

Systematic Innovation



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Our guarantee to the subscriber is that the material featured in the e-zine will not be published elsewhere for a period of at least 6 months after a new issue is released.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

Re-Thinking Physical Contradictions #1: Technical Problems

The least well evolved of all the TRIZ tools feels more and more like the Physical Contradiction story. The more time and energy we devote to updating the Contradiction Matrix tool, the more the Physical Contradiction part seems to fall by the wayside as a lost orphan. Part of the issue is that, one of the larger steps forward in methodological terms, the introduction of the Contradiction Map (or, colloquially, 'Bubble Map') – Figure 1 – has shown users that it is always possible to convert conflicts into physical contradictions and vice-versa. The implied message of the template is, 'don't worry if you're struggling with the physical contradiction part of the story, you can always convert it into a conflict pair the Matrix will help you with'.

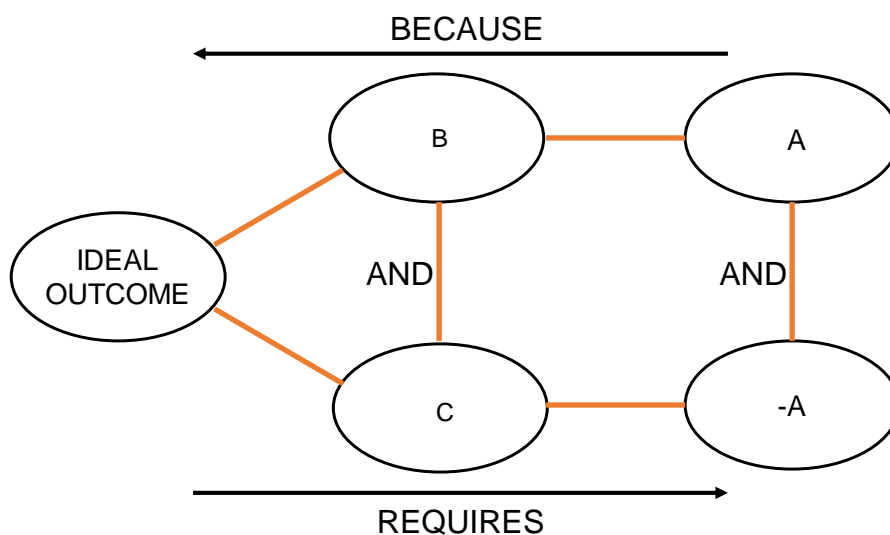


Figure 1: Contradiction ('Bubble') Map

That said, a big part of the rationale for the Contradiction Map is that it is designed to force problem solvers to spend more time in definition mode before they allow themselves to start generating solutions. And, if nothing else, it also offers up more solution directions if the Contradiction Matrix fails to deliver sufficient useful insight into the best solution directions. A better – easier and more efficacious – Physical Contradiction solution generation tool would be a useful addition to the problem solvers armoury.

The heart of the problem with the current tool – based on ideas and concepts we see individuals and groups struggling with when they're trying to use the tool – starts with the Separation strategies on offer. In our current version of the tool, we prompt people to explore three different separation strategies: Space, Time and Condition. This segmentation model is in itself an evolution of the model used in the various different Physical Contradiction models found in Classical TRIZ.

When the method forces users to think about, 'can you separate the contradiction in space? In time? On Condition? The frequent confusion comes in the apparent overlaps between, especially, the latter two. Time *is* a condition. And, for that matter, so is space. Hence, to take a specific example, I want the shirt material to be thick and thin, the difference between:

I want the material to be thick *when* I'm outside, and

I want the material to be thin *when* I'm indoors
(the separation in time question)

and

I want the material to be thick *if* the temperature is low, and
I want the material to be thin *if* the temperature is high
(the separation on condition question)

are semantically very small. And if they are small, then why does the method send me to two quite different sets of solution strategy depending on which one I might choose? Or, indeed, different again, if I determine that I can solve the contradiction using *both* of these separation strategies.

Because time and space *are* conditions, having the distinct 'separate on condition' strategy actually makes little sense. In order to try and resolve this conflict, we've tended to encourage users to interpret this third separation category as 'conditions *other than* time or space'. Which helps solve the first confusion problem, but then opens up a whole new problem: *what* other conditions?

We can get a first clue towards answering this question by heading back to the Pillars of the Systematic Innovation method: Contradictions, Ideality, Functionality, Resources and, perhaps the least well understood, Space-Time-Interface.

This latter pillar, and in particular the word 'Interface' represent the important clue here. 'Interface' represents all the 'betweens': the relationship between entities. And, if we add to this idea the parallel idea of functions being the action of one entity on another, under the influence of a 'field', then we quickly find ourselves able to find a way to help structure a search for possible 'betweens'. If we're going to solve a Physical Contradiction, in other words, that requires the identification and use of a field. And there just aren't that many different types of field for us to explore – Figure 2.



Figure 2: Different Types Of Field

So, we now have three different Separation strategies open to us when we're looking to resolve a Physical Contradiction – Space, Time & Interface. For the latter, we have 11 basic field types we can explore to see if we can harness them to help establish a means of triggering the shift between our two different desired states.

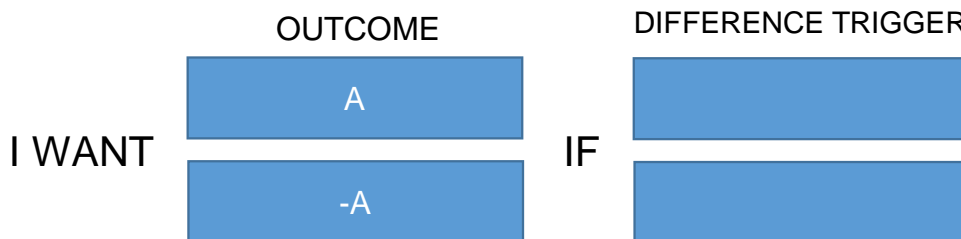
For the 'separation in space' category, we can add a little more sophistication to the search by examining the 9-Windows tool. It tells us that, spacially, there are multiple possibilities problem solvers can use to look for difference: within the system; between the system and the super-system and between the system and the sub-system.

Taken all together, the full range of separation strategies we have available to us, thus looks something like this:

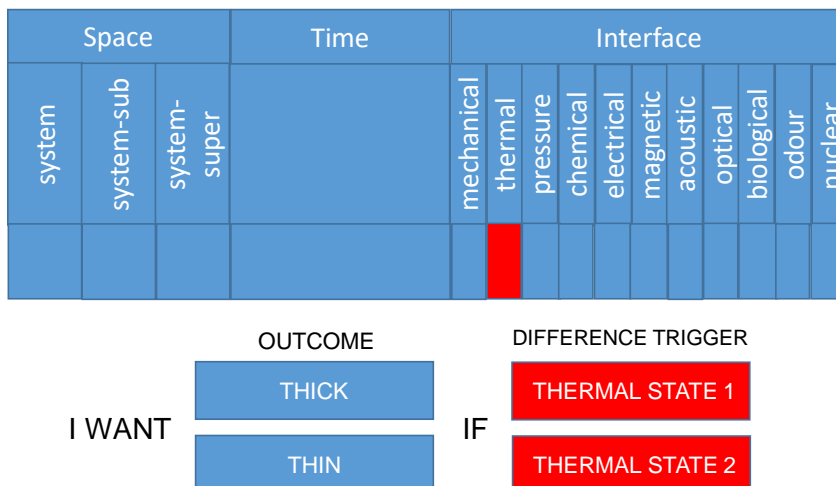
Space			Time	Interface										
system	system-sub	system-super		mechanical	thermal	pressure	chemical	electrical	magnetic	acoustic	optical	biological	odour	nuclear

Figure 3: 15 Possible 'Difference Trigger' Opportunities

Each of the categories offers us an opportunity to identify a suitable 'difference trigger'. The associated question template we've been testing for the last few months looks like this:



As ever, it's often easiest to see the template in action via an example:



So much for the full spectrum of Separation strategies, what we also notice is that, when we examine the spectrum of different physical contradiction solving outcomes (big and small, thick and thin, present and absent, hot and cold, etc), they all fit into the same spectrum of possibilities.

