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Systematic Innovation

e-zine

Issue 2, March 2002

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.

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

My Dream Suit
(I Don't Know What I Want, But I Will When I See It)

Introduction

We were invited to present a paper on TRIZ at the world's first conference on Mass-Customization in Hong Kong during September (1). We thought this might have been because someone involved in Mass-Customization – the idea of producing goods customized to an individual user at the same cost as mass-produced equivalent – had recognized that it was about solving a contradiction. As it turned out, we were wrong. The state of the art in mass-customization seems to be the same old trade-off thinking. Trade-offs in which organizations attempt to find some fictitious optimum compromise between mass OR customization. Often it seems using some fairly elaborate calculation procedures. Oh dear.

The dominance of this kind of trade-off thinking was surprising, but not nearly so much as the lack of mention of B Joseph Pine's name. For those that haven't heard us banging on about it, Joe Pine is the author of the classic mass-customization text (2) – which, as it happens, is a book full of examples of companies who have successfully broken out of the traditional mass or customization trade-off thinking.

In our terms, the basic idea of mass-customization is that illustrated in Figure 1. The basic idea of us analyzing and distilling the contradiction breaking strategies in Pine's book and elsewhere is to provide easy access to those strategies for anyone trying to achieve mass-customization in whatever area of interest – be it cream-cakes, sports cars, web-sites or bank accounts.

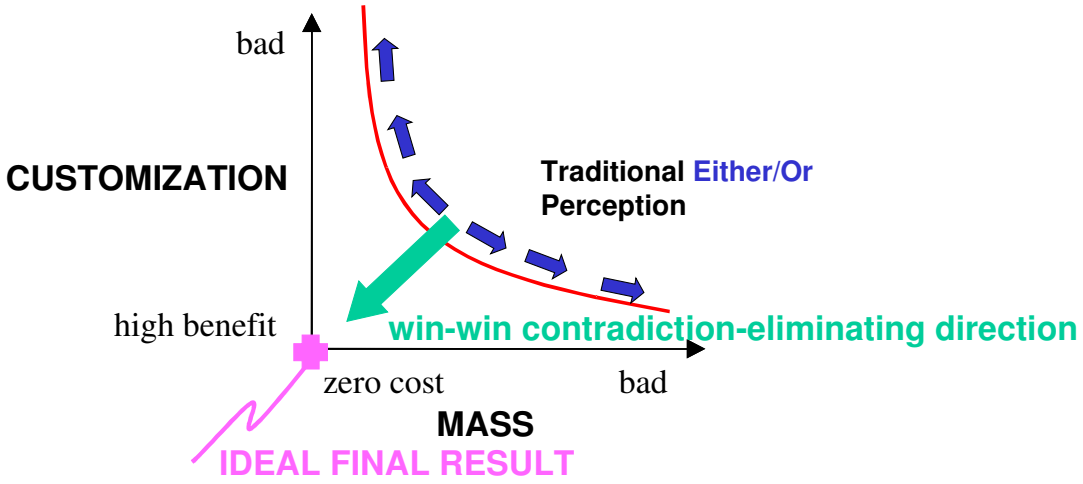

Figure 1: The Essential Contradiction-Breaking Idea In Mass-Customization

Anyway, if we were surprised by the lack of mention of Joe Pine and his first book on mass-customization, it was nothing compared to the shock that his follow-up book, 'The Experience Economy' (3), received so little comment that we began to doubt that we'd ever set eyes on a copy.

The theme of the Experience Economy book is that an underlying trend of market development is a progression from commodity to product to service to experience economies (Figure 2). The basic message in the trend is that customers are increasingly likely to shift to the right along the trend, and so if an organization stands still, it is actually going backwards. The book is again full of examples of organizations recognizing and acting upon the trend – McDonalds, for example, is not in the beef (commodity) business; nor is it in the beef burger (product) business. When it was set up, McDonalds offered customers a service – fast, consistent nourishment (oh well, two out of three isn't bad!). These days, they have recognized that with lots of competitors offering similar services, there is a strong danger of drifting towards commoditization unless they do something about it. The 'something' they have done is shifting towards offering customers (primarily pester-power kids) an experience involving toys, hats, entertainment and singing staff. The fast, consistent 'nourishment' is now almost incidental to the offering.

Figure 2: Experience Economy Evolution Trend

(The book, incidentally also briefly mentions a fifth – and final – evolutionary shift towards a 'transformation' economy – also shown in Figure 2. A gym that offers to ensure that I achieve my stated goal of ending up looking like Arnold Schwarzenager is an example of a 'transformation' product in action. How McDonalds might interpret this is a thought perhaps too frightening to contemplate at this point in time. You might like to send your ideas on a postcard to Ronald!)

The Point

The point of this article is that *if* the mass-customization 'community' is still stuck in trade-off thinking patterns, it has practically no chance of grasping the concept of 'experience' or 'transformation'. We believe that the proper contradiction-breaking interpretation of mass-customization offers a *simultaneous* right-step in the direction of offering customers an experience that your competitors will struggle to come even close to matching.

My Dream Suit

Imagine that I want to buy a suit. These days I basically have two choices. Choice one is that I go to a chain store and accept that I will have to make a compromise and buy a suit that is either slightly too loose at the waist, or slightly too tight around the chest. Maybe I get lucky, and find a store that allows me to buy the jacket separate from the trousers. That way my compromise is reduced to a jacket that is slightly too tight, but the arm length is right, or a jacket with the right chest measurement featuring sleeves that are slightly too long.

Choice two is that I go to a bespoke tailor and get a suit that fits exactly my dimensions, but at a price probably 50 to 300% higher than I would have paid in the chain store.

Some trade-off.

