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Systematic Innovation

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TRIZ and 6 Sigma – Compatibilities and Contradictions

The growing links between TRIZ and 6Sigma offer users some very interesting synergies. We are currently doing a lot of research in this area. The main start point for the research was to try and clearly draw out the distinctions between the different hierarchical levels on which 6Sigma operates. This is something we also did very early on when we were designing the structure of the Hands-On Systematic Innovation book. Readers familiar with that book will be aware of the pyramid picture that we use to distinguish the tool, method and philosophy of TRIZ:

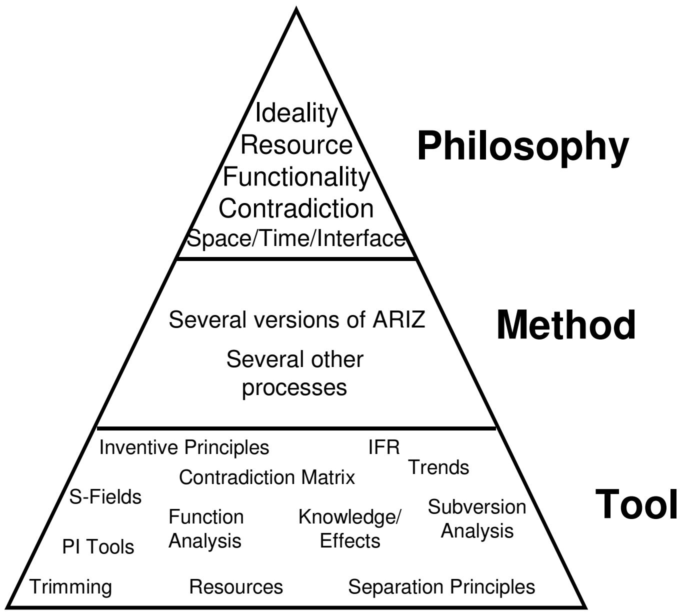


Figure 1: TRIZ Operating Hierarchy

We set about generating an equivalent picture for 6Sigma based on a survey of key texts on the subject coupled with our extensive experience working with the teachings of W.E Deming and assorted Deming-related organisations.

In very simple terms, 6Sigma is in large part a re-invention/re-labelling of Total Quality Management and statistical process control techniques. An increased focus on customer has been added to these foundations, and a variety of tools with outside foundations have been brought under the 6Sigma umbrella.

The emphasis on tangible benefit found in 6Sigma has resulted in a tendency to call a particular tool a '6Sigma tool' even though the roots of that tool may have grown completely independent of 6Sigma. To an extent we can see the same thing happening with TRIZ – the 6Sigma community increasingly viewing TRIZ as a tool that can form a part of the overall 6Sigma structure.

Figure 2 illustrates our perspective on how all of the various elements of 6Sigma fit together into an overall operating hierarchy. We have deliberately maintained the structure used when we were constructing the TRIZ hierarchy in order to be able to draw direct comparisons between the two.

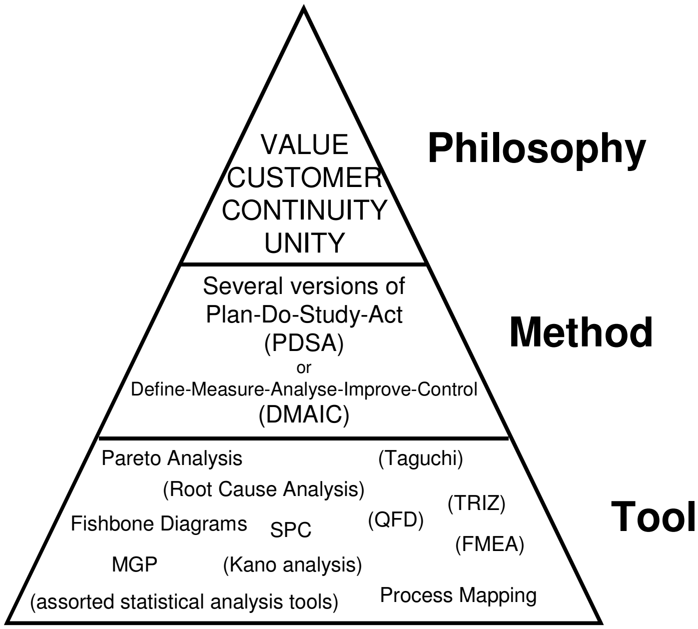


Figure 2: 6Sigma Operating Hierarchy

The bracketed contents of the 'tool' level of the hierarchy show the main tools that have been 'imported' into 6Sigma. Beyond SPC and Process Mapping, the 6Sigma toolkit largely in fact consists of imports. This, of course, is not a bad thing, merely a recognition that at a certain level – like TRIZ – the strategy has been to incorporate excellence from whatever source.

Having introduced this hierarchy picture, the main purpose of this article is now to compare and contrast the differences between TRIZ and 6Sigma. We will seek to do this primarily at the philosophical level in order to identify opportunities for enhancement of both systems.