This insight allows us to draw a much more complete – albeit more complicated – method of mapping the Physical Contradiction space. At the moment, it looks something like this:

		Space			Time	Interface																		
		system	system-sub	system-super		mechanical	thermal	pressure	chemical	electrical	magnetic	acoustic	optical	biological	odour	nuclear								
Outcome	Space	system																						
		system-sub																						
		system-super																						
	Interface	Time	mechanical																					
			thermal																					
			pressure																					
			chemical																					
			electrical																					
			magnetic																					
			acoustic																					
			optical																					
			biological																					
odour																								
nuclear																								

The way we use the template requires us to first establish what physical contradiction-solving *outcome* we're looking to achieve. This tells us which *row* in the table to look at. Then, in order to solve the contradiction, we systematically work our way across each column in order to explore the possibility of using that 'difference trigger' to help deliver us insight into what our solution options actually are.

This template, comprehensive as it is, gives us a number of challenges and opportunities:

- 1) Can we correlate each of the boxes in the template to the Inventive Principles that might help solve the Contradiction we're aiming to solve?
- 2) Can we apply the same basic Space-Time-Interface lens to a better method for solving 'business' and 'process' problems?
- 3) Having found a way to being 'comprehensive', can we also find our way back to 'simple'? (i.e. we want high efficacy and high simplicity)

Those are the three topics we'll be looking at in the second and third parts of this article.

Evolution Potential Hierarchies

Although widely established as a means of analyzing the maturity of a system, and for guiding the generation of future evolution direction ideas, there continues to be confusion over how to get the best out of the Evolution Potential process. I thought I'd use a simple example to illustrate a technique we frequently use within the SI research team to make sure our efforts to get the maximum number of evolution ideas out of using the tool.

Well, when I say 'simple', and I think back to the time I first had the job of designing centrifugal impellers, it didn't feel very simple at all. This is back in the mid-1980s, before I knew about TRIZ. It was the pioneering age of computational fluid dynamics (CFD), so in reality, my main 'design' task was designing the software that would allow us to subsequently design better – more efficient – impellers. At the time we were pioneering the use of 3D analysis tools that allowed us for the first time to model what was happening as air was induced to flow through the impeller. The software made two significant evolution jumps: when I first joined the department, impellers were effectively designed using a 1-dimensional calculation. A lot of the calculations were done using calculators and the job was highly tedious. Then we got 2D software, and now I was developing the 3D version. The design of the impeller itself, however, was lagging somewhat behind – the shape of the vanes effectively being determined, still, from the 1D and 2D calculations.

Here's what we'd have drawn if we'd known about TRIZ back in those days:

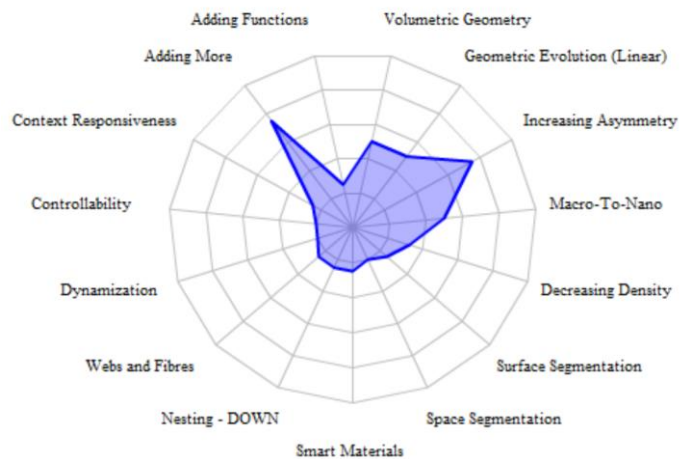
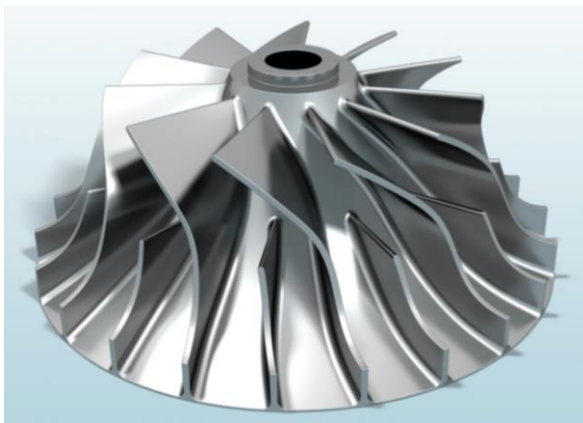


Figure 1: Evolution Potential Analysis Of Typical Centrifugal Impeller

What it would have told us is that, just like we'd seen with the evolution of our software-based design tools, the impeller geometry was ultimately going to become more three dimensional.

That said, to the lay-person, the above impeller picture already looks very three dimensional. So why are we able to say that it will become 'more' three dimensional? The trick to the realization – and the scoring of the axes on the Evolution Potential plot – is to look at the overall geometry of the impeller and score according to the lowest point along the relevant trend scale. Thus, although the impeller looks 3D, when we start looking at many of the individual features we see that they are straight lines. Hence, the overall impeller has been evaluated as being at the second stage ('line') along the Geometric Evolution trend.