We had two experiences of mass-customization on the way to the Hong Kong conference. The first involved the Sabena airlines decision to deliver the luggage of 399 of the 400 people on board the plane to Hong Kong, and deliver ours to Bristol. This was a not so good example of mass-customization. Now being in downtown Hong Kong at 9.30 on a Sunday night wearing only possessions that were highly unsuitable for presenting at a conference attended by important people from around the world, my second mass-customization experience was rather better, ending – in the space of less than half an hour – in the delivery of a pair of trousers fitting my precise dimensions, thanks to a back-of the-shop tailor. Total price? Around half the price of a paperback copy of Mass Customization. Not that the shop appeared to need one.

The trousers we bought are fine. For the money, they are positively excellent. They are not, however, anything that could be considered part of what might call a 'dream suit'. A dream suit would be the one that made us feel like a million dollars, or the one that had just the right colour, or, anyway, had that certain *je ne sais crois* that meant we 'just had to have it'. Probably irrespective of the price. A dream suit would possess a certain magic, or (to make it sound more scientific) x-factor. A dream suit would be the product of an experience offering shop.

Solve the contradiction – big and small, red and blue and if I do it right, not only do I achieve mass-customization, but I also offer the opportunity for a real user experience. Pants that change colour. Pants that recognize when I've eaten too much and re-shape themselves to suit my (hopefully temporarily) revised figure.

The idea that it might be possible to reliably make and offer everyone that comes into a shop their own personal 'dream suit' possibly appears to be a hopeless ambition. How is it possible to tap into the dreams of someone you've never met before? Someone who just happens to walk into your shop out of the blue. It is our suggestion that one way of at least beginning to do precisely that would be to look at the problem from the perspective of ideality and 'self' and solving contradictions.

Take colour. Everyone has their own favourite colour or combination of colours. Cloth manufacturers currently make a guess at what those colours might be, basically hoping that they are good enough at it that enough of us will find a colour close enough to our ideal that we are prepared to make the compromise and buy it. Statistics suggest that currently an awful lot of cloth gets discarded or sold at a massive discount – probably 70%. The usual strategy used by the manufacturer in response to this (apart from getting better at choosing colours) is to evolve to shorter production runs with a wider range of colours. This is trade-off thinking – more colours OR less set-up times. But what about if the manufacturer was able to produce a fabric that instead of being 'grey or blue' was 'grey and blue'. What if they solved that contradiction? What if the fabric was able to change colour? What if the fabric was able to change colour by itSELF?

Solving this 'grey and blue' (or any other colour come to think about it) colour contradiction, might well give me a big step towards my dream suit. Same thing with size – what if the size could be 'big and small', 'long and short'.

We're not, of course suggesting that all of these contradictions have been solved (although as it happens, the idea of colour-changing clothing – or rather camouflage – is already a practical reality, and the squid, chameleon and certain butterflies also seem to achieve the function pretty effectively), but that there needs to be a fundamental shift in thinking from the conventional trade-off paradigm or we will never make these dream-suit jumps.

The same thing applies in other areas. What about my 'dream razor'? My dream razor would remember that I have a mole on my left cheek that is vulnerable to being cut, and would compensate it's blade height when it sees it approaching so I don't have to think about it anymore. So this particular 'dream razor' would have a bade (or rather a portion of the blade) that was both close and less close. In other words it would solve a blade height contradiction. Imagine that every portion of the blade was able to make this high-or-close decision for itself. Does that sound like something that you would buy? A razor that was able to cut following the exact contours and local features of your face? If the price was right (all part of solving the contradiction, right?), we suggest you probably would. Or you might have another definition of what a dream-razor might be. Maybe a dream razor is actually replaced by a dream-hair-follicle that doesn't grow.

It's not just dream suits and dream razors though. What about dream bank accounts? Dream-cars. Dream-shower gel. Dream chocolate.

Each of these things would be a step in the direction of increased ideality. A good definition of ideality in this context is:-

Ideality = (Perceived) Benefits / (Cost + Harm)

The focus of organizations shifts to different parts of this equation depending on where they are along the experience evolution path. This is discussed in more detail in Reference 5. For now, suffice it to say, in the experience economy, the key focus shifts to the 'perceived' part of the equation. Experiences come from tapping into the things that make a customer perceive that a given product is their dream product.

So, what about achieving the dream-suit? Dream car? Dream bank account? If we tackle these desires from the perspective of 'perceived' benefits and recognize that everyone has a different definitions and perceptions of 'dream', the simple final message is that we fundamentally have to solve and eliminate contradictions.

Another Final Thought (!) : Systematic X-Factor Innovation?

The idea of size-changing, colour changing trousers might not be the only factors that make them my dream suit of course. There are many other factors that might be relevant. I will have one set of factors; someone else will have a completely different set of factors. Ideally, the trousers would self-adapt to every individual set of factors. This is contradiction-solving again, but it is also more. What about the factors that I don't understand? Those things that make me pick one suit over another that anyone else might see as identical. The dream suit. The suit with that certain je ne sais crois. The X-factor suit. What do we do about intangible things like x-factors?

The prevailing Western thinking is that these things are unpredictable, that they are 'fundamentally' unpredictable, and that some designers 'have' the knack of deigning x-

factor products and some don't. Some of those that 'have it' would quite vehemently deny the possibility that designing something to possess that x-factor could be reproduced or written down.

We've suggested that contradiction-solving is one such route to making x-factor innovation a systematic thing. We leave you, however, with the final final thought that another way would be to connect this contradiction-breaking philosophy to the Japanese originated concept of Kansei. Kansei is all about systematizing the x-factor identification process. It is an area we will return to in a future newsletter and, hopefully, as a new tool in CreaTRIZ.

