Systematic Innovation

e-zine

Issue 159, June 2015

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Our guarantee to the subscriber is that the material featured in the e-zine will not be published elsewhere for a period of at least 6 months after a new issue is released.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

Developing Better Problem Solving Instincts

It's amazing sometimes how the meaning of an aphorism shifts and evolves over time. If you show the above example to people today and ask them what they think the root cause of the lost kingdom is, the large majority will confidently tell you that it was the lost nail.

The original intention of the story was to remind people that details matter. That was a time before the expression 'root cause analysis' had been conceived. Now, in the first quarter of the 21st Century, many of us have been inculcated into the importance of tracking down and dealing with root causes. To the extent, for the most part, that it has become the default reaction whenever we're faced with any kind of problem situation. Our instincts, in other words, have been trained to automatically assume a) there *is* a root cause, b) we must try and tackle the problem at that level if we're *really* going to solve it. Instinct here means that we no longer consciously think about the logic and relevance of what we're doing any more. Great for saving us time – that's why the brain is so good at forming patterns – and even greater for impressing our bosses… because they didn't get where they are today without learning the importance of tackling problems at their root-cause level – but not so great for doing anything meaningful to truly resolve the problem.

In certain situations, seeking out root causes can be an appropriate course of action. But for the most part, we've trained our instincts to follow what turns out to be a highly inappropriate strategy. The root-cause of the lost kingdom has absolutely nothing whatsoever to do with lost nails.

Lost kingdoms are all about complexity. And as we've discussed several times previously, there is no such thing as a root-cause in a complex problem. Complicated problems have root causes; complex problems have, at best, a 'conspiracy of causes'. Root cause analysis appeared at a time when there were lots of complicated problems. Today, there are very few of them left. Now we live in an interdependent world dominated by human emotions. Put two humans in front of a CNC machine and you just turned a complicated piece of equipment into a complex system. At least you do if you allow either of the people to touch it.

The 'root-cause fallacy' as we have come to call it, is an instinct that is a largely redundant meme from a different time.

SYSTEM·ATIC INNOVAT·ION

It's a fallacy that is strongly linked, we believe, to the dismal innovation track record we see inside just about every enterprise on the planet. Sadly – 'a conspiracy of causes' remember – it isn't the only contributory factor.

So far, we've found at least two other major instinct dysfunctions that also conspire to make enterprises work on the wrong innovation challenges, deliver the wrong solutions, and fail to effectively execute them and turn them into tangible ROI. There are probably more we haven't properly been able to uncover yet, but for the time being, we have several clients asking us to help teach and recalibrate members of their staff to at least be aware of these first three conspirators. Fortunately, all three are eminently manageable. Albeit because instinct is effectively 'unconscious competence' there needs to be a period of having people pass through an often uncomfortable learning cycle:

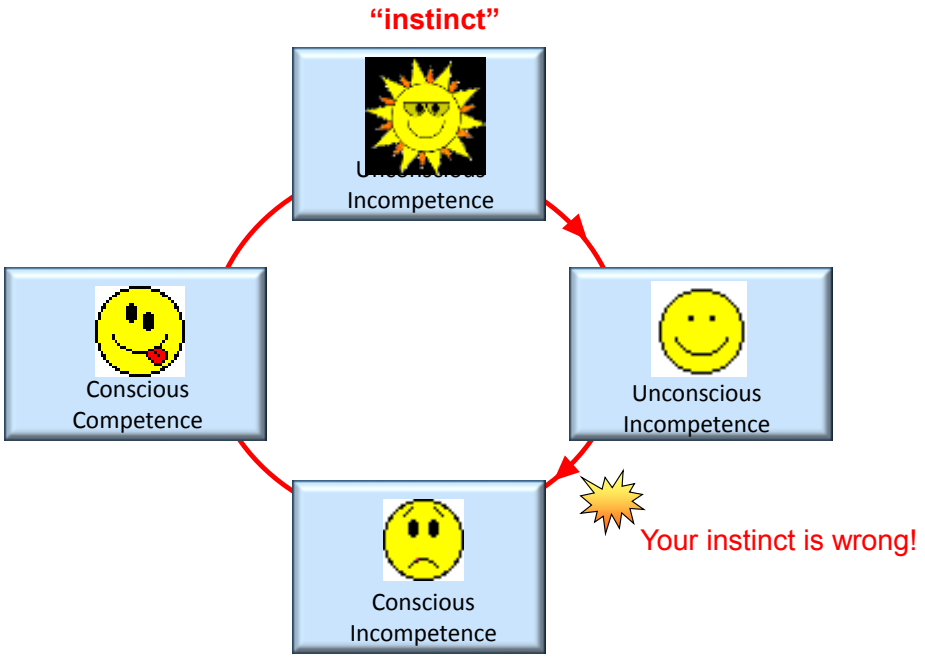


Figure 1: Learning Cycle

Root Cause Fallacy is really just a part of a bigger set of issues associated with our brain's inability to understand the fundamentals of complex systems. Which in turn embraces other dangerous instincts to 'make sure we have all the data' before we embark on a project, try to de-skill everything inside our enterprises down to simple, repeatable job segments, or that 'what can't be measured is irrelevant'. The failure of economists to understand complexity is very likely a strong causal reason behind boom-and-bust cycles. We probably shouldn't blame them too much. The world has had 4000 generations of humans, and for the first 3990 life was closer to complicated than it was complex. That's a lot of generational instinct-building inertia we have to overcome.

There's a similar evolutionary history precedent for the second and third issues too. Here's the second one, introduced by a quote from Bill Gates:

> "We always overestimate the change that will occur in the next two years and underestimate the change that will occur in the next ten."

It's an elegant way of saying 'the world is full of s-curves'. And that for 3995 of our 4000 generations of existence they've largely been invisible because the rate of change of anything has been glacial. Usually literally.

That's no longer true, of course, some industries making discontinuous s-curve jumps at rates approaching two-per-year. In some cases the 's-curve' has had to be re-labelled the 'hockey-stick curve' or 'j-curve'. Either way, our instincts have been programmed over evolutionary time to assume that change, when it happens, happens linearly.

The initial gentle slopes of the s-curve are vaguely linear, so is the post-tipping-point growth period, and so is the mature flat top portion of the curve. But the slope, and therefore rate of change, of all three is different, so unless we know where a given system is on its s-curve, we really have no idea whether or which linear model is even close to being appropriate. Or when it will stop being appropriate.

Again economists seem to offer some of the most vivid illustrations of just how bad our instincts are when it comes to understanding change. If the previous 20 quarters of economic data have shown steady growth – as they did immediately prior to the start of the 2008 GFC – then a linear extrapolation model will clearly tell you and your clients to assume that the growth will continue unabated in the 21st quarter. Never mind that the global economic system was actually about to fall of the top of a very non-linear s-curve.

Let's use another famous person, this time Albert Einstein, to introduce the third instinct dysfunction:

> "You cannot solve a problem from the same consciousness that created it. You must learn to see the world anew."

It's an oft used quote to reveal a human trait closely linked to psychological inertia. Our instinct is again problematic now we exist in a world of massive interdependency. Complexity tells us everything is connected to everything else (hence the clichéd butterfly wing-flap in Sao Paulo causing a tornado in North Devon), but what Einstein was trying to help us see is that the complexity is hierarchical in nature.

Getting people to think in terms of systems is already a major challenge, but fortunately – historically at least – we developed instincts that implicitly recognize that we all of us exist within a system. The problem comes with the almost hidden assumption this instinct contains. The assumption is formed in two parts:

a) Everything *in* my system is controllable
b) Everything outside my system is *random*

This is a tough one to crack. Again not helped by the 'scientific management' learnings of the 19th and 20th Centuries.