In order to begin this comparison, it is perhaps necessary to expand a little on the main philosophical tenets of 6Sigma:

CUSTOMER: the main underlying philosophy of 6Sigma is the focus on customers and the satisfaction of the needs and desires of those customers, whether they be internal or external to an organisation.

VALUE: Added value is what makes a customer select one product or service over another one. 6Sigma thus places considerable importance on the addition of value, and more specifically, the reduction and elimination of 'non-value added' activities.

CONTINUITY: improvement of systems and processes must be a continuous activity; there is no justification for relaxation of efforts to eliminate waste.

UNITY: a successful 6Sigma initiative needs to involve everyone working within the system. There can be no exceptions to this rule; buy-in is essential.

The equivalent philosophical tenets of TRIZ are somewhat different in their nature and focus. To quickly recap the pillars of TRIZ:-

IDEALITY: all successful innovations evolve in a direction of increasing ideality – more benefits; less cost, less harm. Evolution towards an ideal final result occurs through a series of patterns that are repeated across different industries.
CONTRADICTION: systems evolve in the direction of increasing ideality through the successive emergence and resolution of conflicts and contradictions. Evolution is therefore fundamentally discontinuous in nature. The contradiction-eliminating strategies of others have been mapped and can be used to accelerate the evolution of any system.

FUNCTION: customers primarily buy functions (benefits), therefore producers should focus on the function delivered by the products and services they deliver and not just the product itself. If customers find a better way of achieving a function, they will stop buying your product or service.

RESOURCES: anything in or around a system that is not being used to its maximum potential is a resource. Even the things we might think of as 'bad' or harmful in a system can become useful resources if we are able to change our perspective of them.

SPACE/TIME/INTERFACE: the human brain is subject to an effect known as psychological inertia; it fools itself into looking at situations from one specific angle. When we are looking to improve a system, we need to be able to change our perspective of it. Perspective shifts can involve physical (or virtual) space, temporal issues, or the way in which different elements of a system interface and relate to one another.

With these thoughts in mind, we might now look at how the 6Sigma philosophy might affect how we use TRIZ and vice-versa:

How 6Sigma Philosophy Might Affect Our Use Of TRIZ

1) Successful innovation gives customers more ideality; all of the functions (benefits) they want at ever lower cost and harm. Every customer is different from every other customer and in the ideal world, every individual customer gets exactly what they want.

2) TRIZ has traditionally described evolution happening in discontinuous bursts and suggests that in large part these bursts are driven by market demands. Thus, there are times when an introduced innovation will succeed and other times when it will not. Whether there is an apparent 'market need' or not, the CONTINUITY pillar of 6Sigma suggests that the innovation process should be continuous. The idea of generating an innovation that does not have a market demand appears to make little sense. The parallel phenomena of increasingly rapid global change and the increasing importance of intellectual property (at least at the present time), however, do appear to suggest the validity of a continuous innovation philosophy; even if the market is not ready for an innovation, doesn't mean that a company shouldn't own the rights to it.

3) If you don't get 'buy-in' from EVERYONE, an innovation will fail. Traditional TRIZ thinking pays no attention to buy-in. Lack of buy-in is probably the biggest single killer of TRIZ generated innovations – see for example our previous article on 'if TRIZ is so good, why isn't everyone using it.

How TRIZ Philosophy Might Affect The Use Of 6Sigma

1) Give customers what they want. Although they may not explicitly know it, customers buy functions and attributes. We should therefore focus on the functions we deliver rather than our current specific solution. There is little point in reducing the harm or adding more value to an SLR camera if the whole world has decided that digital cameras deliver fundamentally more powerful functions.
2) In addition to adding value by reducing cost and harm, it is also possible to add value by increasing functionality.

3) It is possible to improve a system up to a certain point, but when a fundamental limit has been reached, it will no longer be possible to improve that system any more. Systems hit fundamental limits. These limits occur when something stops us from making the improvements we wish to make. In other words, a conflict occurs. Further improvement of the system requires the elimination of these conflicts. Thus, the process of continuous improvement will involve occasions when optimisation strategies will no longer work and the system then needs to be changed.

Combined Philosophy

Combining the underlying philosophies of both TRIZ and 6Sigma should therefore give us something like the following:-

a) focus on customer ideality
b) customers primarily buy functions
c) work continuously to improve the ideality of the solutions we deliver
d) make ever more effective use of available resources
e) evolution occurs through disruptive shifts and there will therefore be times when an increase in ideality will require a change of the system
f) disruptive shifts towards more ideal solutions involve the successive emergence and resolution of conflicts and contradictions.
g) someone, somewhere has already solved these contradictions, and we can access their solutions
h) psychological inertia will prevent us from seeing problems and opportunities, and we therefore need to develop strategies for shifting our perspective in order to find them
i) innovations will fail unless everyone buys into the process

Non-Linear Evolution From Linear Trend Directions

'It's the whole thing, stupid'
Corollary to 'keep it simple, stupid'

In this article we examine the process of system evolution through the lens of market trend analysis. Many researchers have spent considerable amounts of time and energy failing to translate well known and well established trend directions – for example the list illustrated in Figure 1 – into useful predictions of how a market will evolve. We examine why predictions using these trends tend to be wrong and highlight a simple strategy for improving our chances of getting the predictions right in the future. Market trend analysis is fundamentally different from the sort of technology or business trending found in the systematic innovation method. Systematic innovation trends will help us to understand WHAT directions technological systems will evolve in. Understanding market trends better will enable us to make better predictions on WHEN evolution jumps will occur.