Figure 2 highlights some of the 'straight-lines' we can see on the impeller:

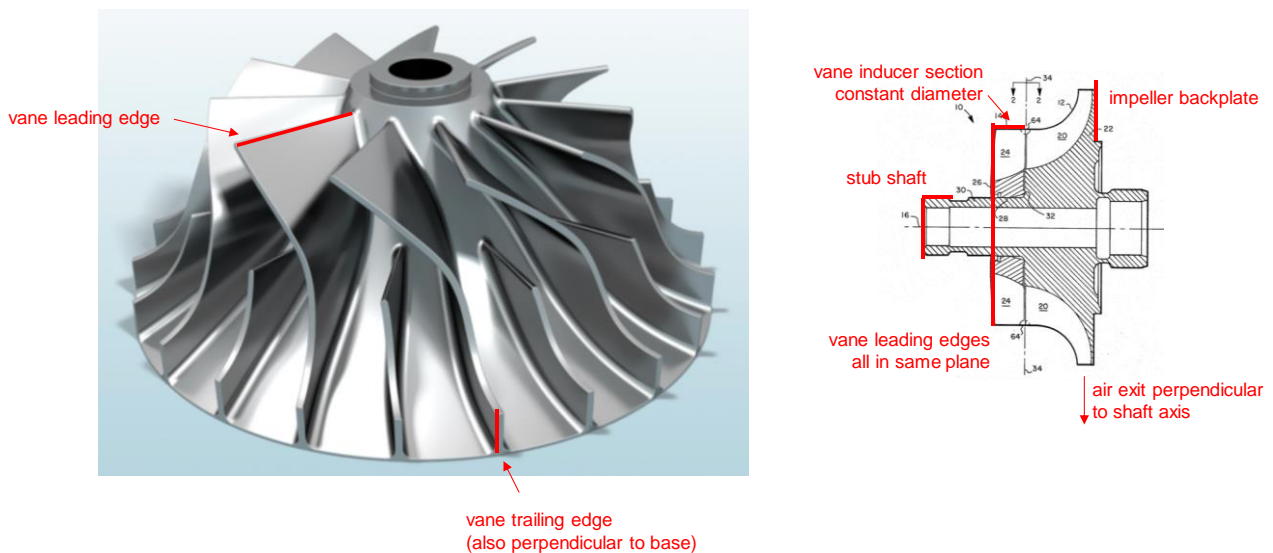


Figure 2: Straight Line Features On Impeller

Each of these features represents an opportunity to design a better impeller: TRIZ tells us that straight lines 'want' to evolve to become curved: the vane leading edges want to be curved; the trailing edges want to be curved; they don't want to be perpendicular to the base, etc.

I could use my 3D design software to help me to work out how to curve each feature, but until I've exploited each and every straight-line and made it curved, my Evolution Potential plot for the overall impeller will remain unchanged. Only, in other words, when there are no more straight-lines can I say the Geometric Evolution Trend score for the impeller has seen a jump to the next, 'curved' stage.

The main reason for adopting this kind of discipline is that as soon as I – or the next designer after me – see a plot in which the 'make it curved' Evolution Potential has been used up, we will stop looking for further straight-lines to make curved.

The problem with this discipline is that it can be an awful long time before my plot shows any progress.

The solution to this problem is to begin constructing a hierarchy of Evolution Potential plots. The high-level plot for the overall impeller may not change for some time, but if I've constructed a plot for a 'vane', or, even more detailed, 'vane trailing edge', then I will have a much more comprehensive means of mapping how much potential I still have available to me.

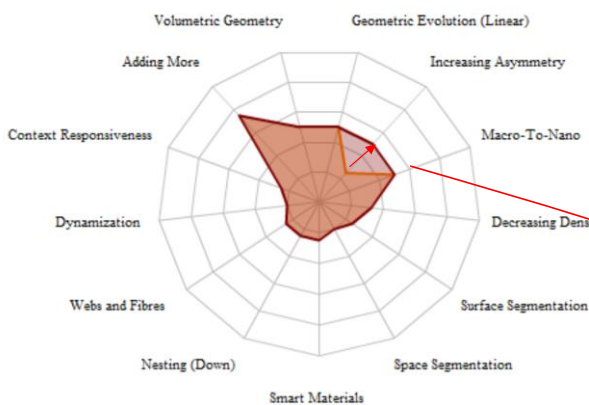
Figure 3 makes an attempt to show what such a hierarchy might look like for our impeller.

For the eagle-eyed reader, you may notice that at the bottom of the hierarchy, the plot has been drawn to include an evolution jump. One of the first things we realized once we started using our 3D design codes was that it was a really good idea to make the vane trailing-edge root orientation such that the vane was no longer perpendicular to the base...



Figure 3: Skeleton Impeller Evolution Potential Hierarchy

...let's have a closer look at the bottom-of-hierarchy plot and the resulting change in the impeller trailing-edge vane geometry...



Hopefully the idea is simple. The real challenge is in the discipline required to construct and manage the hierarchy. I know if I was back in charge of impeller evolution strategy, I'd have a wall full of Evolution Potential plots and would be managing my R&D activities according to all of the untapped potential.

Not So Funny – Buzzword Bingo

Every once in a while, it's worth checking in on the world of cliché in order to establish the state of the nation. The good news from an innovation perspective these days is that there is a version of buzzword bingo dedicated to the topic. Clearly people are starting to understand what 'innovation' means well enough to turn it into a running joke. Hurrah.

Innovation Buzzword Bingo			
Growth hack	Quick win	Blue ocean	Lead user
Deep dive	Disruptive	Jobs to be done	Lean
Blue sky thinking	Game-changing	Customer-centric	Crowd-sourcing
Social media	Out-of-the-box	Design thinking	Open innovation

We're thinking of using it as part of the formal ICMM assessment. If someone shouts 'bingo' within the first week of carrying the card, that correlates to ICMM Level 3. If a line is completed in two-days, there's ICMM Level 2. Complete a line within a day and, congratulations, likelihood is you're working in an ICMM Level 1 enterprise.

Meanwhile, for every Yin there is a Yang. Here's the latest version of 'change resistance bingo'. This one works in exactly the opposite way to the Innovation Buzzword version – the longer it takes to complete a line, the higher the ICMM Level...

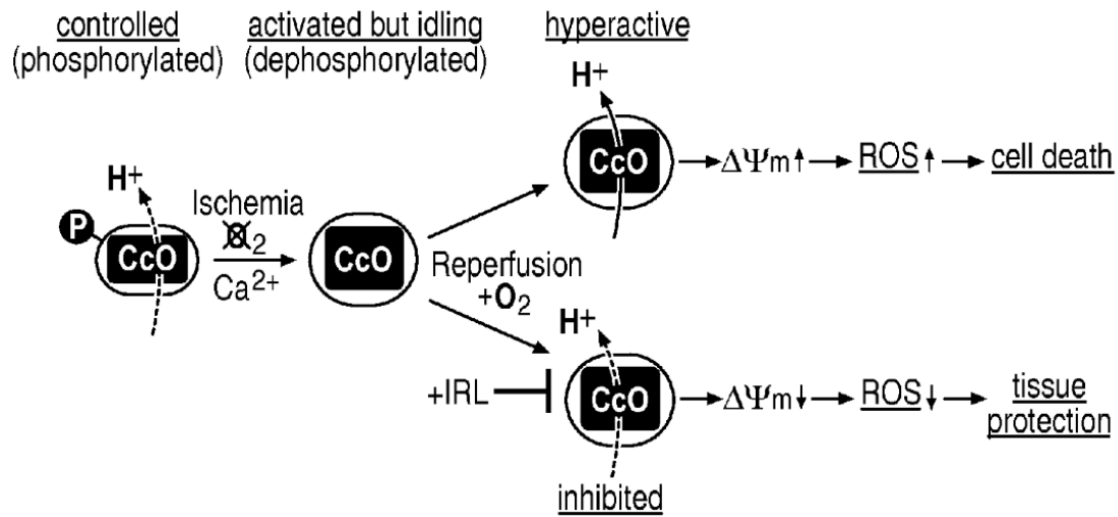
1. We need clear roles and responsibilities	2. The culture needs to change	3. Let's wait until [name] is back	4. What are other organisations doing?	5. We need more data
6. Let's conduct a survey	7. We have tried this in [insert year]	8. Our CEO will not like this	9. Change needs to start at the top	10. We all need to be aligned
11. We need a solid plan	12. The timeline is too aggressive		13. I am in favour, but	14. The strategy is unclear to me
15. We need clear roles and responsibilities	16. We need a broad committee	17. This is too big for us	18. [insert name big strategy consultant] should help us	19. It will only work if <u>everybody</u> participates
20. Tomorrow is another day	21. August is a very bad month [any month counts]	22. We will plan a change management course	23. HQ will have to coordinate	24. It can be done faster