Here's an example of just how insidious the problem can be: A few years ago we were working with a high-volume commodity manufacturer of, let's disguise it a little bit, paper. The management had just introduced a new production line capable of producing many tonnes of paper an hour. Unfortunately they noticed occasional spurts of quality problems that had never been present on the old line. Several months' worth of Design of Experiments activity ensued to try and track down the source of the problem. Every variable in the production line was varied, but no correlation with the quality dips could be traced. The problems were deemed to be 'random'.

Then someone from the process team, no doubt in a state of utter desperation asked some of the line workers what they thought. 'Things seem to be worse on rainy days', one of them said. It sounded strange, but times being desperate, the process engineers made an attempt to try and match the quality problems to local weather records. Sure enough,

the line worker comment had some basis in fact. Basis enough at least for the weather records to be investigated further. Rain showed some correlation, did anything else? A month of tortuous analysis later and the conclusion is that the problem was much worse when the wind was blowing against the prevailing direction. It was an interesting finding, but still didn't really offer up any insight about what the problem was. Again an assumption that, while there was a *correlation* between wind direction and paper quality, there couldn't possibly be a *causal* relationship. Another month went by, then someone brought this picture in to the office:

Figure 2: Flightpaths Around Local Airport
(red star indicating position of factory)

Finally, the team get to see that what they assumed must be random was in actual fact a higher level system that was having an unexpected influence on theirs: when the wind is in the wrong direction, southbound planes take-off and climb almost directly over the factory, causing a vibration that very unluckily affected a part of the production line.

The instinct dysfunction happening here is a failure to recognize that our system are always nested inside other, bigger, systems. Systems, indeed, according to Stafford Beer and the Viable System Model, are essentially recursive. Wherever we are, we always have systems above us and systems below us. 'Turtles all the way' according to the Stephen Hawking story about Bertrand Russell and the old lady:

A well-known scientist (some say it was Bertrand Russell) once gave a public lecture on astronomy. He described how the earth orbits around the sun and how the sun, in turn, orbits around the center of a vast collection of stars called our galaxy. At the end of the lecture, a little old lady at the back of the room got up and said: "What you have told us is rubbish. The world is really a flat plate supported on the back of a giant tortoise." The scientist gave a superior smile before replying, "What is the tortoise standing on?" "You're very clever, young man, very clever," said the old lady. "But it's turtles all the way down!"
Hawking, 1988

To extend the metaphor a step further, our instincts barely allow us to picture one turtle, never mind an infinite stack of turtles both above and below us. People will often nod sagely whenever they read the turtle story. Intellectually we get it, but then ten minutes

later, I'll hear people talking about the problem they have to solve and are still using the word 'random'. On a very base instinctual level we have a lot we have to fight against. Well, at least three. Three types of poor problem solving instinct:

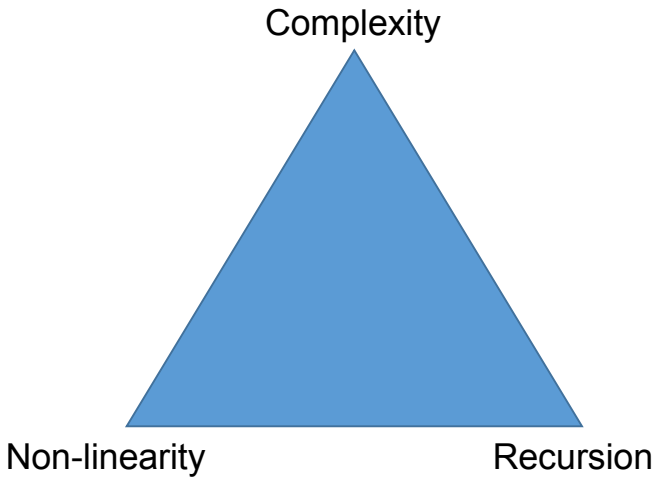


Figure 3: Three Problem-Solving Instinct Dysfunctions

Oh, hold on a minute, here comes a fourth…

A Day In The (Trade-Off) Life

On a whim, I decided to record all of the trade-offs I make in a typical day. Here's what happened:

0700: the alarm goes off. An immediate cluster of trade-offs – after thirty years of trying I still can't find an alarm that doesn't make a sound that annoys me (1). I've taken to using my phone, which saves having two things by the bed, but now I run the risk that someone calls me in the middle of the night (thinking I'm in a different time zone) (2). Okay, so I have the phone switched to silent, but I can't get the display to not illuminate (3). Then there's the temptation to press 'snooze'…

0710: …which I tend to do more often than not. I've still never found a clock that works out the right snooze interval for me. Four minutes is usually not long enough; ten is (today) too long. I get out of bed (4). The cat is still asleep down by my feet… do I try and wriggle out without disturbing her or figure, 'hey, if I'm getting up, everyone should be up' (5). Another tricky trade-off… I disturb the cat, so I know I'll have to go and feed her.

0711: bathroom. Toilet seat up or down (6)?

0714: put on enough clothes to be respectable if the postman sees me through the kitchen window, or not bother (7)? I pick up yesterday's t-shirt… even though it should probably have gone directly into the laundry basket (8). Must remember not to keep it on later (9).

0716: the cat has joined me in the kitchen demanding food. Use yesterday's bowl or offer up a clean one (10)? I look at the sink. It is full of last night's dinner things (11). I look at the cat and shrug my shoulders. Yesterday's bowl it is. I look in the cupboard for a sachet of food. Can't remember what flavor she had last night. I know she doesn't like it if she has the same flavor two-times in a row (12). So now I have the choice of delving into the bin to see what the previous flavor was, or take pot-luck (13). I opt for tuna on the understanding that it has the least unattractive odour (14) when I open the sachet. I tug on the sachet to open the pack. As usual, it opens most of the way, but the tear-strip doesn't come off cleanly (15), so I'm left with tuna gravy dripping on my hand again (16).

0718: put water in the kettle. The transparent water-level indicator is designed for a right-handed person (17) so I can't see whether I've got the right amount of water. I let the tap run a few seconds (18) before putting the kettles nozzle under the flow. By rights I ought to lift the lid and fill through the top, but that takes an extra hand (19), and putting the lid down on the worktop always leaves a ring of water that will need to be mopped up (20).

0719: I get a couple of mugs out of the cupboard. One mug is always the same; the one I choose for myself depends on how I feel. I gaze in the cupboard at the options and nothing seems exactly right (21). I opt for a mug that has 'all work and no play makes Jack a dull boy' (22) written eleven times around the outside. The inside of the cup is not quite white anymore (23). Too many cups of tea and a detergent that is eco-friendly but not as effective (24) as I might like if I want the inside of my mug to look white. While the kettle is heating I open the container containing the teabags. As usual the stupid clasp falls off so I have to spend time re-attaching it (25). A sensible person would have worked out by now that the five seconds it takes to re-attach every time I have a cup of team soon ads up. I probably spend close to 1% of my life fixing the cursed thing instead of replacing it with

something that might actually work. But that involves a shopping expedition, and, I always convince myself I don't have the time (26). I ought to write to the designer and tell him (I assume it's a him, but maybe that's me being sexist? (27)) I think he should think harder about the stuff he designs (28). Or maybe even use one of the things he's designed one day to see exactly what he's inflicted on the rest of the planet. I decide my job list is probably already too full of things I should spend time complaining about (29) and resolve, yet again, to submerge my frustration.

0720: the kettle still isn't boiled (30) so I find myself looking outside for the first time. The window needs a clean (31), but I can see sunshine, so maybe things aren't so bad. I notice the birdfeeder is lying on the ground again. It's a special birdfeeder designed so only the small birds can eat from it (32). The jackdaws, however, having realized it contains food, have learned to swing on the thing until it comes unhooked, falls to the ground and the lid comes off. The hook designer definitely made a good job of making it easy to hang the birdfeeder up, but wasn't so smart when it came to dealing with our jackdaws (33).