* Increasing ELECTRONIC COMMUNICATION in private life
* Increasing GAP between have's and have-not's
* Increasing NEED FOR DIFFERENTIATION between business customers
* Increasing INFORMATION VOLUME
* Need for SIMPLICITY
* Global AVAILABILITY OF SERVICES
* Wish for INDIVIDUAL SOLUTIONS (private customers)
* DEMOGRAPHIC TRENDS (aging population, DINKs)
* Wish for SELBSTVERWIRKLICHUNG ('making the most of one's life')
* TIME as a valuable resource

Figure 1: Well Known Customer Trend Directions

The only sure-fire result of a 'simple' market evolution prediction method is that it will be wrong. The method being proposed here – if we use it correctly – is anything but simple. On the other hand, the principles through which the method operates are simple enough to be described relatively quickly. In-line with complexity theory, what we are looking at here is a means of assembling highly complex models from some very simple 'first principles' building blocks. Our purpose here is to merely to describe some of those building blocks and the operating principles through which we can assemble them together to form a robust and reliable model of market evolution dynamics.

All of the trend directions suggested in Figure 1, or that we might find in the continuous stream of MegaTrends books (now there's a predictable trend), or the output of Faith Popcorn, 'work' so long as the linear assumptions they make remain valid. Anyone living in the real world, of course, knows that any linear assumption is bound to go wrong sooner or later because the world is not a linear place. The predictions made from a single trend go wrong because something comes along and says 'hey, you can't keep going down that road anymore'. Something, in other words, comes along and stops the trend from working anymore.

We can very simply see what it is that comes along and stops a trend from working when we begin to consider multiple trends. For the sake of simplicity, let's look at two. Figure 2 illustrates any two of the market trend directions from above or from the known literature. In the figure, the two trends are progressing as a function of time as per prediction. As shown in the figure, their trajectories are slightly different.

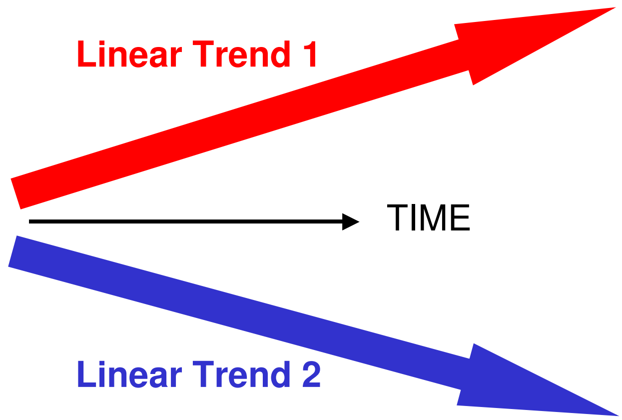


Figure 2: Two Linear Trends In Action

The progression along these two trend paths will continue as per prediction until such times as the differences between them result in some kind of mis-match – further advance along one trend becomes inconsistent with progress along the other. When this happens, there is a conflict. When a conflict occurs, one or both of the trends can no longer progress according to the predictions. Further progress, in fact, can only occur when the conflict has somehow been resolved – Figure 3.

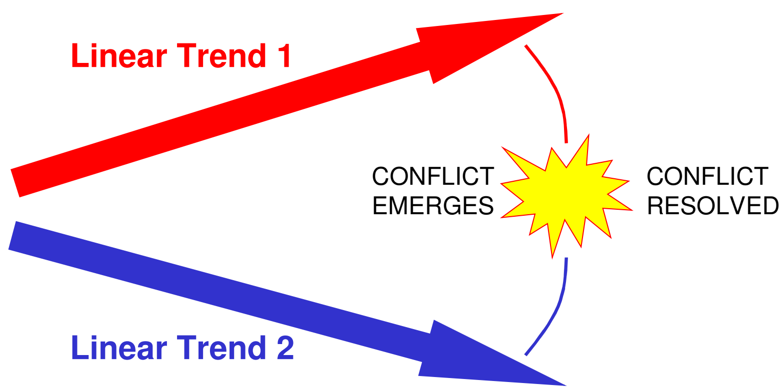


Figure 3: Two Linear Trends In Conflict With One Another

Despite the fact that this model is both generic and simplistic (it fails to recognize, for example, that every individual customer is different and has a different affinity to any given trend pattern), it forms a very solid foundation upon which really effective market evolution models can be constructed.