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Predicting Disruptive Technologies Using TRIZ Trends

Introduction

Anyone who follows some of our articles in TRIZ Journal may be familiar with previous discussions on the subject of when the time is ripe for innovations to emerge (1). We frequently use the picture reproduced in Figure 1 to illustrate the frequently observed scenario in which the fundamental limitations of a given solution become overtaken by customer expectations. This situation results in an 'administrative contradiction' – the customer knows what they want, but the system is unable to deliver it. This inadequacy of the system relative to expectation is a vital innovation driver – and represents a significant element of the 'form follows failure' thesis found in Henry Petroski's excellent 'The Evolution of Useful Things' book (2).

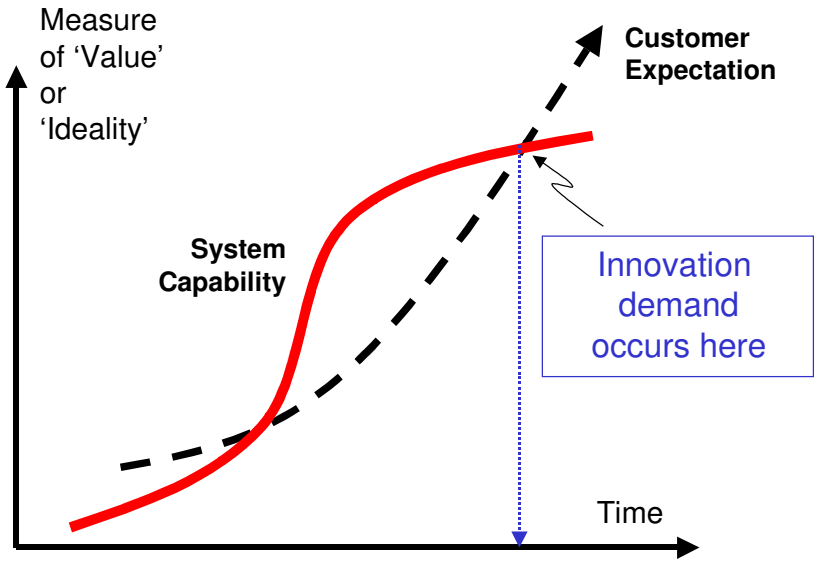

Figure 1: Common Innovation Driver I – Customer Need Exceeds Solution Capability

Our thrust here, however is to look at a different scenario connecting customer expectation to solution capability – that of the case where solution capability exceeds customer expectation (Figure 2). This scenario is the basis for much of the work reported by Clayton Christensen in the essential 'Innovator's Dilemma' book (3).

The central thrust of the Innovator's Dilemma is that traditional 'good' management practice can lead organisations into big trouble when the solutions they offer **exceed** the needs of their customers. In Christensen's words, these situations lead to opportunities for the entry into the market of 'disruptive' technologies. A disruptive technology is essentially one which changes the prevailing business model. Historically speaking, companies

almost inherently fail to thrive (or often even survive) in situations where the market is expecting less of a product than it is capable of delivering.

The aim of this article is to get readers to think about possible disruptive technology opportunities or threats in their business, and, more importantly, to show how the TRIZ technology evolution trends are uniquely placed to help determine what the 'right' disruptive jumps might be.

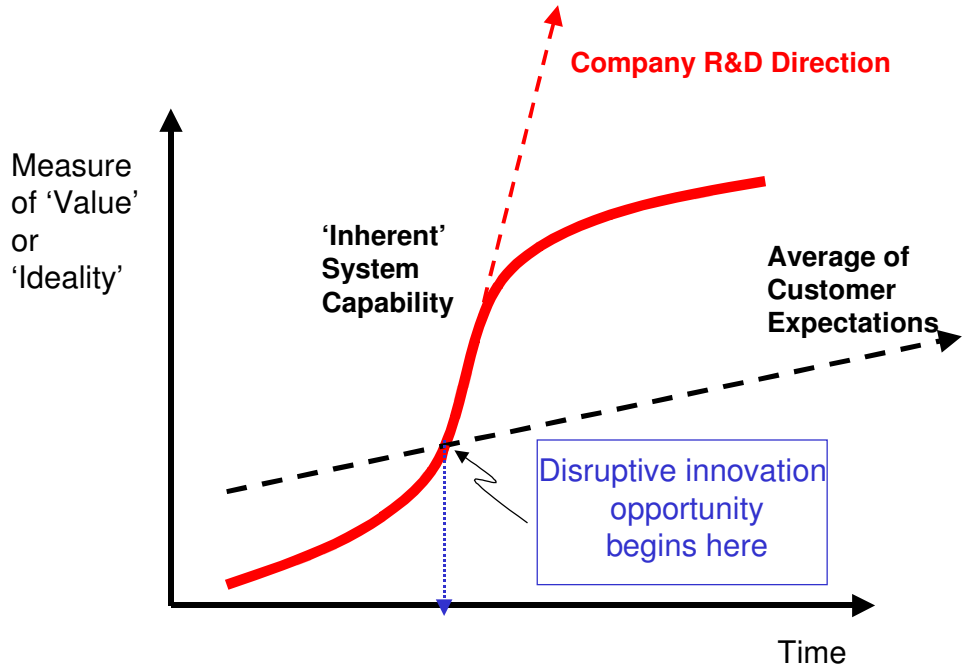

Figure 2: Common Innovation Driver II – Solution Capability Exceeds Customer Need

Case Study – Earth-Moving Equipment

In realising that probably not all of our readers are interested in heavy earth-moving equipment, we hope that everyone can nevertheless extract some useful learning points from this discussion. Those that feel happier thinking about computer disc-drives or accounting software or retail shopping or electric cars might like to explore the details given for those cases given in Christensen's book and see the uncanny parallels to the earth-moving equipment case illustrated here. Meanwhile, when we were kids, our toy of choice was Tonka.