Meanwhile, back in Millennial-Land, seems like the world of resume-writing has taken a great leap forward in the last couple of years. Cliché-wise:

B I N G O				
Team Player	Organizational Skills	Detail-Oriented	Verbal and Written Communication Skills	Hard-Working
Proven Track Record of...	Strong Work Ethic	Responsible for...	Interpersonal Skills	Passion For...
Out-of-The-Box Thinker	Highly Creative	 PONGO RESUME pongoresume.com	Results-Focused	Leadership Skills
Deadline-Driven	Good Computer Skills	Self-Motivated	Fast-Paced Environment	Multi-Tasking Skills
Experienced	Goal-Oriented	Knowledge of...	Reliable and Dependable	Quick Learner

I think I sense a new PanSensic lens in the offing...

Patent of the Month – Light Therapy Treatment



Patent of the month this month takes us on a fairly rare journey into the healthcare domain. I'm not sure whether that's because of the generally low Level of invention in evidence in the large majority of cases, or because the solution generally involves some convoluted piece of chemistry that you need a PhD to understand. This month's choice certainly isn't free of the chemistry-complexity aspects of the story, but the team of inventors at Wayne State University has definitely understood that you don't necessarily need chemistry to solve a chemistry problem. US9,610,460 was granted to the six inventors on 4 April. Here's what their starting point looks like:

An ischemic event occurs when the supply of oxygen and nutrients to an organ or tissue is restricted. For example, the interruption of blood flow to regions of the brain and heart results in myocardial and cerebral ischemia, respectively. Timely restoration of oxygen and nutrients, termed reperfusion, is essential for the survival of the ischemic organ or tissue. However, despite the benefits of this reintroduction of oxygen to ischemic tissue, reperfusion per se can also precipitate tissue death. The mechanisms of this phenomenon, termed reperfusion injury, are complex but involve the formation of cytotoxic oxygen-derived free radicals also called reactive oxygen species that can exacerbate death and dysfunction of previously ischemic tissue. Accordingly, an apparatus and method that limit the production of reactive oxygen species during reperfusion, and thus attenuating lethal reperfusion injury and maximizing the benefits of timely reperfusion is needed.

From a conflict resolution perspective, the problem is quite clear: we need to recover the loss of oxygen, but the return of the oxygen creates a chemical reaction with a harmful component. Here's what that problem looks like when mapped on to the Contradiction Matrix:

IMPROVING PARAMETERS YOU HAVE SELECTED:

Loss of Substance (25)

WORSENING PARAMETERS YOU HAVE SELECTED:

Harmful Emissions (30)

SUGGESTED INVENTIVE PRINCIPLES:

13, 2, 24, 35, 28, 21

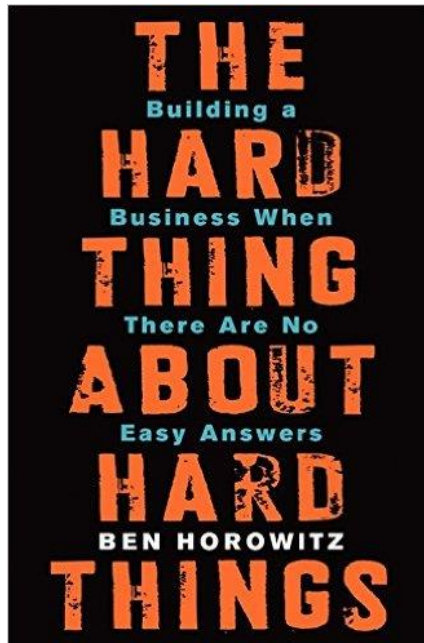
And here's the (beautifully non-chemistry) solution devised by the team, as described in the main Claim of their patent:

A method comprising: identifying an ischemic event in a patient; selecting one or more wavelength ranges, from a plurality of wavelength ranges, based on the ability of the wavelength range to inhibit cytochrome c oxidase; generating light at the one or more selected wavelength ranges, wherein one of the selected wavelength ranges at which the light is generated includes 950 nm; and applying the light, prior to an onset of reperfusion, to organic tissue that has experienced the ischemic event.

A classic instance of a Principles 28, 'add a field' strategy.

Almost invariably when we find ourselves working on problems with chemists they tend to fight against the 40 Inventive Principles because so few of them seem to have anything to do with chemistry. Here's a classic reason why they shouldn't.

Best of the Month – The Hard Thing About Hard Things



The large majority of management texts are written by authors that have never had any skin in the management game. That or they are actual managers who have had skin in the game but were told by advisors that didn't have skin in the game that what they were supposed to write about was 'the formula' that defined what made them successful. Trying to do that in a complex environment is a mostly futile act, and falls into the backwards-forward irreversibility trap. When we've been successful at something, it is easy to look back and see a clear route. Like standing on a leaf on a tree and navigating your way back to the trunk. Conversely, start from the trunk and try and navigate your way to a particular leaf is much more difficult. Success always looks logical after the fact. The trick is making sense of the complexity while stood in a quagmire looking forward.

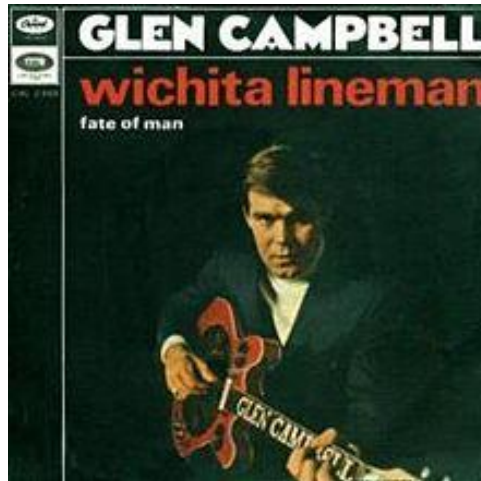
What I love about Ben Horowitz's book is that, first up, he's an author that has and continues to have an awful lot of skin in the business and innovation game. Second, and more importantly, he takes us through a lot of the real stuff that CEOs and innovators need to be aware of. Anyone can give advice to others when everything is progressing to plan; very few people can do it when things are going badly. The Hard Thing About Hard Things is an attempt – and a pretty good one at that – to do the latter. It's start point is where all the other management texts stop. Easy to tell others how to build a coherent business plan; really difficult to explain what to do when people tell you they've bought into it when in reality they haven't. Really difficult, too, when, the day after the plan is published, the world turns upside-down and the plan makes no more sense any more.

