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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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Gracefully Degrading Products
- Principle 22 and Design For Emotion

Designers are finding it increasingly differentiate their designs from those of their competitors. The design industry has seen several evolutionary leaps as designer's have uncovered breakthrough capability innovations. The first generation of industrial design, for example, was essentially about delivering functionality to the consumer. In the second generation, the consumer took functionality as a given and the competition arena thus shifted towards delivering more 'usability' and 'convenience' than everyone else. Nowadays more and more design solutions have also sated the consumers' appetite for usability and convenience. In many arenas, this has meant that designer's have had to again re-focus their attentions. Functionality and usability are increasingly seen as the norm – miss either one and the consumer is unlikely to buy your product. And so the competitive landscape shifts again. This time the shift is strongly focused in the direction of so called 'emotional design'. In TRIZ terms, we may think of this shift as a third stage in a design focus trend – Figure 1.

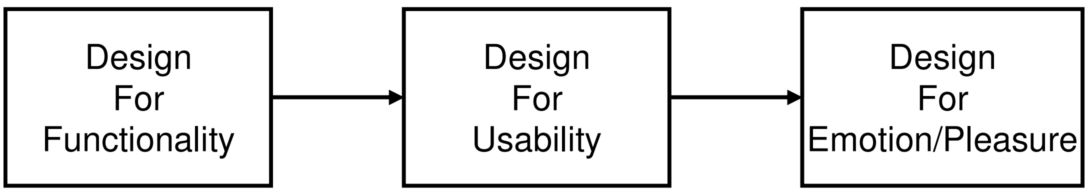

Figure 1: Design-Focus Evolution Trend

References 1 and 2 offer an (academically-focused –i.e. dull) introduction and a more readable outline of the design-for-emotion phenomenon respectively.

Traditionally, TRIZ has been viewed as a rather mechanistic method. While this impression is actually quite wrong, it is nevertheless difficult – based on the published evidence – to justify the fact that it can successfully handle 'emotional' design factors. Reference 3 is one attempt to demonstrate how TRIZ can, in conjunction with other tools, can enable designers to systematically achieve breakthrough 'wow' design solutions.

This article is intended to examine just a tiny aspect of the whole design-for-emotion story. The basis for the article is built on an examination of three products that have suffered from wear. Or rather one of them has 'suffered' while the other two have 'benefited' from wear. All three are illustrated in Figure 2. Your challenge (before you read further) is to try and work out which is the one where the wear is a bad thing, and then why wear is a good thing in the other two:


Worn chrome on pick-up of electric guitar


Worn surface of on-off switch from TV

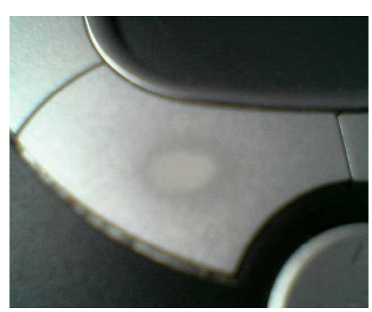
Worn left-click button on laptop computer

Figure 2: 'Good' And 'Bad' Wear Examples – You Decide Which Is Which

If you are struggling to decide which is which, then think about the emotional context of the wear that has occurred in each of the designs.

In all three cases the wear that has taken place is indicative of the amount of use of the product. With the guitar and the laptop, the wear is indicative of how much music (or noise!) and how much work has been created. In both cases, the wear is thus likely to be viewed as a positive aspect; as a sense of pride. In the case of the TV on-off switch on the other hand the wear is indicative of time spent sitting in front of a highly passive form of entertainment, and is thus more likely to inspire feelings of guilt than pride. Even worse, because the wear is visible at a very obvious and visible to everyone position on the TV set, the feelings of guilt are likely to be amplified. For most people, therefore, the worn TV switch would invoke a negative emotional response – 'look how lazy I have been' – and/or negative feelings about the product – 'don't buy a product from Company X because look how quickly it looks worn' (even if the wear has taken several years to appear, the owner is highly likely to push blame away from themselves and onto the manufacturer).

