Systematic Innovation

e-zine

Issue 6, July 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.

Our guarantee to the subscriber is that the material featured in the e-zine will not be published elsewhere for a period of at least 6 months after a new issue is released.

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

More Opportunities

Introduction

Further on from our initial publication of CREAX work on the evolutionary potential concept (Reference 1), we present here a simple example to illustrate how the evolutionary potential radar plot idea can also be used to benchmark different solutions to a given functional requirement in order to help identify threats and opportunities. This '*evolutionary benchmarking'* idea is conceptually very simple in nature. In our efforts to help companies identify opportunities for exploiting their capabilities in other fields, we are finding it to be a very useful initial evaluation tool.

The basic underlying principle operates as follows. Firstly it is necessary to establish a common link between a given technology or capability under evaluation and external systems that may potentially be threatened by it. As is often the case within TRIZ, this common link is FUNCTION: function being the thing that connects different solutions to what customers want to *do* with them. Once we have identified a system that is delivering the same function, we can construct an evolutionary potential radar plot for each system as illustrated in Figure 1.

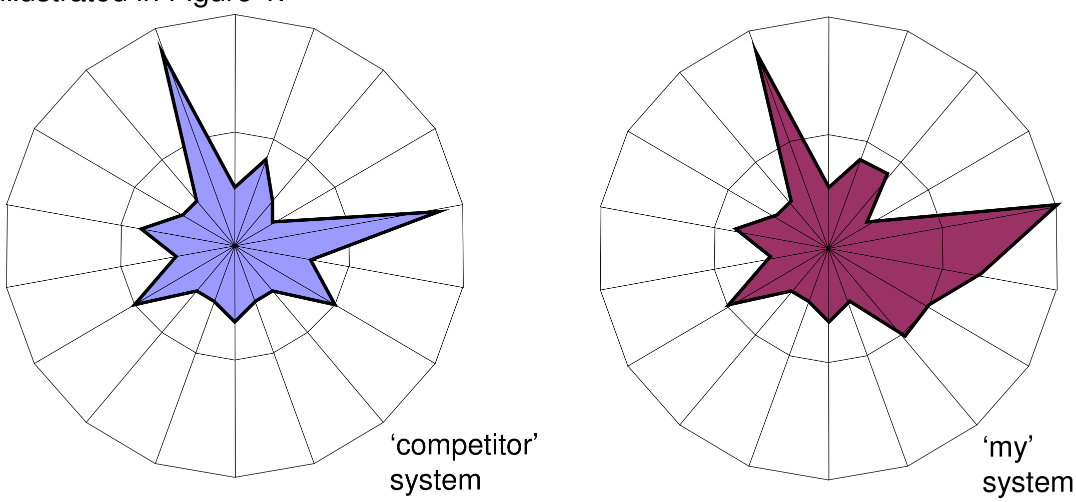


Figure 1: Hypothetical Evolutionary Radar Plots for Two Systems Delivering the Same Main Function

As both systems are delivering the same basic function, the trends that are relevant to each are likely to be similar. Where they are not, a composite list of trends needs to be configured in order to be able to legitimately lay the plots over one another. This is simply done by compiling a list of relevant trends for one system and adding any trends from the other that are not included in the first.

Once this has been done, it then becomes possible to overlay the resulting radar plots for the two systems. Figure 2 illustrates this for our hypothetical example.

Once this has been done, the composite image provides an instant snapshot of the relative benefit-providing capability of the two systems. In keeping with the underlying philosophy of the trends that 'somewhere there is a benefit in progressing along each of the stages', wherever there exists a difference between the two systems, there is the potential for discrimination. Thus, in the Figure 2 picture for example, because 'our' system – the one drawn in purple – is further progressed along several of the physical space related trends, and at least equal everywhere else, we can imply that we have the opportunity to offer benefits that the competitor system cannot. The trick given this situation is to now work out precisely WHAT those benefits might be, and then whether any part of the customer base might value those benefits.