It's a remarkably honest, warts and all, rollercoaster of a journey, full of pithy comments and this-is-how-I-got-this-battle-scar stories. The book is written from a CEOs perspective, but it actually makes a great metaphor for anyone in an innovation role. Right at the heart of the story is Horowitz's hypothesis that if you tried to score the performance of the average CEO on a 1-100 scale, the answer you would get is 22. Not many successful people, he goes on to say, feel comfortable going to work every day knowing that they're scoring an 'F' on nearly everything they do. Welcome to the innovator's lot.

Admittedly, it would have been a better book had Horowitz been aware of TRIZ (why do I always find myself saying that?). There's a great little story in the book, for example, about a complaint he received from an employee about the level of profanity in the organization. Should he ban profanity or ignore the complaint? That's the gist of the story. From a TRIZ perspective, of course, the answer would have been, 'hey, you've just found a physical contradiction, let's solve it so everyone ends up happy'. As it happens, Horowitz's eventual solution to the profanity question was a pretty good one. His solution gives other CEOs a fish to eat, but it doesn't teach them how to fish.

That, ultimately, I think is the difference between a good book and a great one. Horowitz has certainly found some virgin territory to write about. He's one of the few authors on the planet that can genuinely say he's lived what he writes about. And that alone makes for a great read. What he lacks that TRIZ would have brought to the table is the leap from a handful of case studies to a genuinely repeatable way of looking at the CEOs (and innovator's role). But hey, that's the word from someone who's lived with and tested TRIZ for 25+ years. In that role, I found myself writing down several pages of notes and case-study foundations from reading the book. And there really aren't that many books these days that can legitimately say that. With that in mind, I recommend it to anyone interested in either innovation ('wartime' or 'peacetime' – a nugget-size distinction Horowitz makes) or thinking about dipping their toes in the entrepreneurial ocean. Hopefully the book will do its job and ensure 90+% of readers will *not* take the full plunge into the flying-blind, barely-functional world of visionaries and pioneers.

Wow In Music – Wichita Lineman



Imagine pitching this song idea in 1968: There's this guy who works on telephone poles in the middle of Kansas. He's really devoted to his job. Rain or shine, he's committed to preventing system overloads. It's really lonely work, and he misses his girlfriend. Does this sound like a hit to you?

When Jimmy Webb wrote the first lines of "Wichita Lineman"...

*I am a lineman for the county and I drive the main road
Searchin' in the sun for another overload
I hear you singin' in the wire, I can hear you through the whine
And the Wichita Lineman is still on the line*

... not only did he not think he had a surefire hit, he didn't even think the song was finished. An inauspicious beginning for a song that sold millions of records for Glen Campbell, has been recorded by everyone from Johnny Cash to James Taylor to R.E.M., and appears on several lists of the greatest songs of all time.

In late 1967 Jimmy was just about the hottest songwriter in L.A., based on two consecutive monster hits: The Fifth Dimension's "Up, Up And Away," and Glen Campbell's "By The Time I Get To Phoenix." "Phoenix" had been on the charts for six months, although Jimmy and Glen still hadn't met.

"For all we know, 'Phoenix' could have been a one-off thing," Jimmy told interviewers at the time. "Glen might never have recorded another song of mine." They finally met at a jingle session. Soon after that date, the phone rang. It was Glen, calling from the studio. "He said, 'Can you write me a song about a town?'" Jimmy recalls. "And I said, 'Well, I don't know ... let me work on it.' And he said, 'Well, just something geographical.'

"He and (producer) Al DeLory were obviously looking for a follow-up to 'Phoenix.' And I remember writing 'Wichita Lineman' that afternoon. That was a song I absolutely wrote for Glen." It was the first time he had written a song expressly for another artist. But had he conceived any part of "Wichita" before that call? "Not really," Jimmy says. "I mean I had a lot of 'prairie gothic' images in my head. And I was writing about the common man, the blue-collar hero who gets caught up in the tides of war, as in 'Galveston,' or the guy who's driving back to Oklahoma because he can't afford a plane ticket

(‘Phoenix’). So, it was a character that I worked with in my head. And I had seen a lot of panoramas of highways and guys up on telephone wires ... I didn’t want to write another song about a town, but something that would be in the ballpark for him.”

So even though it was written specifically for Glen, he still wanted it to be a ‘character’ song? “Well, I didn’t want it to be about a rich guy!” he laughs. “I wanted it to be about an ordinary fellow. Billy Joel came pretty close one time when he said ‘Wichita Lineman’ is ‘a simple song about an ordinary man thinking extraordinary thoughts.’ That got to me; it actually brought tears to my eyes. I had never really told anybody how close to the truth that was.

“What I was really trying to say was, you can see someone working in construction or working in a field, a migrant worker or a truck driver, and you may think you know what’s going on inside him, but you don’t. You can’t assume that just because someone’s in a menial job that they don’t have dreams ... or extraordinary concepts going around in their head, like ‘I need you more than want you; and I want you for all time.’ You can’t assume that a man isn’t a poet. And that’s really what the song is about.”

He wasn’t certain they would go for it. “In fact, I thought they hadn’t gone for it,” he says. “They kept calling me back every couple of hours and asking if it was finished. I really didn’t have the last verse written. And finally I said, ‘Well, I’m gonna send it over, and if you want me to finish it, I’ll finish it.’

“A few weeks later I was talking to Glen, and I said, ‘Well I guess Wichita Lineman didn’t make the cut.’ And Glen said, ‘Oh yeah! We recorded that!’ And I said, ‘Listen, I didn’t really think that song was finished ...’ And he said, ‘Well it is now!’”

In a recent interview, Glen said that he and DeLory filled in what might have been a third verse with a guitar solo, one now considered iconic. He still can recall playing it on a DanElectro six-string bass guitar belonging to legendary L.A. bass player and Wrecking Crew member Carol Kaye. It remains Glen’s favorite of all his songs.

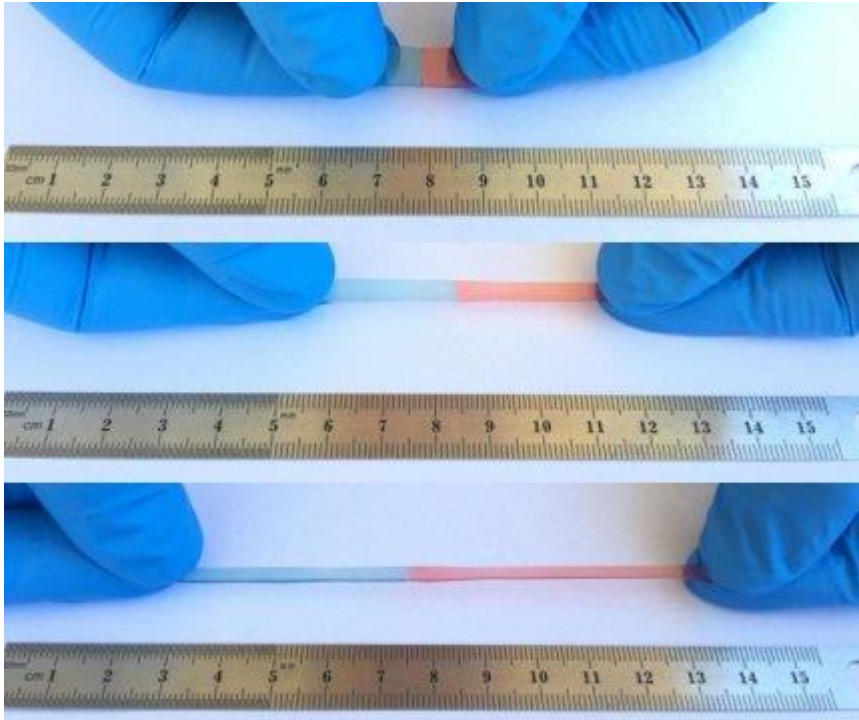
“Wichita Lineman” can serve as ‘Exhibit A’ in any demonstration for songwriters of the principle of (Principle 2) ‘less is more.’ On paper, it’s just two verses, each one composed of two rhymed couplets. The record is a three-minute wonder: Intro. First Verse. Staccato telegraph-like musical device. Second verse. No chorus. Guitar solo. Repeat last two lines of second verse (“and I need you more than want you ...”). Fade. There is no B section, much less a C section.