To again stick with just two trends, we can begin to see how this might be so by examining a modified version of the process described in Reference 1:

1) pick two trends
2) define an ideal final result (IFR) end point to each of the trends

3) extrapolate along both trends in the direction of the two ideal final results and reveal the contradiction that emerges
4) use the Inventive Principles to explore means by which the contradiction can be eliminated.

Let's take an example using a pair of trends from Figure 1.Firstly the trend towards a desire for simple solutions, and secondly the trend towards individualized solutions. Extrapolating to the IFR in the first case might give us something like '*every system does exactly what the user wants without the user ever having to learn any set of instructions'*. Extrapolating to the IFR in the second case might in turn give us something like '*every individual customer gets exactly the product or service they want*'.

Hopefully the contradiction between the two evolution directions suggested by these end points becomes clear very quickly; systems must be simple for any individual user, but must also be different to take account of the fact that every customer is different. Until this simple versus adaptive contradiction is resolved, one or both of the 'increasing simplicity' or 'individual solutions' trends can no longer continue to apply.

The smart forecaster will use this information to start identifying solutions to the conflict before they actually happen (alas with the video recorder, the conflict existed before the solutions started to appear). For example, the increasing emergence of self-learning/adaptive computer systems is an increasingly used technology that admirably helps to solve the conflict. Combine this idea with organizations like Amazon that acquire more and more data about their customers the more they buy and we're well on the way to learning systems that know what an individual customer is like before the product arrives on the doorstep.

In many senses, what we have just done here is similar to what we would have done in a traditional scenario planning exercise. There we would have taken two trends, extrapolated along them to some point in the future and used the resulting market situation as the environment in which our product or service should be designed to fit. The big difference here of course is that in the new method we are extrapolating to stably positioned end points (the two IFRs) and are actively looking to resolve the contradiction that emerges rather than trying to accommodate and trade-off.

Scenario planning sessions rarely extend to looking at more than two or three trends at a time due to the complexity involved. The net result of this is that scenario planning exercise deliver reliable outputs. The implication from the findings of TRIZ on the other hand – that the evolution process acts as the successive emergence and resolution of conflicts and contradiction – provides us with a number of clues that will help us to manage this complexity issue.

For this article we will simply leave readers with the concept of identifying the two most dominant trends in a particular situation and using the conflict emergence and resolution strategy as a means of identifying and eliminating the conflicts before they occur in reality. We suggest this because early identification of emerging conflicts may well be enough to give us an edge in the competitive world we live in. If you think about it, 'competitive edge' is essentially the function and *raison d'etre* of the forecasting process anyway.

Thinking ahead a little bit, what the market trend conflict concept allows us to do when we start looking at the whole thing rather than just one or two select bits is to manage the complex future picture in rather more sophisticated ways. Here's a final thought that you might like to consider before we return to it in a future article: If we take all of the known market evolution trends and arrange them in a Matrix – like the one shown in Figure 4 –

we can look at every pair in turn in order to see whether there might be any recurring patterns of conflict emergence. If there are such patterns – certain contradictions that come up again and again for different pairs of trend directions – then we can probably begin to imagine that the process of designing the future will change considerably.

	Trend 1	Trend 2	Trend3	-	-	etc																		
Trend 1		A																						
Trend 2																								
Trend 3																								
:			B																					
:																					C			
:																								
:													C											
etc																								
																D								
						B																		
												A												
		E																	E					
						G																		

Figure 4: Outline Trend Conflict Mapping Matrix Concept
(letters in boxes represent hypothetical conflicts arising for a given pair of trends)

References

1) Salamatov, Y., 'TRIZ: The Right Solution At The Right Time', Insytec, The Netherlands, 1999 (page 161).

I Think The Coffee's Arrived - Conversations With Other Worlds

We recently had the good fortune to be invited to speak at the recent World Future Society conference in San Francisco and at the PICMET innovation management conference in Portland, Oregon. Both conferences featured a substantial majority of delegates from academic sectors and there were many opportunities for extremely interesting conversations. On the other hand, there were a number of conversations we found ourselves stuck in the middle of when, frankly, we would rather have been somewhere else. Here are our top five 'beam me up, Scottie' conversations.

1) Ideal Final Result 1

Me: (during presentation)…and so I suggest that the concept of evolution towards an ideal final state according to every individual customer is a useful thing to think about when we are examining strategic direction. In simple terms, we might think of the expression 'free, perfect and now', as a useful end-point for evolution of a system.

Academic: (after the presentation) so can you show me any examples of solutions that have successfully evolved to 'free'?

Me: Hmm. It tends to happen most often at the component level in systems – toothbrushes or windscreen wipers – but you could perhaps look at Google or Electrolux's 'functional sales' model and the idea of 'giving' a washing machine to a customer or 'grass that doesn't grow' as an alternative to a lawnmower.

Academic: But they aren't 'free'.