0721: the kettle boils and eventually (34) switches itself off. Not before it's covered the underside of the cupboard with condensed steam though (35). Which I ignore, even though I know I shouldn't (36). I pour the water into the two mugs. My teabag resolves to float rather than let the water pass through and in to the bag (37) and, when the water level approaches the top of the mug, serves to cause some of the pouring water to be deflected out onto the worktop (38). The cat meows. She's finished her tuna and now wants to go outside. The catflap is locked shut because a neighbour's cat has taken to sleeping in our house rather than where it belongs (39). I bend down to unlatch it (40). The cat looks at me like I'm some kind of demented half-wit, then saunters off in the opposite direction (41).

0722: I reach over for a cloth to wipe up the spilled water and wait for the tea to brew (42). I hear the cat. Despite the fine morning, she has decided to conduct her ablutions in the litter tray in the next room (43). A moral dilemma appears: do I do the right thing and go empty it, or head upstairs and pretend what just happened didn't actually happen until I was upstairs? (44)

0723: rather than fetch a spoon, I lift the teabags out of the cups with the tips of the fingers on my right hand (45) (one of the characteristics of playing guitar is that you develop

callouses, this is one of the only plus sides of having them (46)). I give the bags a squeeze and try to remember which of the recycling receptacles (47) I'm supposed to put them in. I probably get it wrong again (48). One day we might stick a label on them so that demented half-wits remember which one is which (49). Meanwhile, I head over to the fridge to find milk. Another moral dilemma awaits. There's a new, unopened bottle of semi-skimmed milk or an opened bottle of skimmed (50). I prefer semi-skimmed in my tea in the morning, but I also know I will be told off if I choose not to make use of an already open bottle of milk. And so, into my cup goes the skimmed milk. I still don't want to use a spoon to stir it with, so instead I try to mix the milk by gently twirling the cup, all the time trying to ensure I don't spill any more liquid over the side again (51).

0724: the post arrives. I go pick it up, put it under my arm, lift the two mugs of tea and precariously (52) head up the stairs. Halfway up, I decide I should go back down and do something about the cat litter tray after all.

0725: the cat litter tray is one of those cunning enclosed designs with only a small opening at the front for the cat to squeeze in and out of. The idea being that when the litter gets throw around during the cat's 'burying the evidence' operation it mostly hits the sides of the enclosure and stays inside the tray (53). Sadly, the cat hasn't understood this concept desperately well and so, as usual, I find myself walking bare-foot across the tiled floor (not my choice (54)) trying to dodge between the shards of skillfully ejected litter (55). I pick up the scoop and set about removing the offending contents of the tray. This is the time when I least like the cat. I'm not too much happier about the designer of the scoop though. He (why do I keep assuming it's a he? (56)) has obviously tried to design a grill onto the surface of the scoop that will allow the good litter to return to the tray, and keep the agglomerated bad litter in the scoop (57). But he obviously wasn't using our cat litter as his datum design case, so, as usual, I end up scooping half a ton of perfectly usable litter into the disposal bag again (58). It would have been nice too if he'd thought about making the scoop self-cleaning at the end of the operation (59). I tie a knot in the disposal bag (60) and head back to the stairs.

0726: I re-enter the bedroom and place a mug of tea on each side of the bed. Time to open the blinds and let the sun in. I grip the three cords (why? (61)) hanging down from the Roman blind and pull. As usual, no matter how hard I grip, not all of the cords move at the same rate (62) and so I'm left with a blind that's raised more on one side than the other...

…and yet again the game of trying to work out which of the three cords to pull in order to get everything level again. Third time lucky! (63)

0727: in the time it's taken me to perform this intricate levelling operation, the cat has trotted in to the room, jumped onto the bed and is curled up fast asleep in my place (64). One day someone will work out how cats are able to switch so quickly between loud and annoying and resolutely unconscious. Meanwhile, lack of that knowledge doesn't help me too much. Don't disturb her, I'm informed, look how cute she looks curled up like that (65). I look at the cat, trying to think nice things. It's a struggle (66). I decide to try and ease her gently across a few inches, but, in another physics defying feat, a sleeping cat somehow manages to magically increase its weight by a factor of several hundred. She is effectively unliftable (67). I try sliding the duvet across instead. This works so I'm able to perch on the edge of the bed, albeit without any duvet left to cover my legs (68).

0728: I re-arrange the pillows (not my choice of filling (69)) and pick up a cushion from the floor (ditto (70)) so I can lean back against the headboard. The headboard is angled slightly to make leaning back more comfortable. Unfortunately, the angle of the headboard doesn't match the vertical end of the mattress and so within a few seconds, the pillows have already started to slide into the wedge-shaped gap (71). Maybe I need another pillow to permanently fill the gap? (72)

0729: I take a first look at the post. Bills (73). I figure I don't need to open them right now, and instead allow myself a few minutes to finish the chapter in the book I failed to finish last night. When its daylight like this, I try and convince myself I don't need to put my glasses on (74). I'm still mad I need glasses at all (75). After a couple of minutes struggling to read a line written in italics, I give in (76) and reach over for my 'free second pair' (77).

0732: The cat begins to snore. Apparently this is 'endearing' (78). It is also my signal to pretend I've finished my chapter and head to the bathroom. The book isn't great, but I can't force myself out of the habit of finishing any book I've started no matter how bad it is (79). The lack of greatness, alas, does mean that I'm easily distracted – e.g. by snoring cats – and as a consequence, it will take me several weeks to finish. All time lost to potentially reading a great book instead (80).

0733: I'm not the last person to use the shower. The other person has a different water temperature preference to me (81), and so having lost the game of trying to switch the water on and remove my arm before the initial spurt of cold water descends from the showerhead (82), I have to spend half an eon re-adjusting the temperature control until I get something vaguely like the temperature I want (83). I'm not a great fan of showers, but it's quicker than running a bath (84). The thought makes me realise the shampoo is by the side of the bath and not in the shower with me (85). I turn off the water, open the door and walk across to retrieve the wayward bottle, making a note to clean up the wet footprints (86) before I leave the bathroom. Back in the shower I flip open the shampoo and squeeze out too much shampoo into my palm (87). It turns out to be okay, because the action of re-closing the cap and bending down to put the shampoo bottle on the shower floor (88) causes half of it to be lost down the drain (89).

0736: I turn the water off and reach out of the shower for the towel. More drips on the floor (90). And the wrong size towel (91). Where's my big beach towel? Outside on the washing line, being 'aired' (92).

0737: back in the bedroom I try and hold my stomach in so the too-small towel stays attached around my waist (93). I take a swig from my mug of tea. Too cold already (94). Do I leave it, or drink the rest all in one go (95)? I decide to drink, do it too quickly and end up with a trail of tepid tea dribbling down my chin (96). Instinctively I wipe it away with the back of my hand, and then look around wondering where to wipe my hand (97). I check to make sure I'm not being watched (98), and reach for the towel (99).

0738: time to sort out some clothes. I open up the sock drawer. My choice seems to be thin socks the wrong colour or thick socks the right colour (100). Every other item of clothing seems to come attached to a different set of dilemmas I don't particularly want to have to deal with (101) – too loose or too tight (102); long sleeves or short sleeves (103); button or zip (104); stripes or plain (105); favourite jeans or ones without a hole in the pocket (106)?

0739: The cat stops snoring, turns herself upside down and opens half an eye to look up at me. I'm not even dressed yet and I've already made over a hundred trade-offs. The cat makes an expression that seems to say, I thought you were in the business of not making trade-offs, dummy. I realise she has a point. And then I realise why the business of looking for contradictions seems so unnatural to so many people. We're all bombarded with trade-offs all the time. Hundreds a day. And almost none of them are we in a position to resolve. So we tend to become conditioned to believe that we have to accept them all.