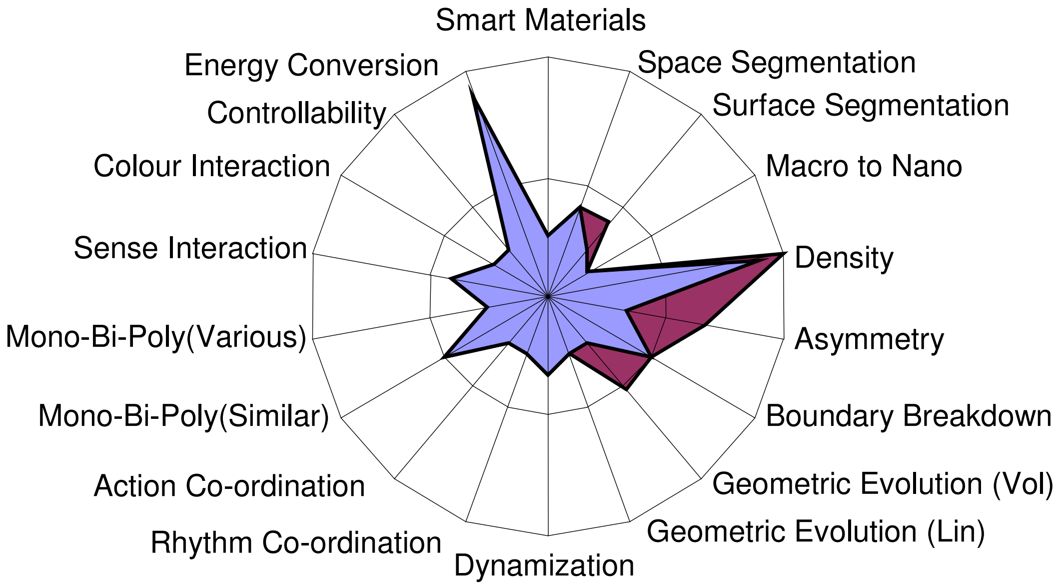


Figure 2: Overlayed Radar Plots Allow Ready Comparison Between Systems

This latter activity is of course likely to be more time consuming than the construction of the radar plot. The point of the article, however, is that the radar plot construction and overlaying process is for the most part automatable. In other words, the preliminary comparison between different systems can be performed by machine.

The CREAX patent analysis team is routinely producing these radar plots for all of the patents that we analyse. We offer the service to client companies who may be looking for those 'Rembrandts in the Attic' (2) that might be able to earn them licence revenues in different industry sectors, as well as using the pictures to help advance the state of the art.

Final Thought

Readers of Hands-On Systematic Innovation or some of our articles on function mapping will be aware of the graphs we sometimes draw plotting different means of delivering a function relative to the main useful attributes that customers are likely to judge them against – Figure 3. The way we draw the graph axes, systems are seen to evolve to the top right hand corner of the graph as ideality increases. The perhaps obvious, but nevertheless we hope useful image we can construct to re-enforce the message is that as systems move from bottom left to top right of the picture, their radar plots will gradually fill out and expand to the limits of their evolutionary potential.