Me: When was the last time you paid Google to use their search engine?

Academic: Someone has to pay.

Me: Absolutely. Just not the customer.

Academic: They pay indirectly. It's not free.

Me: Maybe so. But I think the point I'm trying to make is that smart companies think about their customers and what their customers want. And 'low cost' would often be one of those things – whether that be first cost or life-cycle cost. All the IFR concept does is extrapolate that idea to its limit and then acts as an evolution focus.

Academic: But they're still not 'free'.

Me: I think the coffee's arrived.

2) Ideal Final Result 2

Me: …and so I suggest that the concept of evolution towards an ideal final state according to every individual customer is a useful thing to think about when we are examining

strategic direction. In simple terms, we might think of the expression 'free, perfect and now', as a useful end-point for evolution of a system.
(Different) Academic: Yes, but some people want things to be have a high price.

Me: Yes. That is true.

Academic: So they don't want something that is 'free'.

Me: I agree.

Academic: Like a Rolex watch. Or a Rolls-Royce.

Me: I agree.

Academic: If they were free people wouldn't want them.

Me: Well…

Academic: So how can Ideal Final Result be right?

Me: I think, because it allows us to take into account the fact that every customer has a different idea of what ideal final result means to them. So some people might want a car that has cost them lots of money so that they can show-off to their friends, and others might have a different ideal final result.

Academic: How can it be both things?

Me: It can be many things. Everyone has a different ideal.

Academic: So what's the point?

Me: Well, if we start putting together all the different ideal final results we might start to see some common features. And we might see some contradictions. And if we see them, then we try to come up with solutions that offer both sides of the contradiction.

Academic: So I can have something that is high price and free?

Me: Exactly.

Academic: I wouldn't buy a luxury car if I knew some people got it for free.

Me: So that contradiction hasn't been solved yet. Or maybe it has. I don't suppose everyone pays for the Rolls-Royce they drive.

Academic: I think the coffee's arrived.

3) Loose Network Theory

Me: (during presentation) evolution takes place through non-linear jumps… some of those jumps happen when a technology from one sector jumps to another. There is no mathematical model that can describe the jump of ultrasound from industrial cleaning processes to the washing machine.

Academic (another different one, probably a mathematician, after presentation): Sorry to say, your mathematics statement is wrong. There is a method known as Loose Network Theory.

Me: I know.

Academic: It allows you to describe how quickly information disseminates across a population.

Me: I know. I just don't think it is relevant. Not here. Not when we're talking about specific situations. How would you model the ultrasound dissemination thing?

Academic: I'd map the relations between the industrial application and their immediate network, and then map that network to its immediate network of contacts.

Me: And you think that will give you a useful answer?

Academic: Of course. Six degrees of separation…

Me: So how do you think the emergence of function databases change the maths? The fact that everyone that accesses these databases immediately 'knows' about the existence of other methods of delivering the function? How will that change the model?

Academic: Coffee?

4) Fisher-Pry

Academic: …according to our Fisher-Pry model, we predict that the sales of HD-Rom will overtake the sales of Blu-Ray in 2015.

Me: Fisher-Pry model?

Academic: For plotting s-curves.

Me: I know. I'm just wondering how you thought it might be relevant. Looking that far forward.

Academic: We also used the Volterra-Lotka formula. It gave the same answer.

Me: What about modeling the disruptions? What happens if another technology comes along between now and 2015?

Academic: That wasn't a part of our study.

Me: What about possible shifts in the market? Changing customers?

Academic: The model doesn't need to look at that.

Me: Err. Why?

Academic: Because we put in ‘best’, ‘worst’ and ‘average’ cases into the model.

Me: How do you know what ‘best’ will be?

Academic: (pause) How long ‘til the coffee arrives do you think?

5) Systems On The Edge of Chaos

Academic: ….the forecasts only start going wrong if the system is chaotic. Most times they’re okay.

Me: Most times?

Academic: Mmm.

Me: This is models of markets? With customers? People?

Academic: Of course.

Me: And you don’t think that would make them chaotic?

Academic: The chaos would be bounded.

Me: Me discussing the weekly shopping with my girlfriend is chaotic.

Academic: So?

Me: So we could return home with anything. The shopping list could go out the window if we see something we like that wasn’t on the list. How would you forecast that?

Academic: The chaos would be bounded.

Me: Yes. We could decide to go to a different store possibly. Or decide we’d eat out all week and not bother shopping at all.

Academic: Still bounded.

Me: But not a lot of help for forecasting. Not if I’m trying to project future sales of a product on the shelf.

Academic: Over a population, everything would average out. Your changes in one direction would be compensated by other customers deviating in the other direction.

Me: What about if there’s a newspaper story about someone tampering with the products. How would that average out? If I had to take all the stock off the shelf. Or if a chef on TV used the product in a recipe and ten million viewers decide they’re going to go to the supermarket and try it the next day?

Academic: Then we'd say there was a special cause.

Me: And?

Academic: The model wouldn't be valid anymore. We'd have to build another one.