0741: I head downstairs and wake up my computer. I'm working on a client project. They're trying to reduce the friction between two surfaces, but all attempts to date have increased the manufacture cost. Maybe here, finally, is one I can do something about…

First World Problems – Slicing Pizza

Where to begin with this one? Cutting pizza. Nightmare. It takes too long, the slices are never the same size, you can never cut all the way through the crust, the topping sticks to the cutter or falls off the crust when you try and pick it up. One estimate suggests that over 10% of all clinical depression cases in the Western world are directly attributable to the stresses of slicing pizza. It's a scandal.

Fortunately, the Contradiction Matrix has something to say about the subject:

IMPROVING PARAMETERS YOU HAVE SELECTED:

Speed (14)

WORSENING PARAMETERS YOU HAVE SELECTED:

Force/Torque (15) and Stability (21) and Loss of Substance (25) and Manufacturing Precision/Consistency (42)

SUGGESTED INVENTIVE PRINCIPLES:

28, 13, 3, 10, 35, 5, 18, 19, 2, 15, 25, 12, 33, 1, 29, 16, 17, 38, 23, 24

Which should help direct us towards the best of the pizza cutting solutions out there in scary-kitchen-appliance-land. Here are a few of the must-have solutions:

Principle 28 and the laser-guided cutter:

Or, just add a motor. Circular or chain?

Principle 17, Another Dimension for that lost-topping trauma:

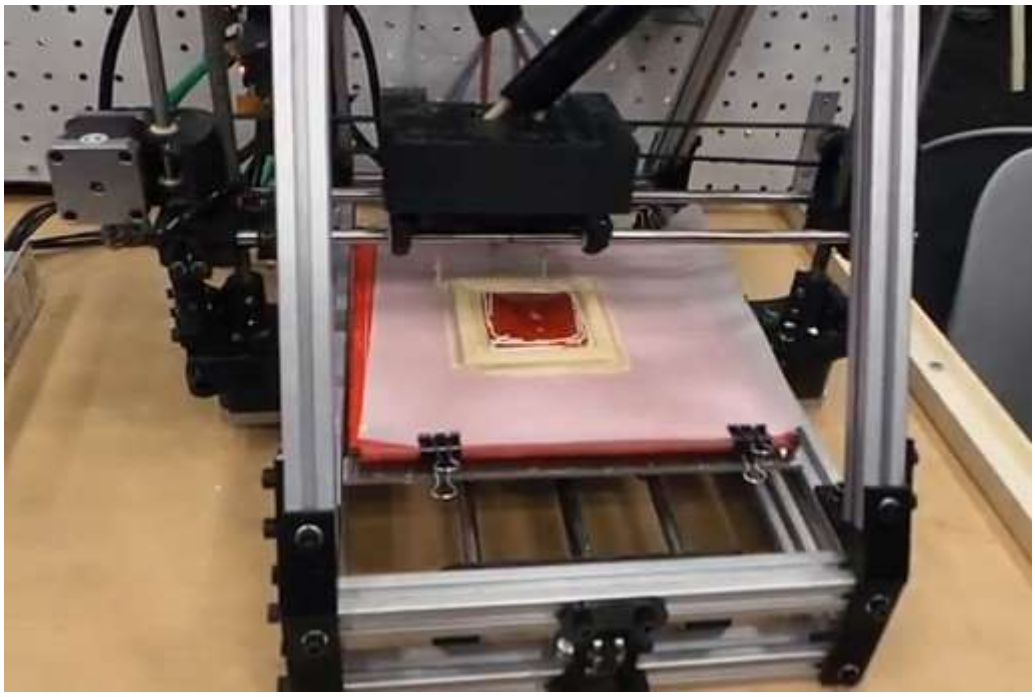
No left-handed version available, sadly.

Principle 1, Segmentation – one wheel good, two wheels better….

…if two cutters are good, eight must be even better:

SYSTEM ·ATIC INNOVAT· ION

All of them, of course, are foolish.
Not least of the reasons being that, in true ‘the customer wants the hole not the drill’ fashion, all pizzas should be precisely the right size without any effort at all. Enter the (Principle 25) 3D-printed pizza machine:



Remember you read it here first.

Patent of the Month – **Contactless Stimulation of the Central Nervous System**

Patent of the month this month is US9,044,596, granted on June 2 to a team of inventors from Vanderbilt University in Nashville, Tennessee. As hinted by the patent's title, the researchers have developed a novel method for contactless simulation of the central nervous system. This technique involves the use of infrared neural stimulation (INS) to evoke the observable action potentials from neurons of the central nervous system.

Prior to the invention, the preferred solution for achieving nervous system stimulation has been through the use of electrical stimulation. Here's how the inventors describe the state of the art in their background description:

Neural stimulation is typically the process of using an external source to activate ion channels causing depolarization of the neural membrane and evoking an action potential to propagate down the axon of a stimulated neuron. Electrical, thermal, chemical, optical and mechanical methods have been reported to generate action potentials in both the central nervous system (CNS) and peripheral nervous system (PNS). Electrical stimulation has been the gold standard for the stimulation of neurons for both clinical and basic research applications. For nearly two centuries, neurons have been activated by electrical stimulation through the injection of a current or change in voltage delivered via an electrode placed on or near the neural tissue. The injected current or change in voltage causes an increase in the transmembrane potential to activate voltage-gated ion channels which generates action potential propagation down the neuron's axon. However, electrical stimulation can have limited spatial precision due to inherent electrical field spread which can recruit unwanted neural tissue, and electrical stimulation results in a stimulation artifact which can mask relevant neuronal signals resulting from the stimulation event

In addition to this issue of electrical stimulation exciting too large of a volume of tissue and therefore not providing local excitation problem, electrical stimulation also requires physical contact with tissue, which is rarely possible when it comes to the central nervous system.

Here's how we might best map this pair of problems on to the Contradiction Matrix:

IMPROVING PARAMETERS YOU HAVE SELECTED:

Trainability/Operability/Controllability (34)

WORSENING PARAMETERS YOU HAVE SELECTED:

Loss of Energy (27) and
Compatibility/Connectivity (33)

SUGGESTED INVENTIVE PRINCIPLES:

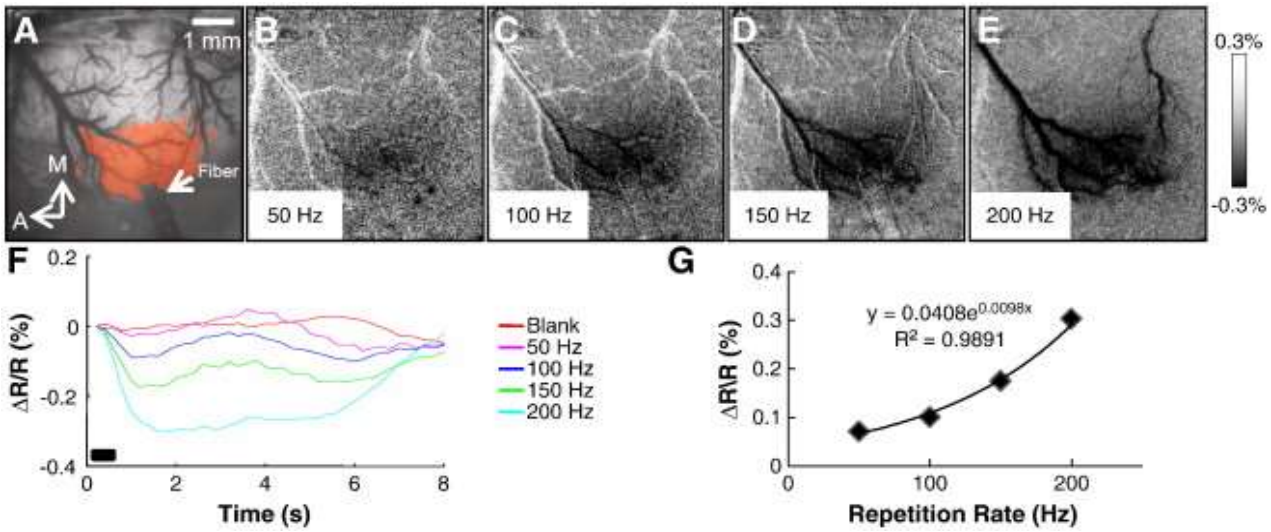
25, 28, 19, 1, 13, 24, 3, 6, 2, 4, 16

And here's how the inventors have solved the problem:

…applying a pulsed infrared laser at a stimulation site in the CNS; and evoking responses from a region of interest of the CNS that is at or adjacent to the stimulation site by the pulsed infrared laser. In the method, the pulsed infrared laser penetrates a predetermined penetration depth of the stimulation site….