Why did such an unlikely song become a standard? There are many reasons, but here’s one: the loneliness of that solitary prairie figure is not just present in the lyric, it’s built into the musical structure. Although the song is nominally in the key of F, after the tonic chord is stated in the intro it is never heard again (Principle 2) in its pure form, with the root in the bass. The melody travels through a series of (Principle 17) haunting changes that are considerably more sophisticated than the Top 40 radio norms of that era. The song never does get “home” again to the tonic – not in either verse, nor in the fade-out. This gorgeous musical setting suggests subliminally what the lyric suggests poetically: the lonely journeyman, who remains suspended atop that telephone pole, against that desolate prairie landscape, yearning for home.

Check out an insightful radio documentary about the song here:

<http://www.bbc.co.uk/programmes/b013f96w>

Investments – Self-Healing Polymer



Taking a cue from the Marvel Universe, researchers report that they have developed a self-healing polymeric material with an eye toward electronics and soft robotics that can repair themselves. The material is stretchable and transparent, conducts ions to generate current and could one day help your broken smartphone go back together again.

The researchers presented their work this month at the 253rd National Meeting & Exposition of the American Chemical Society (ACS).

"When I was young, my idol was Wolverine from the X-Men," Chao Wang, Ph.D., says. "He could save the world, but only because he could heal himself. A self-healing material, when carved into two parts, can go back together like nothing has happened, just like our human skin. I've been researching making a self-healing lithium ion battery, so when you drop your cell phone, it could fix itself and last much longer."

The key to self-repair is in the chemical bonding. Two types of bonds exist in materials, Wang explains. There are covalent bonds, which are strong and don't readily reform once broken; and noncovalent bonds, which are weaker and more dynamic. For example, the hydrogen bonds that connect water molecules to one another are non-covalent, breaking and reforming constantly to give rise to the fluid properties of water. "Most self-healing polymers form hydrogen bonds or metal-ligand coordination, but these aren't suitable for ionic conductors," Wang says.

Wang's team at the University of California, Riverside, turned instead to a different type of non-covalent bond called an ion-dipole interaction, a force between charged ions and polar molecules. "Ion-dipole interactions have never been used for designing a self-healing polymer, but it turns out that they're particularly suitable for ionic conductors," Wang says. The key design idea in the development of the material was to use a polar, stretchable polymer, poly(vinylidene fluoride-co-hexafluoropropylene), plus a mobile, ionic

salt. The polymer chains are linked to each other by ion-dipole interactions between the polar groups in the polymer and the ionic salt.

The resulting material could stretch up to 50 times its usual size. After being torn in two, the material automatically stitched itself back together completely within one day.

As a test, the researchers generated an "artificial muscle" by placing a non-conductive membrane between two layers of the ionic conductor. The new material responded to electrical signals, bringing motion to these artificial muscles, so named because biological muscles similarly move in response to electrical signals (though Wang's materials are not intended for medical applications).

For the next step, the researchers are working on altering the polymer to improve the material's properties. For example, they are testing the material in harsh conditions, such as high humidity. "Previous self-healing polymers haven't worked well in high humidity, Wang says. "Water gets in there and messes things up. It can change the mechanical properties. We are currently tweaking the covalent bonds within the polymer itself to get these materials ready for real-world applications."

Only one patent application so far (US20160049217), but if it gets granted in its current form – Claim 1 is a classic piece of inventor chutzpah! – it could well be worth a lot of money.

Generational Cycles – GenY & Gender Differences



Generation Y, Millennials, generally defined as people born between 1982 and 2001, were supposed to be the generation that forged what has been called “a new national consensus” in favor of gender equality. Indeed, in February the prominent Columbia professor Jeffrey Sachs labeled the 2016 election, where an extremely qualified female candidate lost to a man with a history of disrespecting women, “a blip” on the road to the egalitarian society that will be achieved once millennial voters outnumber their conservative elders.

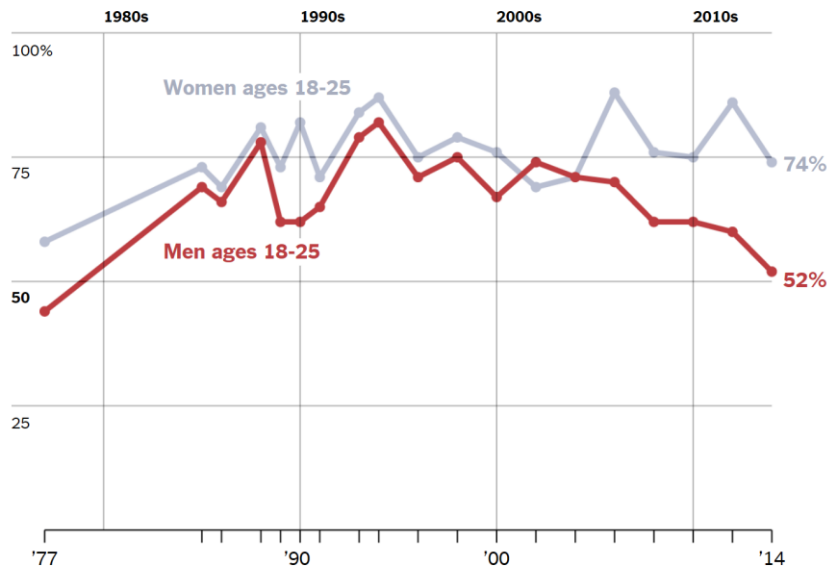
But the GenY cohort lumps together everybody from age 17 to 34, a group varied by race, ethnicity, religion, income, education and life experience. Don't think for a second they are united. As a set of reports released Friday by the Council on Contemporary Families reveals, fewer of the youngest millennials, those aged 18 to 25, support egalitarian family arrangements than did the same age group 20 years earlier.

Using a survey that has monitored the attitudes of high school seniors for nearly 40 years, the sociologists Joanna Pepin and David Cotter find that the proportion of young people holding egalitarian views about gender relationships rose steadily from 1977 to the mid-1990s but has fallen since. In 1994, only 42 percent of high school seniors agreed that the best family was one where the man was the main income earner and the woman took care of the home. But in 2014, 58 percent of seniors said they preferred that arrangement. In 1994, fewer than 30 percent of high school seniors thought “the husband should make all the important decisions in the family.” By 2014, nearly 40 percent subscribed to that premise.