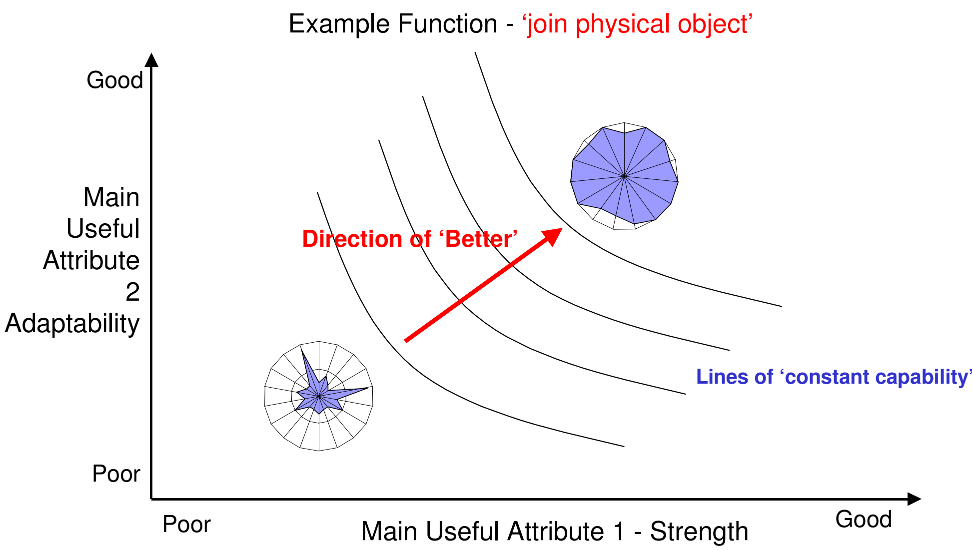


Figure 3: First Example Evolution – Addition of New Bristle Functions

References

1) Mann, D.L., Dewulf, S., 'Evolutionary Potential in Technical and Business Systems', TRIZ Journal, June 2002.
2) Rivette, K.G., Kline, D., 'Rembrandts in the Attic', Harvard Business School Press, November 1999.

Case Studies: Closed Circuit TV Surveillance Camera

Sometimes we fail when a client asks us to help them to solve a problem. Sometimes the lessons we learn during those failures can help to offer some general thoughts that might help others to use the TRIZ process more effectively in their own cases.

One such failure was a job that started from the question 'how do I reduce the manufacturing cost of my product'. The product in question was a closed-circuit TV based surveillance camera of the sort illustrated in Figure 1. (For obvious reasons, the one illustrated should be interpreted as merely representative of the system we were actually working on – confidentiality issues prevail, even when the customer doesn't pay).

Figure 1: Typical CCTV Surveillance Camera

Like the one illustrated, the camera unit under consideration is basically an off-the-shelf high-resolution video camera which has been attached to a structure that is designed to enable complete 360° pan and 100° tilt capability via a remote control signal. In order to achieve this level of functionality, the system comprised separate motor and actuator drives for the pan function and for the tilt function. In order to permit the 360° pan function, the system included a slip ring arrangement to enable the signal information to be transferred to and from the camera without the possibility of wires getting knotted. Beyond these basic components, the system was provided with other components delivering environmental protection and tamper-proofing functions. A simplified function and cost attribute analysis for the system is illustrated in Figure 2.

Interestingly, the system had been the subject of an ongoing programme of manufacture cost reduction activities. In this sense, the designers had already done a pretty good job of 'optimizing' the design of the current system – in that the ratio of component count to functions required was fairly close to 1 – which, in terms of the metrics employed by methods like Axiomatic Design and Design for Manufacture and Assembly, is pretty close to 'optimal'. In TRIZ terms, the system was rapidly approaching 'maturity' within the context of the current design.

The primary scope for trimming, in fact, seemed to reside with the possibility of eliminating one of the motor drives, and using the remaining drive to power both pan and tilt mechanisms. (In terms of the Law of System Completeness, of course, the fully trimmed system still has to include an engine (electric motor in this case), transmission (gearing system), tool (camera), control system (external controller) and interface (environment under surveillance)). The low price of the motors coupled with the increased complexity required of the transmission system in order to achieve pan and tilt functions (usually simultaneously) meant that the expected cost reduction benefits of this kind of switch were not expected to be sufficient.