So, a fairly clear illustration of Principles 28 (IR laser) and 19 ('pulsed').

Vanderbilt researchers have previously pioneered the application of pulsed infrared beams for stimulation of the peripheral nervous system. The present technology extends the application of similar stimulation to the central nervous system, and has done so through what sound to be a series of experiments to establish the best pulse rates and frequencies ("*wherein the wavelength of the pulsed infrared laser beam is predetermined based on the penetration depth of the stimulation site of the CNS, and the radiant exposure of the pulsed infrared laser is predetermined based on the numerical aperture of the optical medium and the distance of the optical medium from the stimulation site*").

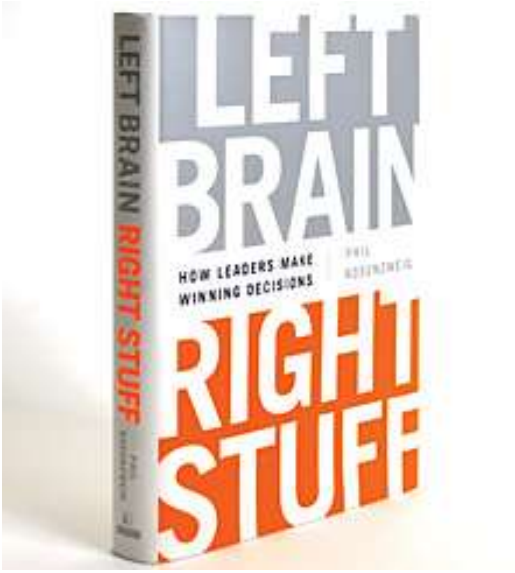


Intrinsic signals produced by different rates of INS. (A) Blood vessel map. Location of fiber optic is indicated by arrow. Orange pixels indicate significant pixels in t-test between 100 Hz stimulation and blank condition. (B–E) Activation maps of laser repetition rates: 50 Hz (B), 100 Hz (C), 150 Hz (D), 200 Hz (E). (F) Time course of response resulting from laser stimulation conditions 50 Hz (red), 100 Hz (blue), 150 Hz (yellow), and 200 Hz (aqua blue) and blank conditions. (G) Laser repetition rate vs. the peak amplitude of the intrinsic signal. Scale bar next to (E) indicates clipping range of images (B–E).

The claimed competitive advantages of the invention are that it:
• Can modulate intrinsic optical response for individual eye for potential functional stimulation testing
• Provides functional specifications for potential deep brain stimulation application
• Can be engineered to target a specific volume of tissue, due to penetration depth control
• Potential to stimulate a single neuron, due to improved spatial precision
• Contactless stimulation can be minimally invasive

It also looks set to disrupt a whole series of other non-invasive patient interventions – eg cochlear stimulation is specifically mentioned – as well as potentially opening up a whole new avenue of human-computer-interface possibilities. We think this is one to keep a close eye on in the coming months and years. Keep looking in at the University's Biomedical Photonics laboratory: http://research.vuse.vanderbilt.edu/bmeoptics/.

Best of the Month – Left Brain, Right Stuff



Over the past few years, we've seen the release of what very quickly became an excess of books devoted to the art and science of decision making. Authors like Dan Ariely, Daniel Kannehman, the Heath Brothers, and many more have all penned tomes devoted to advancing the understand why we do what we do. It's a typical phenomenon: a pioneer makes a creative leap ('economists always get things wrong because they fail to tap into the 'irrationality' of human nature'), and a thousand others jump on a band wagon.

But then something else happens. Someone gets to make a definitive statement about the initial idea. That person might just be Phil Rosenzweig. The author of his own creative leap in *The Halo Effect: … and the Eight Other Business Delusions That Deceive Managers*, one of our candidates for best business book of the last two decades.

Left Brain, Right Stuff continues with this theme of questioning what we really know about a well-trodden topic. In this case, it's decision making. Rosenzweig has a knack for shedding light on key areas that many books of this ilk have overlooked, misinterpreted, and/or failed to adequately address. Laboratory experiments by academics might tell us something about individual decision making in isolation, but it's more important to focus on decisions made in the business world. And for that we need a new, context-laden framework.

Rosenzweig challenges the reader to contemplate the context of real-world decisions. While this is much messier than the aforementioned experiments, it's essential for us to ask questions like:

- Is a reward based upon relative or absolute performance? And what is the relationship between the two?
- Are payoffs distributed or even known? Is it "winner take all" or is second prize a set of steak knives?
- Can the decision maker influence performance (as in business) or not (as in the lottery)?
- When is it wise to adopt an ostensibly "irrational" strategy?
- When–if ever–does the decision maker receive feedback? Immediately? Ten years down the road?

SYSTEM·ATIC INNOVAT·ION

What's more, Rosenzweig's storytelling is utterly compelling. You feel like you're at the table when the AT&T-Cingular deal went down. He complements his decision-making framework with interesting narratives of actual events (business, NASA). And he even manages to make golf sound interesting. This is no academic text, but, as I did when I read – and re-read – The Halo Effect, I walked away with a greater appreciation for the context of business decisions than I suspect I ever would have done had I been able to find an academic reference.

Readers looking for simple five-point checklists will find this book wanting. To that I say, "good." Success in life and business hinges upon much more than pithy bromides. It's messier and much more nuanced, and this challenging book is wonderfully readable breath of fresh air. And something to make the bandwagon jumpers feel ashamed to boot.

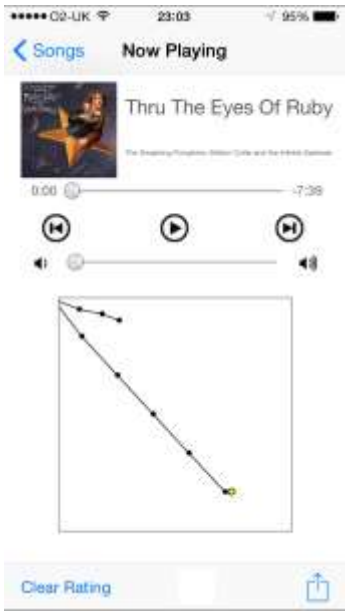
Wow In Music – Thru The Eyes Of Ruby

"The night has come to hold us young"

Romantic, joyful, epic, powerful, tormented, tearful, distressed, peaceful … and the list could possibly go on and on while Thru The Eyes of Ruby gradually unravels it's heroic story. Very few songs I know of take me to so many different and, at the same time, contradictory places and emotions. The 1995 success by the Smashing Pumpkins, the alternative rock band from Chicago, appeared in a double album, Mellon Collie and the Infinite Sadness, featuring twenty-eight songs, an impressive demonstration of creative breath, sometimes very successful, other times not so much. Anyways, it helped the Pumpkins to become one of the most successful and acclaimed bands of the 1990s, achieving a glorious number one on the Billboard 200, ten times platinum status in the United States, and gave the band a best-seller for an entire decade.