A general hypothesis that emerges from these three examples is that wear – and particularly 'graceful' wear – of a product can be a way of ensuring a strong emotional bond between the owner and the product. All three products belong to this author. The guitar, thanks to the signs of wear, is probably one of the first things that would be retrieved if the house was burning down. The emotional response to the worn laptop is less extreme, but nevertheless it is fair to say that an emotional bond has been formed to an object that is almost the epitome of replaceable in this modern computer age. As far as the TV set is concerned, however, it is very unlikely that the manufacturer will be given a second chance.

By 'graceful' it is important to note that the wear that takes place should be a gradual process. If the chrome had fallen off the pick-up in the first six months of the life of the guitar, the reaction would have been more likely to be negative than positive.

The determination over whether the wear will create a positive or a negative emotional response will depend largely on whether the wear is associated with a productive or non-productive activity. The creation of music or output from a laptop is symbolic of hard work. The wear in these cases says 'look how hard I worked' to outsiders. A worn TV on the other hand sends out the message that time has been spent wastefully.

The Inventive Principle most closely connected to graceful wear in Principle 22, Blessing In Disguise. We might add a new description into the definition of the Principle in order to reflect the emotional design opportunities presented by graceful wear:

22D *'Make positive functional use of wear and degradation in components'*

The contradiction most closely associated with the advantage being delivered by graceful wear is that we wish to improve emotional bond and the thing that stops us is that all mass-produced products come off the production line looking the same.

Manufacturers of denim jeans have made various attempts to create new products that look like they have been lived in (all generally involve trade-off and compromise – e.g. stonewashing produces fading, but considerably reduces the life of the material). It is not clear whether a pair of simulated-wear jeans invokes the same emotional response in consumers as that created when the wear occurs naturally. Probably it doesn't.

The art of creating artifacts that will age and wear gracefully like the guitar and like the laptop button can be a serious manufacturing challenge. Resolution of this challenge is most likely achieved through the appropriate selection of materials. At this point in time the 'emotional design' subject is new enough that there is no (commercially available) database of wear characteristics of different materials.

The lack of such a database needn't however, prevent designers from engaging the emotional senses of consumers by designing products that make active use of Principle 22 and wear gracefully.

References

1) Jordan, P.W., 'Designing Pleasurable Products', Taylor & Francis, Contemporary Trends Institute, London, 2000.
2) Norman, D.A., 'Emotional Design: Why We Love (Or Hate) Everyday Things', Basic Books, New York, 2004.
3) Mann, D.L., 'Common Ground – Synergies Between TRIZ, Perception Mapping and Kansei Engineering', paper presented at Research Into Practice conference, University of Hertfordshire, July 2004.

Product Life And The System Complexity Trend

This article examines another of the underlying mechanisms of the TRIZ system complexity trend – Figure 1. In a previous article we have seen how the trend is affected by the emergence of new technologies that first add new functions and then begin to *displace* components that deliver other functions (Reference 1). In this article we explore the impact that product life and investment cost has on the trend.

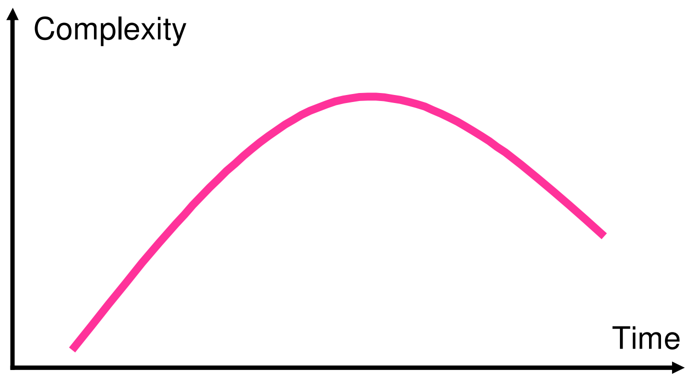

Figure 1: Complexity Increase-Then-Decreases Trend

The phenomenon is probably easiest to see through a specific example. The one we will use here involves roof tiles. There are many different types of available roofing material, the choice of which in any specific application will depend on, amongst other things, local custom, climate and economic factors. In nearly all cases, however, the primary function of the roof is to provide protection from the elements for the occupants residing under the roof.