A different survey found a similar trend, in this case concentrated mainly among men. In 1994, 83 percent of young men rejected the superiority of the male-breadwinner family. By 2014 that had fallen to 55 percent. Women's disagreement fell far less, from 85 percent in 1994 to 72 percent in 2014. Since 1994, young women's confidence that employed women are just as good mothers as stay-at-home moms has continued to inch up, but young men's has fallen. In fact, by 2014, men aged 18 to 25 were more traditional than their elders.

Young People, Old-School Views

Percentage of young Americans who disagreed with this statement: "It is much better for everyone involved if the man is the achiever outside the home and the woman takes care of the home and family."



Source: General Social Survey

Such slippage in support for gender equality may have been a factor in the 2016 election, even though voters 18 to 30 were more likely than any other age group to vote for Hillary Clinton. An analysis of exit polls by Kei Kawashima-Ginsberg of Tufts University reveals that millennial support for a white woman in 2016 was 10 percentage points lower than their vote for a black man in 2008. Furthermore, the gender gap among young people was larger than in previous elections. While 63 percent of young women voted for Mrs. Clinton, only 47 percent of young men did so.

The political scientist Dan Cassino suggests that the increased support for male leadership in home life among 18- to 25-year-olds may reflect an attempt to compensate for men's loss of dominance in the work world. Youths surveyed in 2014 grew up in the shadow of the financial crisis, which accelerated the longstanding erosion of men's earning power. During the 2016 primaries, when Professor Cassino asked voters questions designed to remind them that many women now earn more than men, men became less likely to support Mrs. Clinton. Perhaps a segment of youth is reacting to financial setbacks suffered by their fathers. Indeed, a 2015 poll commissioned by MTV found that 27 percent of males aged 14 to 24 felt women's gains had come at the expense of men.

It's not just the youngest millennials who seem resistant to continuing the gender revolution. Overall, Americans aged 18 to 34 are less comfortable than their elders with the idea of women holding roles historically held by men. And millennial men are significantly more likely than Gen X or baby boomer men to say that society has already made all the changes needed to create equality in the workplace.

Are we facing a stall or even a turnaround in the movement toward gender equality? That's a possibility, especially if we continue to pin our hopes on an evolutionary process of generational liberalization. But there is considerable evidence that the decline in support for "nontraditional" domestic arrangements stems from young people witnessing the difficulties experienced by parents in two-earner families. A recent study of 22 European and English-speaking countries found that American parents report the highest levels of

unhappiness compared with non-parents, a difference the researchers found is “entirely explained” by the absence of policies supporting work-family balance.

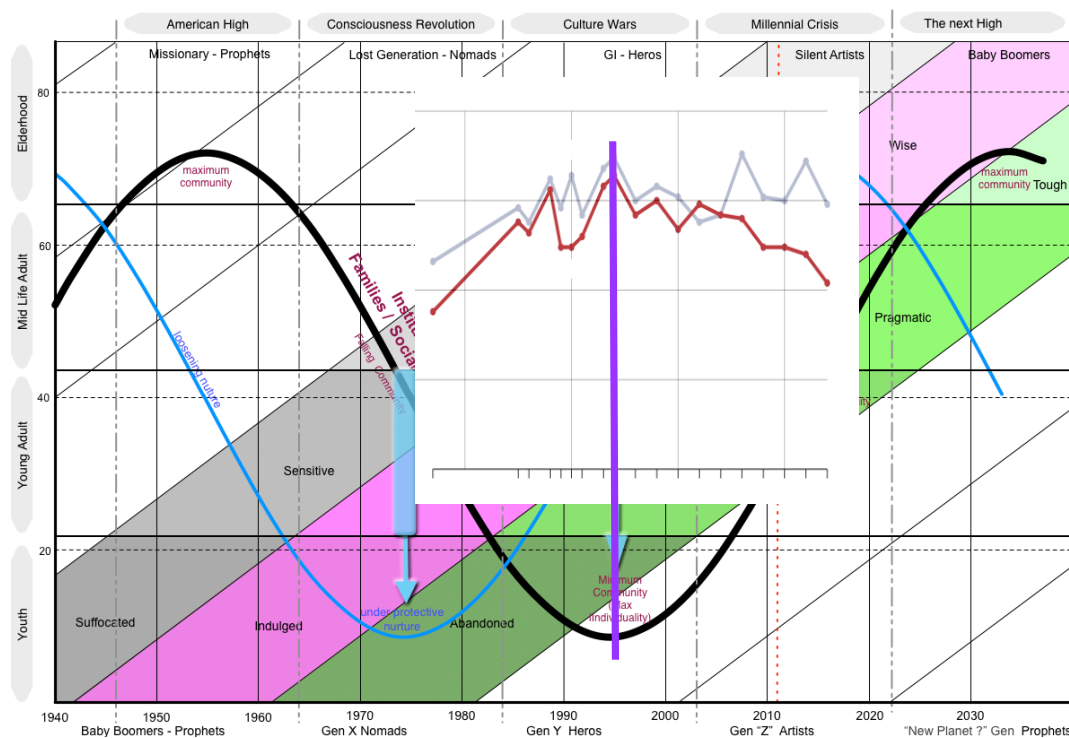
No wonder some young people think that more traditional family arrangements might make life less stressful. Tellingly, support for gender equality has continued to rise among all age groups in Europe, where substantial public investments in affordable, high-quality child care and paid leave for fathers and mothers are the norm.

The availability of such options increasingly outweighs cultural support for traditional gender arrangements. When young Americans are asked about their family aspirations, large majorities choose equally shared breadwinning and child-rearing if the option of family-friendly work policies is mentioned.

Furthermore, the financial advantages of dual-earner couples over male-breadwinner families have increased significantly in recent years, and an unequal division of housework has become progressively more damaging to relationships. The minority of couples who do manage to divide chores and child-rearing equally report higher levels of marital and sexual satisfaction, and more frequent sex, than do men and women in homes where the wife does most of the housework and child care.

But most young parents will not be able to sustain egalitarian values and practices without better work-family policies. Those should be possible to attain, given that more than 80 percent of Americans — and strong majorities of both sexes — support paid leave for mothers, with 70 percent favoring it for fathers, too. Among 18- to 29-year-olds, that rises to 91 percent favoring paid leave for mothers and 82 percent favoring it for fathers.

If, but only if, we can win such reforms, we may find that rather than growing out of youthful egalitarian idealism, as the popular view of aging might lead us to expect, more young Americans may *grow into* it, creating the most egalitarian family arrangements yet.



In terms of the Strauss & Howe generation cycle model is concerned, there is an extraordinary correlation between the women-at-home finding of this research and the increasing-decreasing community (black sine curve) oscillation.