The thing about this song is that it really stands out of the crowd, guiding you to places you wouldn't expect. From a quiet, almost restful piano solo introduction, the music quickly gets the listener to a state of reflection and perplexity: "Wrap me up in always and drag me in with maybes". The lyrics tell a story of a gone love. The music, interlacing bits of progressive rock and heavy metal, becomes loud, fuzzy, and energetic. The appearance of the drums (0:15) (Principle 5) and the sudden disappearance of the guitar (0:36) (Principle 2) makes you ask yourself: what just happened? Dynamics and instrumentation contribute to build the atmosphere: crescendos, diminuendos, power chords, soft singing, loud explosive guitars, introspective confessions, cries, not just one but many wow moments, everything happens! In the end (from 5:56 on), the vocals go away, quietness is re-established in a long breath (6:57), (perhaps a sigh? Maybe Principle 39?) with the reprise of Mellon Collie.

To me, Thru The Eyes of Ruby tells a poetic story of humankind. Here is how RealME describes it:

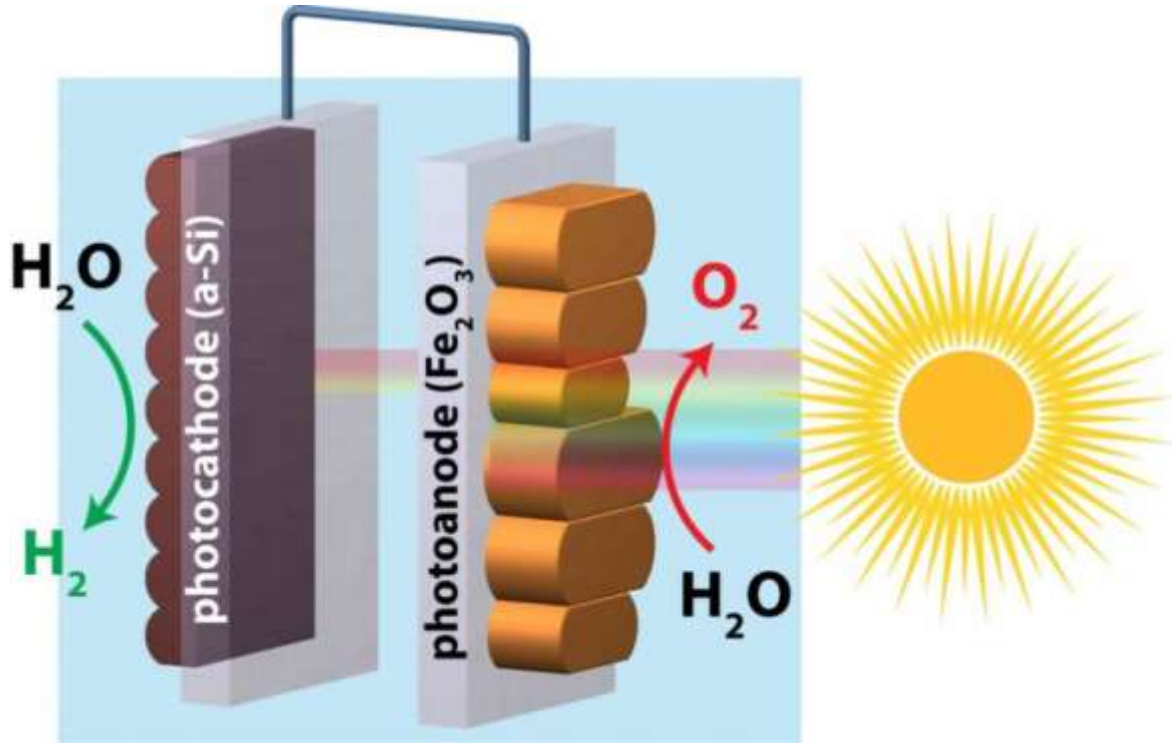


We are still trying to understand this (machine generated) emotion track. We invite you to do the same… you can start by downloading the RealME app from the Apple Store.

Failing that, feel free to play spot the paradoxes peppered through the song's lyrics. I count 12. Which might just be some kind of record. As well as offering up a few more clues about what makes the song so good.

Wrap me in always, and drag me in with maybes
Your innocence is treasure, your innocence is death
Your innocence is all I have
Breathing underwater, and living under glass
And if you spin your love around
The secrets of your dreams
You may find your love is gone
And is not quite what it seemed
To appear to disappear
Beneath all your darkest fears
I believe in never, I believe in all the way
But belief is not to notice, belief is just some faith
And faith can't help you to escape
And with this ring I wed thee true
And with this ring I wed thee now
And with this ring I play so dead
But no one's asking for the truth, so let me tell you
If you spin your love around
The secrets of your dreams
You may find your love is gone
And is not quite what it seemed
To appear to disappear
Beneath all your darkest fears
To the revelations of fresh faced youth
No one will come to save you
So speak your peace in the murmurs drawn
But youth is wasted on the young
Your strength is my weakness, your weakness my hate
My love for you just can't explain
Why we're forever frozen, forever beautiful,
Forever lost inside ourselves
The night has come to hold us young

Investments – Solar Water-Splitter



Finding an efficient solar water splitting method to mine electron-rich hydrogen for clean power has been thwarted by the poor performance of hematite. But by 're-growing' the mineral's surface, a smoother version of hematite doubled electrical yield, opening a new door to energy-harvesting artificial photosynthesis, according to a report published online this month in the journal *Nature Communications*.

Re-grown hematite proved to be a better power generating anode, producing a record low turn-on voltage that enabled the researchers to be the first to use earth-abundant hematite and silicon as the sole light absorbers in artificial photosynthesis, said Boston College associate professor of chemistry Dunwei Wang, a lead author of the report.

The new hydrogen harvesting process achieved an overall efficiency of 0.91 percent, a 'modest' mark in and of itself, but the first 'meaningful efficiency ever measured by hematite and amorphous silicon, two of the most abundant elements on Earth,' the team reported.

'By simply smoothing the surface characteristics of hematite, this close cousin of rust can be improved to couple with silicon, which is derived from sand, to achieve complete water splitting for solar hydrogen generation,' said Wang, whose research focuses on discovering new methods to generate clean energy. 'This unassisted water splitting, which is very rare, does not require expensive or scarce resources.'

Wang said the findings represent an important step toward realizing the potential performance theoretical models have predicted for hematite, an iron oxide similar to rust. 'This offers new hope that efficient and inexpensive solar fuel production by readily available natural resources is within reach,' said Wang. 'Getting there will contribute to a sustainable future powered by renewable energy.'

The team, which included researchers from Boston College, UC Berkeley and China's University of Science and Technology, decided to focus on hematite's surface imperfections, which have been found in earlier studies to limit 'turn-on' voltage required to jump-start photoelectrochemistry, the central process behind using artificial photosynthesis to capture and store solar energy in hydrogen gas.

The team re-evaluated hematite surface features using a synchrotron particle accelerator at the Lawrence Berkeley National Laboratory. They established a new 're-growth' strategy that applied an acidic solution to the material under intense heat, a process that simultaneously reduced ridges and filled depressions, smoothing the surface.

Tests immediately showed an improvement in turn-on voltage, as well as an increase in photovoltage from 0.24 volts to 0.80 volts, a dramatic increase in power generation.

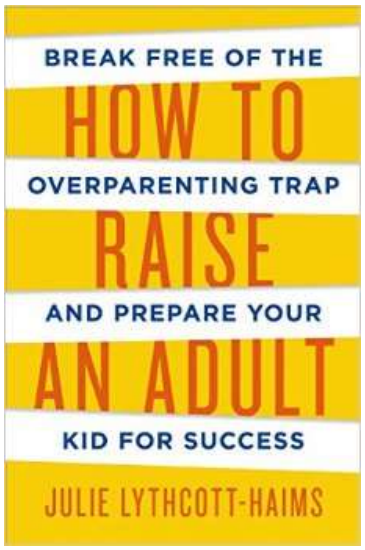
The team reported that further modifications to the new hematite-silicon method make it amenable to large-scale utilization. Furthermore, the 're-growth' technique may be applicable to other materials under study for additional breakthroughs in artificial photosynthesis.