In recent times, environmental awareness has caused many home owners to consider adding some form of solar energy collector onto their roof. Such collectors will typically take the form of photo-voltaic cell arrays or heat exchangers – to either convert solar energy into either electrical energy or to heat a supply of water. In either case, the fact that a new function is being added to the roof means that the complexity of the 'roof' system is forced to rise. As shown in Figure 2, that increase in complexity emerges because the homeowner is forced to add something to what is already there.

Figure 2: Typical Solar Panel Added Onto An Existing Roof

Increasingly, however, there is a choice as forward thinking manufacturers begin to offer roofing materials that integrate the solar energy collecting and converting components into the tiles. Such integration represents a decrease in the overall complexity of the roof since the weather protection and solar collection functions become integrated into a single system – i.e. an integrated 'solar-tile' represents an example of a system on the downslope of the complexity-increases-then-decreases trend. This integrated solution is in most ways a 'more ideal' solution than the retro-fit option – it uses resources more effectively, is more efficient, is more aesthetically pleasing and eliminates the need for having to attach and pierce through the existing roof.

If this is the case, the new might begin to wonder why every customer doesn't automatically opt for this solution. The reason that they don't is that a roof is expensive, and expected to last for many years. In such a situation, few if any consumers are prepared to scrap what may still have twenty or thirty more years of life left in it in order to reap the benefits of a 'more ideal' system. This phenomenon gives manufacturers and consumers a difficult set of trade-off decisions to make – either scrap a roof with potentially many years of remaining useful life, add an ugly, inefficient system to an existing roof, or do nothing (and hence continue to have high energy cost).

These trade-offs are, of course, interesting from the Contradictions perspective. There may indeed be some useful solutions that emerge by examining the problem in the context of the Contradiction Matrix. Our focus here, however, is that the high cost and long life expectancy of things like roofs is a serious contributor to the complexity increases-then decreases trend.

The only way to demonstrate the benefits of solar roofing to consumers is to get a critical mass of data from other consumers who have adopted and proven the system. The economics of replacing complete roofs is – initially at least – not practical, and hence the only way to progress is to hope that enough consumers will be willing to retrofit a system onto their existing roof. It is a classic 'can't get there from here' situation. As Figure 3 indicates the drive for a more ideal system is hampered by the economic practicalities of having to first complicate an existing system.

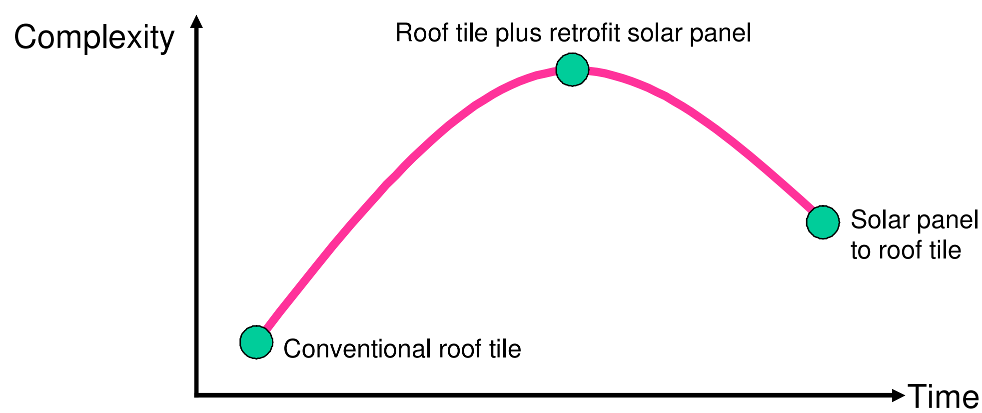

Figure 3: Complexity Trend In The Roof Design Context

(complexity migrates to the lower-scale – increases in the material in this case so that the overall structure can become less complex)

References

1) Patent of the Month, March 2004.