Christensen details the evolution of earth-moving equipment from the original steam-driven mechanical devices of the type illustrated in Figure 3 to the hydraulic machines prevalent in today's earth moving environment. The introduction of hydraulic machines was indisputably 'disruptive' to the mechanical excavator business model.

To over-simplify grossly, the evolution of mechanical excavators was largely driven by the manufacturers (initially correct) belief that their markets were interested in moving ever greater amounts of earth per shovel load, and that this was particularly so for their most profitable customers. Consequently 'sound' management practice meant that the evolution of mechanical excavators was targeted at the earth-moving needs of the most profitable

customers. As time went on, the industry found that it was possible to make bigger and bigger machines capable of moving more and more earth.

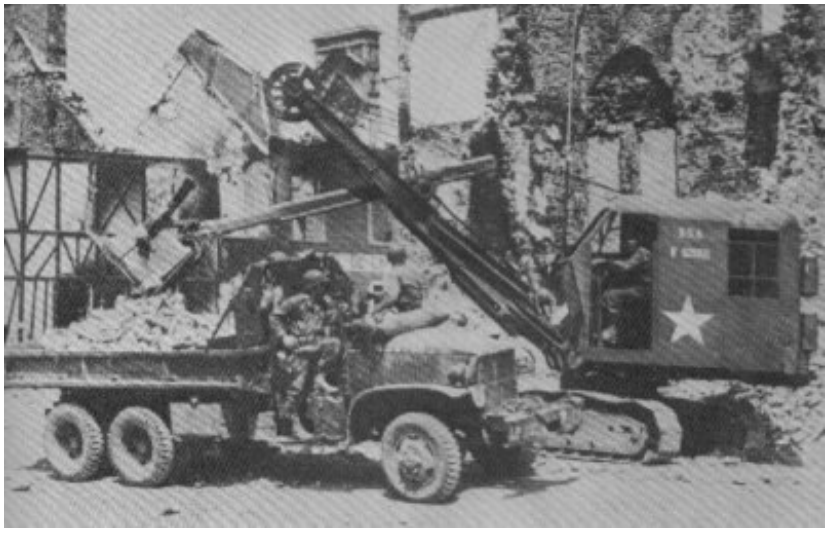

Figure 3: Mechanical Earth-Moving Equipment – Using Cables To Transmit Loads

Further evolution of the earth movers to increase shovel load size, however, although serving customers at the high end of the market began to exceed the requirements of other customers to whom shovel size increase was not worth the increase in cost and other down-sides that came attached to such big machines. These customers were becoming ripe for a disruptive technology insertion.

They got one when JCB introduced the first hydraulically powered earth-movers in 1947. The first hydraulic 'backhoes' were inferior to the cable-actuated mechanical machines in just about every traditional performance measure used by the existing customer base: to these (high profit generating) customers the new machine was not particularly attractive. On the other hand, the new machines did offer a considerable number of new advantages, not least of which was a whole new level of compactness, portability and flexibility of operation, and a marked improvement in safety if something went wrong.

The new hydraulic machines thus carved themselves a whole new market of customers to whom the new advantages outweighed the deficiencies of a smaller load carrying capability. The new machines began to sell in large quantities, but principally to a newly created customer base.

As is so often then the case, the revenues from this new customer base (albeit they were still not sufficient to be of great interest to the established cable-activated machine manufacturers – hence 'good management practice' said to ignore them) funded the development of increasingly capable hydraulic systems. The hydraulic machine evolution entered a phase where it was able to rapidly catch-up with the performance capabilities of the mechanical machines. It did this whilst simultaneously preserving the advantages of compactness, portability, flexibility and safety. In another highly reproducible evolution pattern, the increasing capability of the hydraulic machines was happening at a rate greater than the changing requirements of the customers with the highest earth-moving requirements. Before too long the net value of the evolving hydraulic machines thus met and exceeded both the customer expectation and the fundamental ideality limits of the

mechanical machines – Figure 4. As is so often the case, the disruptive technology eventually won the day – and today the mechanical, cable actuated earth-movers are restricted to very small niche applications.

The connection with TRIZ here is that it helps predict the evolution of systems, and in this case, specifically suggests the evolution from mechanical to fluid-based systems.