'It is a delight to see that a simple re-growth treatment can do so much to improve the performance of hematite,' said Wang. 'Due to its prior poor performance, hematite has been pronounced 'dead' by many leading researchers in the field. We are happy to show that much can be harvested from this earth abundant, non-toxic material.'

Read more here:

Ji-Wook Jang, Chun Du, Yifan Ye, Yongjing Lin, Xiahui Yao, James Thorne, Erik Liu, Gregory McMahon, Junfa Zhu, Ali Javey, Jinghua Guo, Dunwei Wang. **Enabling unassisted solar water splitting by iron oxide and silicon**. *Nature Communications*, 2015; 6: 7447 DOI: 10.1038/ncomms8447

Generational Cycles – "How To Raise An Adult"



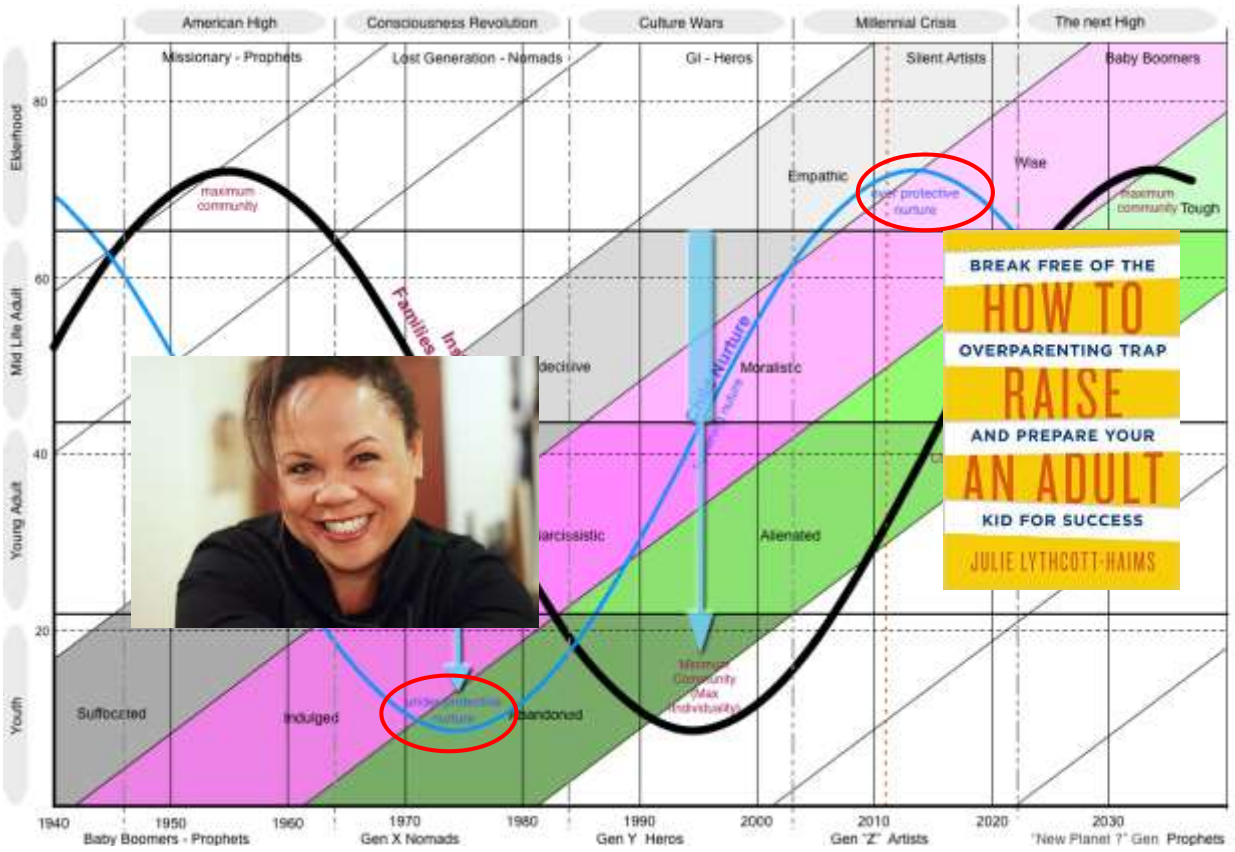
This month saw the publication of what looks like the start of a sea-change in the parenting literature. 'How To Raise An Adult' is the first work of Julie Lythcott-Haims, former Dean of Freshmen at Stanford. And, perhaps tellingly, an early Nomad (born in 1967). The book comes in the wake of twelve years of watching new arrivals at the University becoming ever more 'curated' by their helicopter parents.

While tales of meddling parents have probably reached a fever pitch, Lythcott-Haims's bleak portrait may just be, as rather pithily described in the NY Times review of her book, 'the "Black Hawk Down" of helicopter parenting'. Lythcott-Haims tells a series of parental interference horror stories suggesting not just a lack of common sense, but a lack of wisdom and healthy boundaries (if not personal dignity) as well. Instead of allowing kids to experiment and learn from their mistakes, parents hover where they're not wanted or welcome, accompanying children on school trips or shadowing them on campus. Caught up in what the author calls the "college admissions arms race," parents treat securing their children a spot at one of 20 top schools (as decreed by U.S. News and World Report's popular but somewhat dubious rankings) as an all-or-nothing proposition. Concerned about the effects of a flawed high school transcript, parents do their children's homework, write or heavily edit their papers, fire questions at teachers, dispute grades and hire expensive subject tutors, SAT coaches and "private admissions consultants" (26 percent of college applicants reported hiring these in 2013). Even after kids graduate, the madness continues. Lythcott-Haims offers anecdotes of parents touring graduate schools, serving as mouthpieces for their shy, passive children, and submitting résumés to potential employers, sometimes without their children's knowledge. These behaviors do more than mold kids into dependent beings, she argues; they corral and constrict their possibilities and their imaginations. "We speak of dreams as boundless, limitless realms," Lythcott-Haims writes. "But in reality often we create parameters, conditions and limits within which our kids are permitted to dream — with a checklisted childhood as the path to achievement."

Lythcott-Haims takes pains to demonstrate that over-parenting doesn't merely threaten a child's future income; it also does enormous psychological harm. She cites a 2011 study by sociologists at the University of Tennessee at Chattanooga that found a correlation, in college-student questionnaires, between helicopter parenting and medication for anxiety

or depression. One researcher at a treatment center for addicts in Los Angeles found that “rates of depression and anxiety among affluent teens and young adults . . . correspond to the rates of depression and anxiety suffered by incarcerated juveniles.” Other studies suggest that over-parented kids are “less open to new ideas” and take “less satisfaction in life.” For Lythcott-Haims, the message behind this research is the same: Kids need to sally forth independently without constant supervision. They need to try and even fail. And when they fail and look around for a parent to bail them out, they need to hear the words, “You must figure this out for yourself.”