Not So Funny – Stupid Rules Part 27

Idea-generating processes can be simple or elaborate, and no idea is too small for consideration. At Portland, Maine-based Banknorth Group, for example, CEO William Ryan runs a "Stupid Rules" contest inviting employees to identify corporate rules that are, er, stupid. If the company agrees and the rule is abandoned or altered, the employee receives a small cash prize. One recent entry contended that the 'rule' keeping people waiting in the cold until the bank doors were unlocked at 8 a.m. was both inhumane and unnecessary. Banknorth checked FDIC requirements and found that it could let people in before the bank's official opening time. The new policy? Early arrivals are let in and offered a cup of coffee, says Ryan.

A bit like the 'least Ideal Final Result' concept, searching for the most stupid rule can be a great way of innovating. Very often, the problem comes with systems and company cultures in which employees are fearful of challenging stupidity. 'It's more than my job's worth' is a common attitude amongst many customer facing employees.

A typical one: 'only one piece of hand luggage per passenger'. There is an intelligent way to interpret this rule and the stupid way. The real problem for airlines is hold space inside the passenger cabin – hence many have the size-check frames at check-in. This is sensible. This author has had two occasions now where even though the two pieces of luggage both fit simultaneously into one of these size-check frames, the 'one piece of luggage' rule has still meant that we have to check one piece of luggage.

We are now on the look out for other examples of Stupid Rules. Every one, we figure, presents an opportunity to innovate and create a customer 'wow'.

Patent of the Month

Those familiar with the TRIZ Space Segmentation trend shouldn't be too surprised to learn that foamed structures possess an ability to perform functions that monolithic, solid structures are unable to perform. An oft stated concern with many foams is that the more material that is removed, the weaker the structure will be. This from the invention disclosure under investigation here:

In the construction industry, it is well known to use panels as partition walls in order to subdivide the building area into separate areas such as rooms and offices. Usually they consist of an insulating mineral fiber core, and two outer facing layers encompassing the core, and an air gap or hollow space. The insulating materials such as mineral fibers are arranged between the facing layers in such a manner so as to provide thermal and/or acoustic insulation. However, a major disadvantage of such partitions or panels having mineral fiber cores is the lack of mechanical strength of such fibers which therefore require a costly supporting structure or densification. In addition, mineral fiber products are unpleasant to handle causing skin irritation and possibly presenting a health hazard.

Later on in the disclosure the inventors go on to discuss the contradictions involved in the manufacture of foams in more detail:

Certain large pore, open-celled foams are known. However, they also possess one or more drawbacks. For example, thermoset resins such as melamine and semi-rigid polyurethane can be used to prepare foams which display the desired large pore, open-celled structure believed to be required for sound management. However, thermoset resins are not recyclable, are costly to manufacture, and are unsuitable for use in humid or wet environments due to their hydrolytic instability. Thermoplastic polymer foams are generally inexpensive to manufacture by a convenient extrusion process, are recyclable, and exhibit hydrolytic stability, and therefore offer an advantage over thermoset resins. However it is difficult to achieve a large-pore thermoplastic foam with an open-cell structure by a convenient direct extrusion process. These difficulties exist because cell opening and foam expansion contradict each other. That is, the growing cells within the foam must remain dosed in order to grow, but developing a large pore requires that a hole must develop on the cell wall shortly before the end of expansion.

Dow Chemical, the owners of the patent are users of TRIZ. While it cannot be stated with certainity that TRIZ played any part at all in the invention made by the inventors, it is nevertheless interesting to see the contradiction that has been 'solved' mentioned so explicitly in the invention disclosure.

The patent, in case anyone wants to have a look at it themselves is:

United States Patent	***6,720,362***
Park	**April 13, 2004**

Perforated foams

Abstract

Thermoplastic polymer foams having sound deadening properties satisfactory for demanding applications are provided which have mechanical strength, which are economical to manufacture, and which are hydrolytically stable. Methods of preparing these foams are also provided. The foams are useful in sound management, cushion packaging, filtering, and fluid absorption and exhibit one or more of the following properties: 1) average cell size greater than about 2 mm; 2) substantially open-cell structure and 3) relatively large pores connecting the cells. In order that the foam be acoustically active, the foam should possess a substiantially open-cell structure and a relatively low airflow resistivity. Foams with substantially open-cell structure and relatively low airflow resistivity are prepared by mechanically opening a foam having an average cell size greater than about 2 mm. In most cases, such mechanical opening creates relatively large pores connecting the cells.

