists, industry-shifting educators and best-selling authors… not quite sure how we're managing to do it, but we are. Check it out at dangermouth.org.

FutureProof

Due to a family bereavement, Darrell's planned FutureProof book-launch workshop has had to be postponed. As soon as we can find a new slot in the calendar, we'll publish the new dates. Apologies to those that had reserved the original date in their diary.

New Projects

This month's new projects from around the Network:

FMCG – Innovation North Star Strategic Project
FMCG – Developing World Consumer Anthropology Project
Law – Future Strategy Project
Agriculture – Concept Design Study
Government – Future Infrastructure Strategic Study
Electronics – Troubleshooting Workshops
Conglomerate – Measurement-Design Project
NGO – Troubleshooting Project
Consumer Electronics – SI Workshops
Finance – Investment Appraisal Tol Development

our policy to always seek permission to use such images. We seem, however, to be entering a world in which a small minority of copyright owners are actively seeking to hide their ownership. We will leave our readers to speculate on the possible reasons for this. In the meantime, all readers should note that any images where we have not been able to trace ownership, no copyright infringement is intended, nor do we claim to own any of such images. For the benefit of any hidden copyright owners that make themselves known to us, we will be happy to remove said images should they wish. The SI ezine is a free publication with a purely educational focus. SI does not and will not make money from any of the images contained within the ezine.