Biology – Bramble

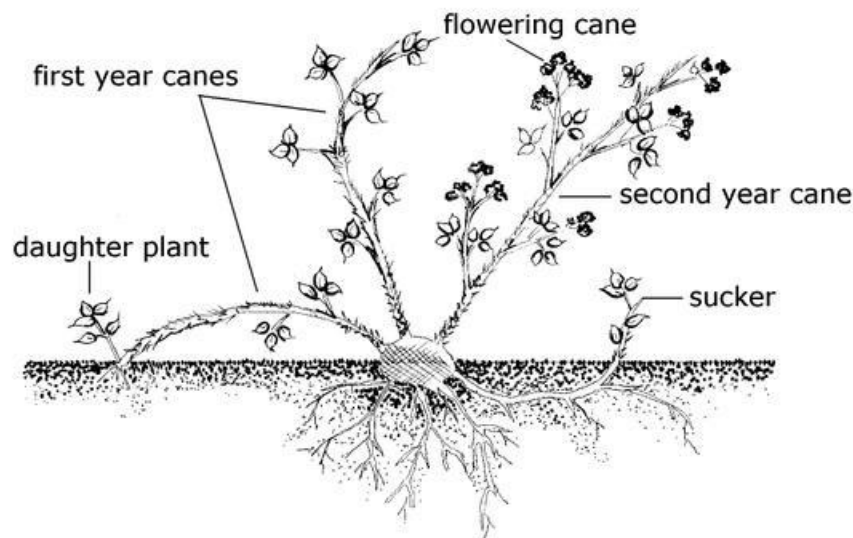


I've inadvertently become something of an expert on the destruction of brambles in the last month or so. We'd managed to let them take over a big chunk of our garden and it turned out that it was my job to do something about it. After a couple of hours, my arms looked like I'd been self-harming. Brambles don't like being removed. The thorns are bad enough – there's probably a separate case study to be written about how even the most innocuous looking thorn manages to pierce thick leather gardening gloves – but the real problem is that you can't just look for the main stem and roots and solve the problem there.

What's much more likely to happen is that you locate a likely looking stem, start pulling at it to work out where it's attached to the ground, only to find that it appears to be attached at both ends. Something like this:



What the cunning little devil has done is made itself a second root. The growing stem has recognized somewhere along its growth trajectory that, hey, I seem to be close to soil again, why don't I stop being a stem and turn into more root. Something like this:



It's a pretty good strategy for making life more difficult for gardeners to remove. I'm not sure that was the evolutionary driver though. It was probably something more like a desire to spread as far and wide as possible, but, the further you get from your roots, the further the root system has to pump the water required to support life at the most distant parts of the plant. Here's what the two conflicts – the human one and the distance one – look like when mapped on to the Contradiction Matrix:

IMPROVING PARAMETERS YOU HAVE
SELECTED:

Productivity (44)

WORSENING PARAMETERS YOU HAVE
SELECTED:

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

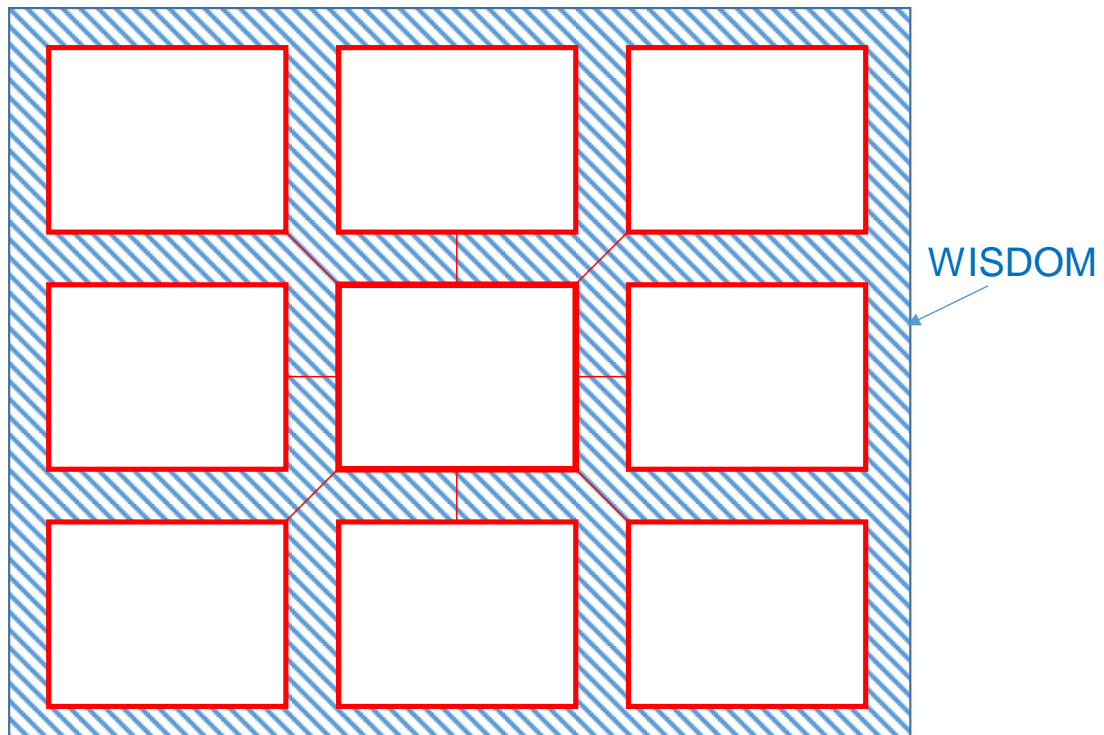
SUGGESTED INVENTIVE PRINCIPLES:

**1, 14, 10, 7, 39, 17, 19, 18, 3, 31, 24, 35,
30**

Top of the list of suggestions is precisely what throwing out 'daughter plants' and 'suckers' is all about – Segmentation. A very simple strategy – once evolution has worked out how to do it! – but, given the fact that the scars on my arms are still present a fortnight later, probably quite an effective one.

Short Thort

"It's not what you look at that matters, it's what you see."
Henry David Thoreau



News

IMechE TRIZ Webinar

Darrell will be giving a free 1 hour '21st Century TRIZ: Breakthrough Problem-Solving Without The Learning Curve' webinar through the IMechE on 29 September at 12.30pm UK time. Sign up here: <http://www.imeche.org/training-qualifications/training-details/21st-century-triz-breakthrough-problem-solving-without-the-learning-curve>

Dubai

Darrell will also be keynoting at the Dubai Quality Group's upcoming Ideas Arabia 12th International Conference & Competition 2017. The conference will be held from 10-11 May 2017 at Four Seasons Dubai.

Buckingham SI Accreditation Short Course

The online booking form for the SI Accreditation Short Course is now live at the University's website. The workshop dates are confirmed as 26-30 June...
<https://www.buckingham.ac.uk/event/structured-innovation-methods-and-tools/>

IMechE Webinar

...the booking form for our 21st Century TRIZ webinar is also now live...
<http://www.imeche.org/training-qualifications/training-details/21st-century-triz-breakthrough-problem-solving-without-the-learning-curve>

New Projects

This month's new projects from around the Network:

- O&G – ICMM Assessment
- O&G – SI Certification Workshops
- Automotive – Design-Make Project
- Consulting – Design-Thinking+TRIZ Workshops
- Energy – TrenDNA Project
- Electronics – Innovation Mentoring Programme
- Government – IP Strategy Project
- Logistics – PanSensic Project
- Financial Services – PanSensic/TrenDNA Project
- Healthcare – SI Workshops
- FMCG – Design Project