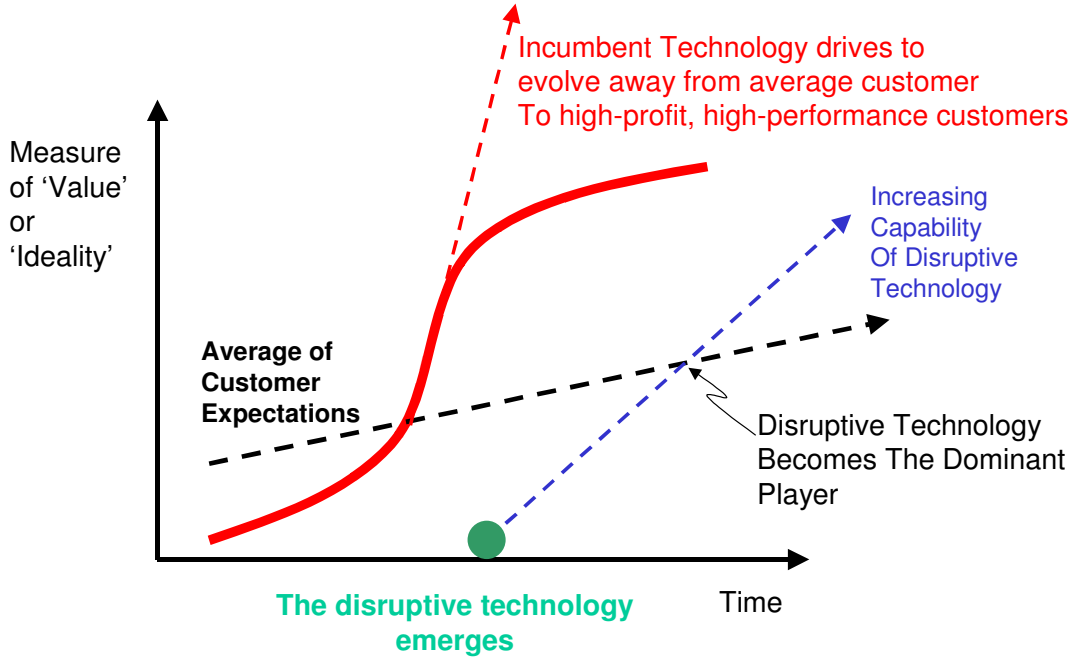

Figure 4: How The Disruptive Technology Overcomes The Established Technology

The trend (Figure 5), in other words, could have been used to predict the eventual dominance of the hydraulic systems over the mechanical. The trend, however, doesn't end with the hydraulic system, it suggests that these will eventually be overtaken by field-based systems.

Figure 5: Partial View of TRIZ 'Dynamization' Trend

Seeing as the hydraulic backhoe (Figure 6) is the currently dominant earth-mover, we might now switch from historical analysis to future prediction mode by using the TRIZ trend alongside Christensen's disruptive technology model to have a go at showing what both together would tell us about the future of earth-moving:

Figure 6: Present Day Backhoe Earth Mover

Field-Based Earth Movers

As described in the CreaTRIZ advanced trends tab, the reasons systems jump from fluid to field based solutions are various – increased reliability, increased design flexibility (positioning of components), increased efficiency, increased controllability, increased safety, reduced harm from leaks, etc.

As far as load carrying capability is concerned, however, an electrically actuated backhoe using the best of today's electrical actuation capability will not match the earth-moving performance of the hydraulic systems. The current customer base is thus unlikely to be attracted to an electrical machine.

According to the disruptive technology model, the new electrically-based earth mover needs to find a new customer base to whom shovel load size performance is not as important as some of the inherent benefits of shifting away from hydraulics if it is to define a foundation from which to grow. Almost inherently, these customers don't exist today, or, if they do, they are highly unpredictable in terms of what they actually want. Hypothetically, for an electrical earth-mover, they might include a growing market of domestic users (see how the market for sit-on lawn-mowers evolved for example), or anyone requiring to dig lots of small holes with as little human labour as possible – e.g. cable companies – where the increased controllability and flexibility (i.e. the tool needs connecting to the power source by a simple wire only) of an electrically operated system would outweigh the reduced shovel-load performance. According to the model, these applications will in the short term be less profitable than the high performance hydraulic systems (which explains why the incumbent hydraulic companies are unlikely to be interested – at least based on historical evidence).

The next part of the prediction then goes something along the lines that because the electrical system is at the start of its evolutionary potential path, it doesn't need nearly so much investment to begin increasing the performance of the machines. Revenues from the new customer base fund development of higher shovel load systems; the electrical

systems will then eventually become able to match the performance of the hydraulic systems, while retaining the other flexibility, controllability, reliability, etc advantages the hydraulic systems will never match – Figure 7.

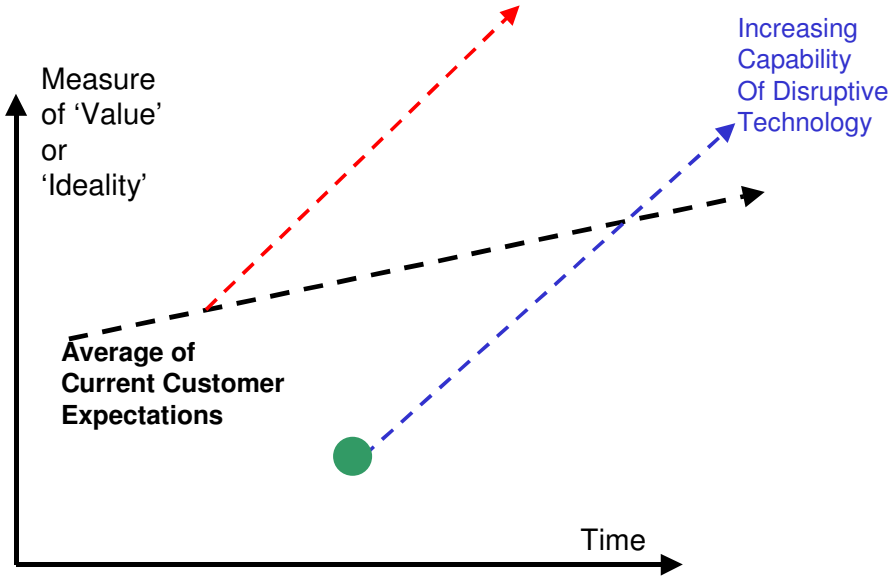

Figure 7: Disruptive Technology Wins Because Technology Evolution Commonly Exceeds Customer Expectation

Eventually, the electrical systems will achieve the performance capabilities of the hydraulic systems, after which point, the days of hydraulics will be numbered.

Thoughts

Disruptive technologies usually 'win' because technology performance capability often rises more quickly than customer expectations.

The disruptive technology is highly likely to be initially inferior in terms of the traditional performance measures of the incumbent technology. The disruptive technology thus usually has to find a new customer base to sustain it in the initial development stages.

The new customer base is unlikely to match the profitability of the existing market in the short term. 'Good management practice' thus means the existing companies will not exploit the new technology (NB Christensen's book offers strategies to remedy this problem – albeit they are almost inherently painful and come attached to a short term drop in profit.)

The cycle repeats every time an established technology 'grows' away from the evolving customer requirement.