Me: So any kind of disruption…

Academic: If the system is chaotic….

Me: The coffee's really great over here isn't it?

Patent of the Month

An easy choice this month. Another technology area that we keep fairly close tabs on is solar energy and conversion of solar energy into electrical energy. The work at North Carolina State University on molecular photo-sensitizers has always appeared interesting in this context. Inventors at the University were awarded US Patent 6,603,070 on August 5.

United States Patent	**6,603,070**
Lindsey , et al.	**August 5, 2003**

Convergent synthesis of multiporphyrin light-harvesting rods

Abstract

The present invention provides a convergent method for the synthesis of light harvesting rods. The rods are oligomers of the formula A.sup.1 (A.sup.b+1).sub.b, wherein b is at least 1, A.sup.1 through A.sup.b+1 are covalently coupled rod segments, and each rod segment A.sup.1 through A.sup.1+b comprises a compound of the formula X.sup.1 (X.sup.m+1).sub.m wherein m is at least 1 and X.sup.1 through X.sup.m+1 are covalently coupled porphyrinic macrocycles. Light harvesting arrays and solar cells containing such light harvesting rods are also described, along with intermediates useful in such methods and rods produced by such methods.

Inventors: **Lindsey; Jonathan S.** (Raleigh, NC); **Loewe; Robert S.** (Morrisville, NC)
Assignee: **North Carolina State University** (Raleigh, NC)

The method used by the inventors is one of those examples in which they have jumped to a completely different route to solving the energy conversion problem than everyone else operating in the field. Previous ‘state of the art’ in that context are the Gratzel cell design strategies that incorporate high levels of porosity into thick colloidal semiconductor films in order to increase light capture rates. Gratzel cells are typically around 10% efficient in converting solar energy.

In addition to poor efficiency, probably the biggest single problem with state of the art solar converters is their high manufacture cost. This is one of the major issues tackled by the new invention. Cost reductions of around 90% relative to the Gratzel cell approach are projected. Such jumps are made possible by avoiding the usual tendency to incremental improvement and jumping to another technology.

The US6,603,070 approach jumps to a completely different design philosophy, and is thus classifiable as a Level 4 invention in TRIZ terms. The description in the invention disclosure is probably unfathomable to anyone working outside the organic chemistry specialism. So here is some text taken from articles written about the NCU work:

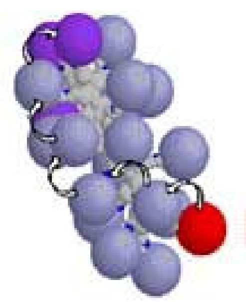
“US chemists have constructed a molecule that mimics the ability of green plants to capture sunlight and use the energy for photosynthesis. Such artificial light-harvesting molecules might one day provide the means for solar-powered chemical processing.

Photosynthesis in plants – the conversion of carbon dioxide and water to energy-rich sugar – takes place in compartments called chloroplasts in the leaves. The light is absorbed by "antenna molecules": pigments that help to capture light across the full visible spectrum. These molecules, packed together in a so-called 'photosystem', help to channel the absorbed energy onto a chlorophyll molecule in the photosynthetic reaction centre at the heart of the photosystem.

When it is excited by this energy, the chlorophyll spits out an electron. The electron is transferred to another molecule, called an acceptor, from where it is relayed between several further molecules until it reaches a second photosystem. Here the electron is used in a chemical reaction that ultimately produces an energy-rich molecule used to power sugar synthesis.

It sounds like a complicated chain of events, but at the root of it all is the capture of sunlight and its use to pump an electron onto an acceptor molecule. From that point on, the photosystem is primed for action. So it is these initial steps that Darius Kuciauskas and colleagues from Arizona State University, along with Jonathan Lindsey and coworkers at North Carolina State University, have set out to mimic.

In the chloroplast, the various components of the photosystem are separate molecules, but they are organized by being embedded in a membrane. Kuciauskas and colleagues decided instead to link their synthetic components together through chemical bonds. This had the attraction that the tethering units could be selected for their ability to act as 'wires'



(or ‘light harvesting rods’) to transmit the absorbed energy of the light.

The antennae of the artificial construct are plate-shaped molecules called porphyrins, which constitute the light-absorbing heart of chlorophyll itself. The researchers linked three of these to a fourth, all via energy-conducting arms. And to the central porphyrin they also attached their artificial reaction centre: a chemically modified porphyrin from which dangled a ball-shaped sixty-carbon-atom molecule called C_{60}. This ball provides the acceptor molecule which will end up holding an electron.