Inventors: **Park; Chung P.** (Baden-Baden, DE)

Assignee: **The Dow Chemical Company** (Midland, MI)

The patent is a model example of combining a large bunch of different ideas (and Inventive Principles) into a holistic whole – getting into the details reveals use of Principles 3, 10, 24, 28, 34, 35 and successive Segmentation (1) followed by Merging (5).

In many ways, a patent with many learning points and one, therefore, that deserves to be studied by anyone interested in the process of invention and protection of invention.

Best of the Month

Analysts at the RAND Corporation lay out ten international-security developments that they suggest are not getting the attention they deserve. This is a rather long article worthy of attention. The ten issues highlighted are: the proposed wall between Israel and Palestine; implications of the shrinking population of Russia; the Hindu-Muslim divide; AIDS and African armies; the Tehran-New Delhi axis; anti-satellite attack; defense-industry Goliaths; the aircraft carrier shortage; the Indus water fight; and finally, urban warfare.

http://www.theatlantic.com/issues/2003/07/rand.htm

As many of our regular readers will know, any trend direction only starts to get really interesting when it conflicts with another one. The RAND article is particularly commended, even if you have no personal interest in security issues, since it gives an excellent introduction to how two (apparent) rights can still lead to a contradiction. No mention in the article as to how any of the identified conflicts can be solved, but definitely plenty for TRIZ practitioners to think about.

Investments – Water Repellent Also Absorbs (Nature - December 30, 2003)

http://www.nature.com/nsu/031229/031229-1.html

As can be seen from the date, we're a bit slow with this one. Anyway, better late than never, and especially so with any solution that focuses on solving contradictions. The nature article reports a new material that can repel or absorb water. Any application where there are contradictory requirements to repel AND absorb water should be interested in the discovery. It could be used to guide flowing liquids, or be used in clothing, diapers, filters, or a whole bunch of other things. The coating, made from zinc oxide, is normally water-resistant - liquid droplets roll off when the surface is tilted. But when the material is exposed to ultraviolet light, it becomes water-absorbing. Droplets flatten into a smooth film and soak into the surface.

The main downside so far is the amount of time it takes to revert back to being repellant after the UV has been used to trigger the shift to absorbent. It currently takes seven days in the dark before the material becomes repellent again. Ultimately, of course, research will shorten this transition time. In the meantime, according to classic innovation dynamics theory, the scientists responsible for the discovery should be looking for applications where either only the repellant-to-absorbent transition is required, or where the transition back to repellant is not required quickly. A classic 'opportunity finding' task… one where we can think of several examples if we think carefully about functions different users may wish to perform.

Biology – Caddis-Fly Larvae

Generally dull brownish, caddis flies have long antennae and hairy wings that fold rooflike over the abdomen. They feed primarily on plant juices and flower nectar, though a few are predaceous. They achieve special mention in our biology feature thanks to their extra-ordinary use of available resources (Principle 25B). Many caddis-fly larvae construct a portable case from grains of sand, bits of shells, twigs and plant debris. Basically, when you see the larvae in action, you will notice that they will use just about anything they find lying around in ponds and streams. Literally anything that can be used to provide a combination of camouflage and protection and can be glued together by the sticky substance they secrete.

As can be seen in the picture, the larvae make a case that surrounds the their abdomen while it matures.

All in all, a great example of nature making use of existing stuff in order that precious living resources can be minimized. The caddis-fly larvae only have to find the sticky secretion to build their protective shell; the hard protective shell comes from the outside world. The idea of using existing resources is in no way unique to the larvae of course – the hermit crab, for example is a great one for using existing shells to make its protection – but the added advantage of the sticky secretion is that, as the larvae grows it can simply add more protection material without ever having to be in a vulnerable no-shell state.