When a customer's appetite for 'performance' is sated, they will increasingly make purchase decisions based on reliability, convenience and price – we will return to these areas in future newsletter articles.

In the meantime, the major point of this article is to implant readers with the vital connection between the disruptive technology business model and the TRIZ evolution trends. It is highly likely that the form of the disruptive technologies can and will be predicted by TRIZ.

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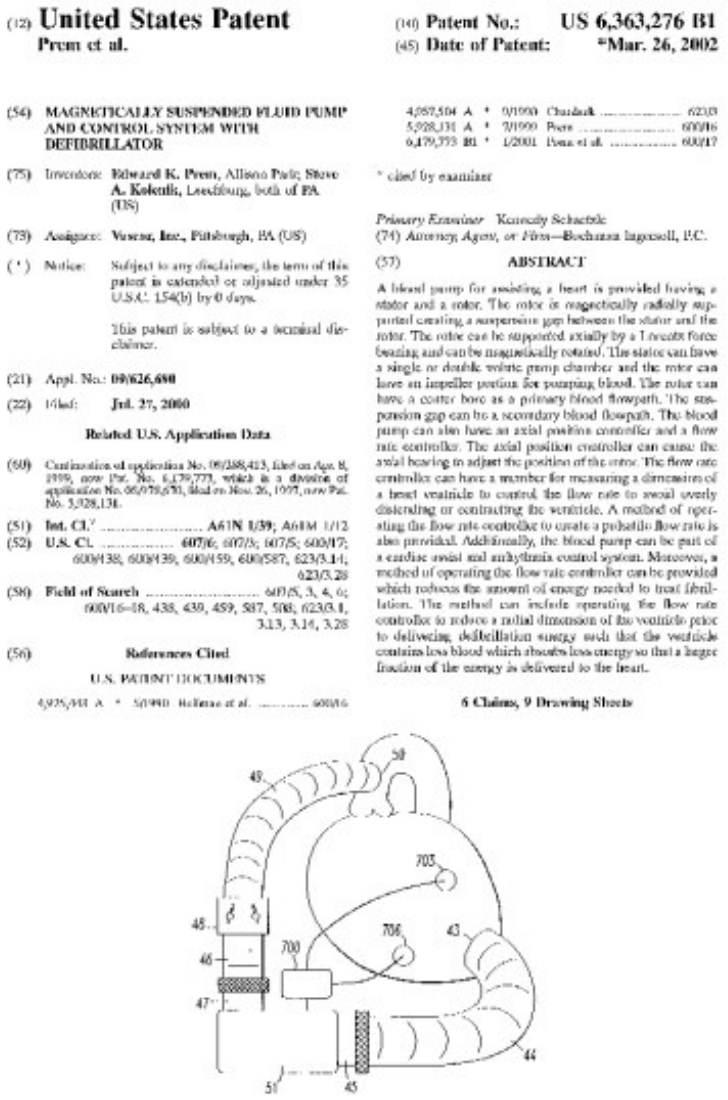
Humour

A competition this month: what Inventive Principle(s) are in operation in the following cartoon?

Non-Viagra-based prize (unless you tell us otherwise!) for the most inventive answer.

Patent of the Month

Our patent of the month this month is a medical invention awarded to Vascor Inc. in the US on March 26:



(12) **United States Patent**
Prem et al.

(10) **Patent No.: US 6,363,276 B1**
(45) **Date of Patent: *Mar. 26, 2002**

(54) **MAGNETICALLY SUSPENDED FLUID PUMP AND CONTROL SYSTEM WITH DEFIBRILLATOR**

(75) Inventors: **Edward K. Prem**, Allison Park; **Steve A. Kolenik**, Leesburg, both of PA (US)

(73) Assignee: **Vascor, Inc.**, Pittsburgh, PA (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

This patent is subject to a terminal disclaimer.

(21) Appl. No.: **09/626,690**

(22) Filed: **Jul. 27, 2000**

Related U.S. Application Data

(60) Continuation of application No. 09/288,413, filed on Apr. 8, 1999, now Pat. No. 6,179,773, which is a division of application No. 08/978,670, filed on Nov. 26, 1997, now Pat. No. 5,928,131.

(51) **Int. Cl.**[7] **A61N 1/39**; A61M 1/12

(52) **U.S. Cl.** **607/6**; 607/5; 607/5; 600/17; 600/438; 600/439; 600/459; 600/587; 623/3.14; 623/3.28

(58) **Field of Search** 607/5, 3, 4, 6; 600/16–18, 438, 439, 459, 587, 508; 623/3.1, 3.13, 3.14, 3.28

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Primary Examiner—Kennedy Schaetzle
(74) *Attorney, Agent, or Firm*—Buchanan Ingersoll, P.C.

(57) **ABSTRACT**

A blood pump for assisting a heart is provided having a stator and a rotor. The rotor is magnetically radially supported creating a suspension gap between the stator and the rotor. The rotor can be supported axially by a 3 newton force bearing and can be magnetically rotated. The stator can have a single or double volute pump chamber and the rotor can have an impeller portion for pumping blood. The rotor can have a center bore as a primary blood flowpath. The suspension gap can be a secondary blood flowpath. The blood pump can also have an axial position controller and a flow rate controller. The axial position controller can cause the axial bearing to adjust the position of the rotor. The flow rate controller can have a member for measuring a dimension of a heart ventricle to control the flow rate to avoid overly distending or contracting the ventricle. A method of operating the flow rate controller to create a pulsatile flow rate is also provided. Additionally, the blood pump can be part of a cardiac assist and arrhythmia control system. Moreover, a method of operating the flow rate controller can be provided which reduces the amount of energy needed to treat fibrillation. The method can include operating the flow rate controller to reduce a radial dimension of the ventricle prior to delivering defibrillation energy such that the ventricle contains less blood which absorbs less energy so that a larger fraction of the energy is delivered to the heart.