Interested readers might also like to check out:

http://www.triangletechjournal.homestead.com/solarampapril2001.html

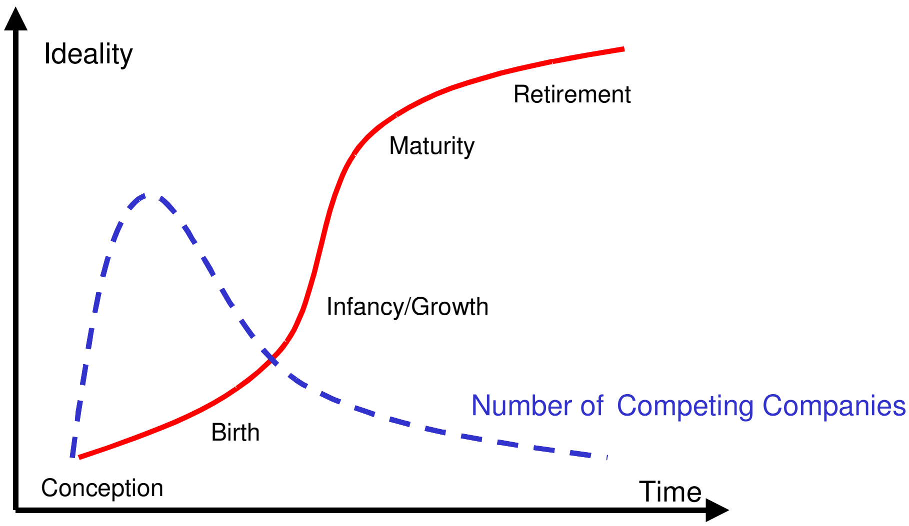
One of the exciting possibilities opened up by the rod approach to the energy conversion problem is one of flexibility. There appears to be considerable potential in the invention for solar cells that are flexible enough to be integrated into the design of tents or clothing.

Best of the Month

No TRIZ-specific recommendations unfortunately this month.

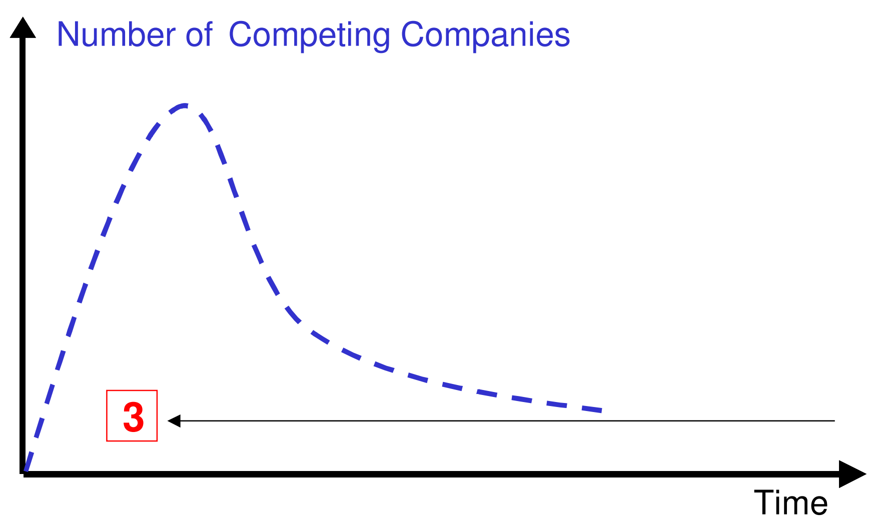
The best output from the other knowledge sources that we track is the book 'The Rule of Three'. The book has been one of the texts under investigation by the TRIZ-for-Business research team.

The basis of the book builds from the characteristic reported by James Utterback in the seminal text 'Mastering The Dynamics of Innovation' relating to the number of players in a given industry over its lifespan. The characteristic – one we often use on courses and in strategic trend sessions – is illustrated in the Figure below.



The graph highlights a generically applicable trend in which the number of companies found in an industry first increases rapidly (as more and more decide that there is money to be made by entering the market), and then decreases as the market matures and 'natural selection' has sifted the strong companies from the weak.

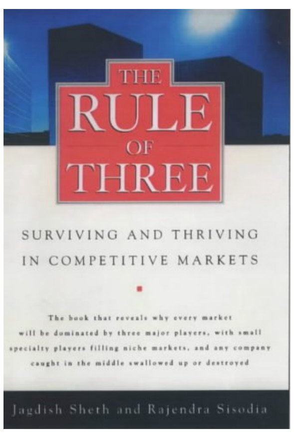
The Rule of Three book (see cover picture below) was actually published in 2002 by the Free Press. It provides compelling evidence that the number of competing companies in an industry sector always tends towards **three** major players as that industry matures.



Over a hundred case study examples of the ‘converge on three’ rule in action are presented, and reasons why the rule works are suggested. The book details a number of sub-rules (for example, although the number of major players will always tend to three, there is no limit on the number of niche-specialists that are able to survive and thrive in a given sector). All in all, the book provides some very useful guidelines for companies. The guidelines depend on whether a company is Number 1, 2 or 3 (each should adopt different strategies), a niche specialist, or somewhere inbetween – a place the book describes as ‘the ditch’ and ‘the waiting room for the bankruptcy court’. It also contains a very useful chapter on disruptive innovations, pointing out the presence of four possible sources of a disruption:-

- Technical (e.g. digital cameras)
- Market shifts (e.g. demographic or cultural shifts)
- Regulation shifts (e.g. government legislation)
- Investment shifts (i.e. use of money to deliberately provoke a disruption)

The latter two are of particular interest since they fall outside the scope of traditional TRIZ/QFD type evolution analyses. Any serious strategy definition session, in other words, needs to at least consider all four possibilities.