The irony, of course, is that after years of lamenting the benign neglect suffered at the hands of 1970s parents who told kids to “go outside and play until dinnertime,” today’s parents are starting to second-guess the ways they’ve overcorrected such hands-off child-rearing. Indeed, Lythcott-Haims’s explicit instructions for parents read like a page straight out of a ’70s-era parenting playbook: “Value free play.” “Work on creating space between you and your kid.” “Don’t apologize or overexplain.” Oh, and give your kids chores — lots of chores. Which, given her age and therefore Generation cohort isn’t such a surprise. Plot the dynamics onto a Generation Map and we begin to see a clear picture of just how the extremes of the societal nurture oscillation really work:

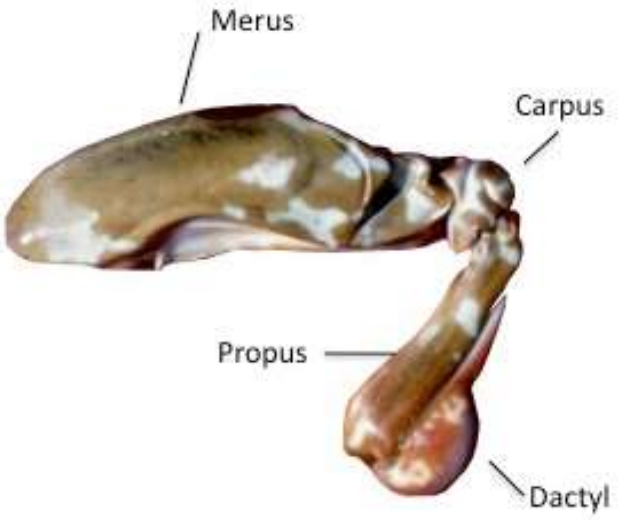


Lythcott-Haims was raised during the very apogee of the nurture cycle and worked at Stanford between 2000 and 2012 when the nurture curve was rapidly converging on the opposite end of the scale. The publication of her book this month comes at a moment in time when the curve has hit its turning point.

Judging by the media interest in the book, one suspects ‘How To Raise An Adult’ might just be the parenting tome that triggers the scheduled change of the tide.

Biology – Mantis Shrimp II

We first featured the remarkable mantis shrimp *Odontodactylus scyllarus*) back in 2008 (Issue 78, September 2008). Back then the contradiction-resolving evolution story was about its vision system. This time around, thanks to a recently published piece of research from scientists at the University of California, we can extend the mantis shrimp's list of remarkable characteristics to include its prey-battering appendage.



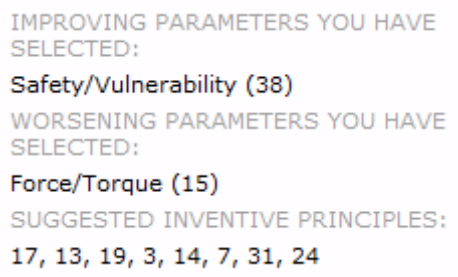
Peacock mantis shrimp use the hammer-like appendage to smash open snail shells for food. Not only does high speed imaging reveal that peacock mantis shrimp forelimbs reach maximum speeds from 12-23 m/s (not bad considering it's in water!), but it also showed that cavitation bubbles were forming between the appendage and snail shell. The researchers found that, as a result of the limb's extraordinary speed, the water cavitates when the limb strikes the prey. Cavitation is a destructive phenomenon; when vapour bubbles collapse, they essentially cause a small implosion in the water which produces heat, light and sound.

By linking high speed imaging with force sensors and acoustic sensors, the researchers were able to show that mantis shrimp wield two types of strike forces – the first force is due to the appendage physically striking the snail shell and the second is due to the collapse of the cavitation bubble. Thus, for each predatory strike, mantis shrimp work like jack-hammers with a series of four force peaks from the impact of the first appendage, the collapse of the first cavitation bubble and then the impact of the second appendage and the collapse of the second cavitation bubble. All of this happens in less than 800 µs, with peak forces of 1500 N (over 2500 times the animal's body weight). The "dactyl club" can reach an acceleration of 10,000 Gs, unleashing an initial impact on the poor unsuspecting prey equivalent to the speed of a .22 caliber bullet.

These findings have offered important new insights into the physical consequences of fast movements in aquatic environments. Furthermore, they raise key questions about the evolution of fast movements and the co-opted use of cavitation.

The newly published research now turns the story the other way around: how come the appendage is able to survive the impact(s) with the prey?

Here's the basic contradiction to be solved and how human engineers have sought to resolve it:



And here's how the mantis shrimp has done it: The appendage is made of a composite material containing fibers of chitin, the same substance found in many marine crustacean shells and insect exoskeletons but arranged in a helicoidal structure that resembles a spiral staircase. Sounds a lot like Principle 14, right? Pretty obvious…

This spiral architecture, the new research shows, is naturally designed to survive the repeated high-velocity blows by filtering out certain frequencies of waves, called shear waves, which are particularly damaging…. Not so obvious, and definitely somewhere close to amazing.

The findings could allow researchers to use similar filtering principles for the development of new types of composite materials for applications including aerospace and automotive frames, body armor and athletic gear, including football helmets.

"This is a novel concept," said David Kisailus, the Winston Chung Endowed Professor in Energy Innovation at UC Riverside's Bourns College of Engineering. "It implies that we can make composite materials able to filter certain stress waves that would otherwise damage the material."

"The smasher mantis shrimp will hit many times per day. It is amazing," said Pablo Zavattieri, an associate professor in the Lyles School of Civil Engineering and a University Faculty Scholar at Purdue University.

The researchers modeled the structure with the same mathematical equations used to study materials in solid-state physics and photonics, showing the structure possesses "bandgaps" that filter out the damaging effects of shear waves traveling at the speed of sound.

Watch a remarkable video of the shrimp appendage in action here:
https://www.youtube.com/watch?v=A2Ic1Xt3BK8

And read more here:
Nicolás Guarín-Zapata, Juan Gomez, Nick Yaraghi, David Kisailus, Pablo D. Zavattieri. **Shear wave filtering in naturally-occurring Bouligand structures**. *Acta Biomaterialia*, 2015; DOI: 10.1016/j.actbio.2015.04.039

Short Thort

"You are never dedicated to something you have complete confidence in. No one is fanatically shouting that the sun is going to rise tomorrow. They know *it's going to rise tomorrow. When people are fanatically dedicated to political or religious faiths or any other kinds of dogmas or goals, it's always because these dogmas or goals are in doubt."*
Robert M. Pirsig

"And your doubt can become a good quality if you train *it. It must become* knowing*, it must become criticism. Ask it, whenever it wants to spoil something for you,* why *something is ugly, demand proofs from it, test it, and you will find it perhaps bewildered and embarrassed, perhaps also protesting. But don't give in, insist on arguments, and act in this way, attentive and persistent, every single time, and the day will come when, instead of being a destroyer, it will become one of your best workers--perhaps the most intelligent of all the ones that are building your life."*
Rainer Maria Rilke

News

International Conference On Systematic Innovation
The 6th ICSI will be held in Hong Kong at the University of Science & Technology from the 15th to the 17th of July. We are happy to announce that Darrell will be attending the conference and presenting a keynote address ('Systematic Innovation: Past, Present & Future') and tutorial ('Getting More Out Of Systematic Innovation: Retraining Problem-Solving Instincts') on the 15th. More details at the systematic-innovation.org website.

US
It's been a long time, but we finally have a trip to the US in the diary. 24 August to 2 September are the planned dates. Most of the working days are already committed, but there are a couple of spares if anyone is interested in having Darrell come along and do something with you. Get in touch with Cara in the first instance if you think you might wish to organize something.

Managing for Growth
We're happy to confirm that the second 100-day MfG programme will commence at DTU in Copenhagen, starting in August. Anyone interested in participating should get in touch with Ellen Als at the University Business School in the first instance. Darrell will be teaching a 2-day innovation session on 7 and 8 September.

Unlocking Innovation Scheme
We will be presenting a TrenDNA introduction session at the 30 September UIS day for the UK railway industry companies….

TrenDNA Software
…hopefully by that time, we'll have a Beta version of the TrenDNA software available for Beta-user trials.

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

HR – Innovation Strategy workshop
Automotive – Breakthrough Technology Concept Workshop
Semiconductor – Innovation Strategy workshop
Automotive – Competitor analysis project
Government – PanSensic study
Construction – PanSensic study
Mining – SI workshops
Logistics – Future Market Trends project study