6 Claims, 9 Drawing Sheets

We like the patent because it demonstrates a number of TRIZ principles. The first principle demonstrated is the idea that someone somewhere has already solved a problem something like yours. In this case, the 'something' is magnetic bearings – which are well established in non-medical applications. The invention transfers key features of magnetic bearings into a blood pumping system.

Related to this, and the second thing we like about the invention is the evolution along the dynamization trend from conventional mechanical bearings to a field-based system. As defined in the trend, the reasons for the jumps to the field-based solution are many and various. In this particular case, the advantages are cited as long-life, reliability (i.e. no contact between rotating and stationary parts) and controllability.

Another trend in use in the patent is the geometric evolution trend. The invention disclosure talks about "*The rotor assembly can preferably be suspended by permanent*

magnet radial bearings and a Lorentz-force axial bearing" and as such has evolved the magnetic field from its conventional one or two dimensional action into a three dimensional effect. We like the idea of three-dimensional field solutions.

Other interesting features:-

"The Lorentz-force axial bearing can generate bi-directional axial forces in response to an applied current. The blood pump can also include an axial position sensor and an axial position controller. The axial position sensor can monitor the axial position of the rotor and provide feedback to the controller to maintain the axial position of the rotor. The axial position controller can also adjust the axial position of the rotor such that steady-state axial loads due to gravity, acceleration or the centrifugal pump impeller are offset by the inherent axial forces generated by the permanent magnet radial bearings"

Or, in other words, the bearing load compensation action is made largely self-compensating thanks to the inherent capabilities of the Lorentz force.

And

"All blood contacting surfaces of the pump are continuously washed to avoid blood clots and protein deposition".

I.e. the shape of the internal passages of the pump are designed in such a way that the motion of the blood itself keeps the pump clear of potential clots.

Best of the Month

At last a TRIZ-specific recommendation for this months 'best-of'. March's issue of TRI+Z Journal contained an article called 'Breakthrough Thinking' by Larry Ball. The article operates like a mini problem solving guide. It helps to have some familiarity with TRIZ before entering, and some readers will no doubt disagree with some of the content. We particularly liked the sections on 'improving functions to extreme', 'storage of fields' – which offers a nice addition to the repository of useful TRIZ data tables and some of the new perspectives on separation principles for physical contradictions (e.g. 'separate by scale', 'separate by direction, path or plane'). The latter contains some quite elegant examples.

From the less TRIZ-specific perspective, our recommendation for the month is 'Surfing the Edge of Chaos' by Richard Pascale, Mark Milleman and Linda Gioja (Crown Business Press, New York, 2000). The theme of the book is the parallel between business and natural system evolution. The book derives four natural principles that may well have a profound effect on the way organisations think about business. These are:-

1) Equilibrium is death
2) Innovation takes place on the edge of chaos
3) Self-organisation
4) Organisations cannot be directed; only 'disturbed.

We were initially drawn to the book because of the chapters on the importance of self-organisation in a business context. While these chapters are very good, the most interesting aspect of the book for us turned out to be the ones on the (perhaps non-instinctive) subject of equilibrium. We say 'non-instinctive' because many of the companies we see appear to have equilibrium (stability, optimised performance) as a high level goal. The book contains powerful arguments to demonstrate why this is a bad goal.

Best Of The Month II

Hands-On Systematic Innovation is now available. Over 150 copies have already been sold (many thanks to those that have purchased a copy prior to any kind of detail on its content!).

The book opens with the sentences “In keeping with the rising interest in TRIZ in all corners of the world, the number of books on the subject is rapidly heading skyward. So why write another one?” The answer is simply that when we looked across the range of available TRIZ books, there was nothing we found we could wholeheartedly recommend – either because the author was more interested in impressing than connecting, or (more usually) because although a book was good at describing TRIZ, it didn’t provide answers to the usual question of ‘okay, now what should I *do*?’. Hands-On Systematic Innovation is a ‘doing’ book. Its aim is to help readers generate tangible benefit from wherever their start point – whether it be an experienced TRIZ user or novice, or any type of technical problem or opportunity situation.

The net result is a 460 page tome (don’t worry, you don’t have to read it all!) segmented in a way that enables the reader to find what they want very quickly, including a complete start-to-finish problem definition through tool selection through solution generation through evaluation process for those that want it. It contains a number of newly uncovered trends of evolution, serious revisions of the somewhat abstract s-field tool, a novel knowledge and effects database, and a whole host of case study examples tying the whole thing together.

If you like any of Darrell’s work in TRIZ Journal, we think you will like this book.

Investment – Solar Amp

As electricity rates and demand increases, researchers at NC State's SolarAmp believe they have a design that will make solar panels cheaper..

20 Years: The Past and The Future

For the last 20 years or so, Americans have enjoyed a relatively low cost supply of both oil and electricity, leaving little financial incentive to explore other forms of energy. Now as costs increase, more electric users are eyeing the possibly of using solar power to supply electric needs.

A group of scientists led by North Carolina State University's Dr. Jonathan Lindsey believes they have the solution that will help propel solar energy possibly by as much as 20 years into the future.

Cost Is The Biggest Factor

These solar modules, called PhotoVoltaics, turn sunlight into electricity. And they are extremely expensive, which explains why you don't see a solar panels on every rooftop.

Dr. Lindsey of NCSU says in its current form, it is very expensive to make PhotoVoltaics (PV) because they are made in a similar fashion to computer chips.

"It's hard to see those prices coming down," said Dr. Lindsey about the current PV component costs.

Instead of building the PV components in the current fashion and hope that costs eventually decrease over time, Dr. Lindsey and his group hope to leapfrog this whole process.