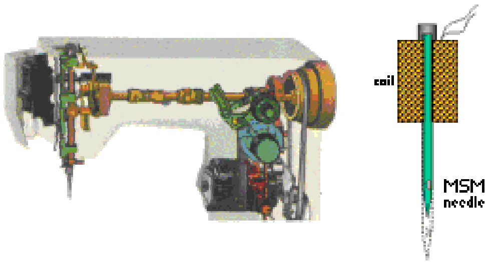


Investments – Magnetic Shape Memory Effect

Magnetic Shape Memory (MSM) effect is a new invention in actuator materials field, allowing even 50 times greater strains than in previous magnetically controlled materials (magnetostrictive materials). In MSM materials the magnetic field moves microscopic parts of the material (so called twins) that leads to a net shape change of the material. The mechanism enables also more complicated shape changes than conventional linear strain, such as bending and shear. Strains can be even 10 % (depending on the material). Shape change times are typically measured in milliseconds, and durability can be measured in hundreds of millions of cycles without deterioration. Finnish company, AdaptaMat develops and utilizes MSM materials. AdaptaMat's commercial MSM materials produce typically 3.5 to 6 % reversible strain at 0 to 2 MPa stress in actuator use.

Currently the company produces and sells MSM material pieces in rectangular or square shapes. Minimum dimension is 0.1 mm and maximum 40 mm. For larger shapes laminated structure can be used. Upon request, other shapes can be manufactured. They also produce MSM actuators for research use and can provide our expertise to selected customers in R&D projects, building the MSM material into prototype demonstration devices.

MSM materials' field of application seems to be very wide, ranging from automotive applications to home electronics. Complicated mechanical structures can be simplified by using MSM materials. Consider a sewing machine: traditional sewing machine has a rotating electric motor and a large number of parts in a rather complicated mechanical transmission system, although the desired motion of the needle is up and down. A sewing machine based on MSM technology could consist of an electromagnet (coil) and a needle made of MSM-material.



Magnetically controlled shape memory materials (MSM) replace machines

AdaptaMat has patents issued and pending to MSM mechanism and applications in several countries. In addition to developing MSM materials ourselves, we are also sponsoring and taking part to research projects in, e.g., Helsinki University of Technology (Espoo, Finland) and MIT (Boston, MA, USA). MSM materials can provide new solutions to many future products where electricity or magnetic field is used to create motion or force. Find out more at: http://www.adaptamat.com/

TRIZ And Biology – Delayed Fertilization in Bats

The life-cycle of the bat is subject to the vagaries of the local climate in which it lives. Early or late arrival of Spring, for example, can have a significant effect on the availability of food, the successful completion of pregnancy and the subsequent chances of survival of new-born offspring. In order to maximize the chances for a successful pregnancy and birth, therefore, the female bat has a contradiction to solve. She needs the flexibility to begin gestation according to weather patterns that may change considerably from year to year. At the same time, there is no guarantee that a male bat will be around to fulfill its function when the time is right.

Bats solve the contradiction using a process of delayed fertilization. In simple terms what happens is that the male and female mate during the autumn or winter, and the female stores the donated sperm until such times as she believes the conditions are favourable to begin pregnancy. The female bat has thus evolved in such a way that sperm can be stored (and according to some research, actually be nourished) within the oviduct for several months before the appropriate egg is released from the ovary.

This is a classic example of Principle 10A in action ('introduce a useful action into an object or system (either fully or partially) before it is needed').

Further evidence (Reference 1) suggests that the continuing uncertainties in weather during gestation can also cause problems with the likelihood of survival of the offspring. By introducing a feedback loop (Principle 24!) between temperature and availability of food and gestation period, the female bat has evolved a capability to extend normal gestation (typically 40-70 days depending on the species) by 20% or more. This kind of retarded pregnancy is an example of Principle 15 ('allow a system or object to change to achieve optimal operation under different conditions').

Reference

1) Altringham, J., 'British Bats', The New Naturalist Library, Harper Collins, 2003.

SYSTEMATIC INNOVATION

Jonathan Hey

Jonathan Hey and the Blue Hand of Berkeley

And so this month we say a fond ‘a bientot’ to Jonathan Hey. Jono joined us directly from the University of Bath last year and has made a tremendous impact on the way we do things in his year with us. He is now on his way to do a PhD at Berkeley in California. We wish him every success in his endeavours and hope that he finds the time to continue some of the great work he has started transforming TRIZ into a methodology for the 21st Century. Jono is about twice as smart as everyone else in CREAX put together; we will miss you, friend.