The research group headed by Dr. Lindsey has recently completed the results of years of collaborative research on a new molecular-based solar cell, which they project could reduce solar module costs by as much as 60%.

SolarAmp Is Born

They are now looking for external funding to turn their findings into a commercial business, which they have dubbed SolarAmp.

Dr. Jonathan Lindsey from North Carolina State University, Dr. David Bocain of the University of California, Dr. Dewey Holten of Washington University and Dr. Gerald Meyer of Johns Hopkins University make up the research team.

The group has been working towards creating a molecular-based solid state solar cell which aims to substantially reduce the costs of PhotoVoltaic modules.

"We know enough...to create a revolutionary new solar cell," says Dr. Lindsey.

By revolutionary, Lindsey means cheaper. If their research is borne out in production, solar power could become much, much less expensive and could even reduce costs to the

point where they are competitive with buying electricity from a utilityespecially if you live in California.

Currently the most cost-efficient solar power is being developed at around $2 per Watt.

SolarAmp's lower cost for solar photovoltaic production would create substantial savings which could help to take solar power into the world of mainstream energy.

The keys to SolarAmp's unique technology lie with the use of unique light harvesting rods which Dr. Lindsey and Dr. Bocain have been developing for almost 20 years.

Efficient Shish-Ka-Bobs

SolarAmp's use of these ultra-thin light harvesting rods that look like "shish-ka-bobs" allow the absorption of sunlight in a highly efficient fashion.

Sunlight absorbed by these rods transcend toward the underlying semiconductor material, which converts this raw energy into electricity.

Other researchers have tried other methods of making PV's more efficient. Some have tried to use layers or thick films to become more efficient, but fall short of the SolarAmp solution in a variety of ways.

The layer solution, with many layers of light absorbing material, have efficient energy transfer once light reaches them. However, they typically have very poor light absorption due to the thin nature of the layer.

Other thicker solutions attempt to overcome this challenge with a thick film approach. However little energy reaches the semiconductor due to the lack of conductivity between these layers ultimately lowering the efficiency.

Using the unique light absorbing rods developed by Dr. Lindsey, SolarAmp cells create both the thickness required for efficient light absorption along with the highly efficient energy flow to the semiconductor, greatly increasing the overall efficiency of the cell.

A Thinner and More Flexible Solution

In addition to greater efficiency, the thin film-like materials that SolarAmp will be using allows for relatively low production costs.

"We're looking at what is at least a 10 fold savings," said Dr. Lindsey, comparing projected costs of manufacturing a molecular-based PhotoVoltaic compared to the current manufacturing process.

The thin types of underlying flexible semiconductor and light rods to be used by SolarAmp, allow the possibility for this solution to be ultra-thin, flexible, and lightweight.

"They are absolutely not brittle," said Dr. Lindsey about the absorbing rods.

With advent of flexible PhotoVoltaics modules, it could perhaps provide the possibility of such future applications as solar layered tents and even solar clothing allowing people to charge and run portable devices by "plugging" in to their solar jacket.

Solar Power Revisited

Contrary to popular opinion solar power is not some new phenomenon that popped up in recent times after the energy crises. French mathematics professor Auguste Mouchout received the first solar patent for a motor driven by solar power in 1861.

In the 140 years since, there have been numerous innovations and attempts to tap into the abundant energy of the Sun. Every year the earth receives 6000 times more sunlight energy than humans currently use on an annual basis, and in the last 20 years the world has increased its consumption of energy by 40%, of which 85% comes from fossil fuels.

SolarAmp Seeks Funding

SolarAmp formed as a business in October of 2000 with the addition of Bill Conklin, a former IBM R&D and marketing executive. Conklin, who said he helped take many new technologies to market at IBM, seems to believe that the market is ready for a cheaper solution.

"There's only one issue in solar polarcost," said Conklin. "How do you get the cost down? "

"Every place you're installing solar panels today...we can go in...much, much cheaper," he added.

The company is now seeking $3.6M in outside funding of which it says it has secured $600k from individuals.

"What we need is funding...to turn that [research] into a product," said Conklin.

Dr. Lindsey seemed confident that if the research group had enough funding, it would only be a matter of time before a finished product would be completed.

"I don't have any worries on the technical side," commented Lindsey.

The group is out talking to area venture capitalists and angel groups in addition to strategic sources such as energy companies. SolarAmp plans to use its funding to complete a full working prototype within 24 months.

They believe they can go to market after the prototype completion in an additional 18 to 24 months to begin to stake its claim in the growing solar power arena.

World Solar Market

In the year 2000, worldwide shipments of PV modules resulted in around $2 billion in sales, with annual worldwide sales expected to increase to about $27 billion by 2020, according to the National Renewable Energy Laboratory.

Currently this market is about 75% outside the US, as solar solutions tend to thrive in more remote locations where hard line electricity is more limited and in markets such as Germany and Japan where energy costs are high and the government subsidies help

foster solar use and growth. Japan represents 27% of the world wide solar shipments alone. SolarAmp believes it's solution can help to grow this market even larger, as it attempts to speed the cost efficiency curve by several years.

Outside Analysis

Paul Maycock, the principal with PV Energy Systems, a Solar Power advisory firm, while unable to comment on the actual SolarAmp technology without lab analysis, states that it may be a challenge to bring this (or any new solar technology) to market within the projected 4 years due to the complications and learning curves associated with manufacturing equipment processes.

Despite some of the uncertainties that are ahead of SolarAmp as it moves to commercialize its product, it appears that the solar power industry as a whole is on the brink of breaking through to a more mainstream role in the world's energy production.

SolarAmp and the principles behind it hope to be an integral part of this expanding role.

"Nobody has really created a breakthrough," said Conklin of SolarAmp. "The industry is really looking for somebody to have a breakthrough."