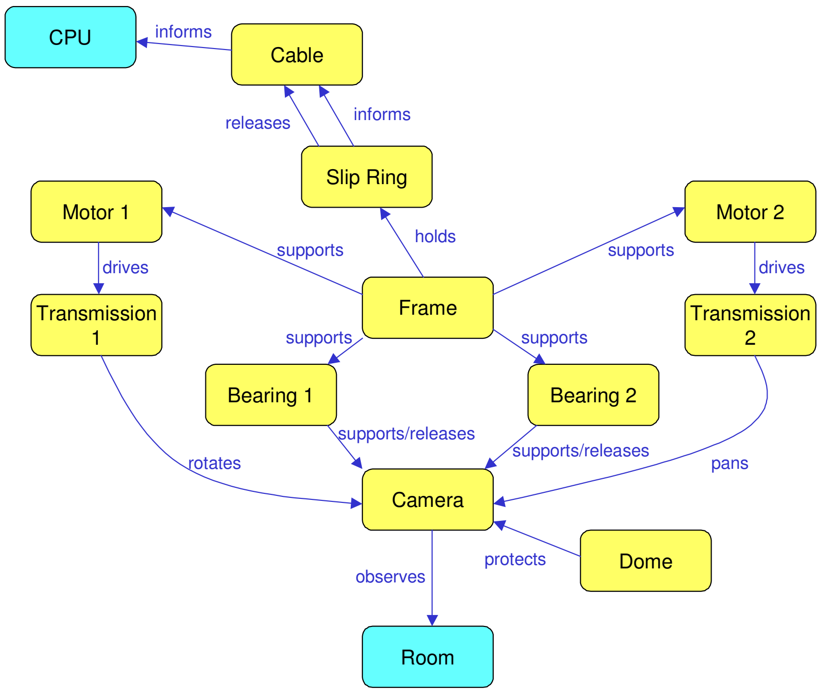


Figure 2: Simplified FAA Model for the Camera System

The target cost reduction for the system was stated as 30%. The expected benefit of switching to the single-motor option was of the order of 5%. Given this finding plus the evidence pointing to the fact that the part count was already close to 'optimum', the problem situation appeared to be one in which the potential to improve the current system was incompatible with the target – Figure 3.

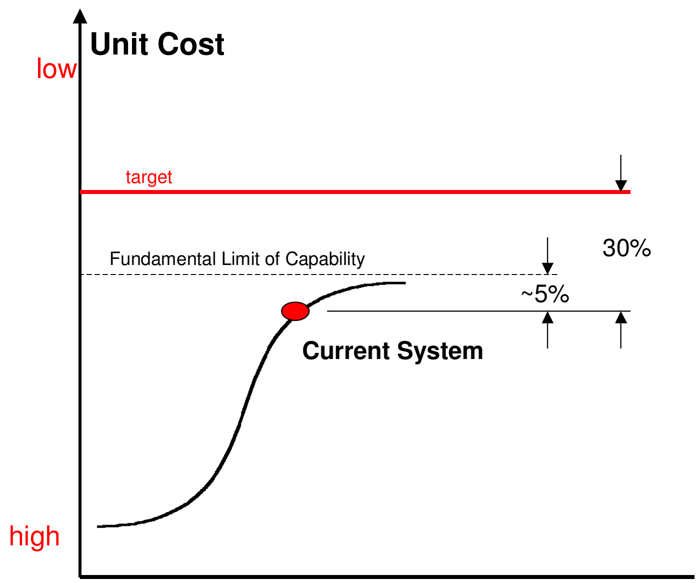


Figure 3: Conflict Between Fundamental System Capability and 'Target'

The Figure 3 situation – a target incompatible with the fundamental capability of the system is of course a very common one across the whole of the technical and business environment. The dynamics of evolution uncovered by TRIZ research clearly show that the primary mechanism by which this kind of incompatibility is overcome involves the identification and resolution of contradictions within the current system.

The client, while not necessarily pleased to hear this news, did accept that maybe the situation required a more fundamental re-examination of the current system. As such, we started the search for the limiting contradictions in the system and thus potential means of re-defining the way the overall functions were delivered.

In trying to identify contradictions it was found that although it was clear that the feature required to be improved was 'manufacture cost', the corresponding worsening features appeared to be somewhat less clear – it being possible to match to a wide range of the 39 parameters in the Matrix. With this in mind, we adopted a slightly different approach and took a look across the relevant 'manufacture cost' related rows in the Matrix to see which Principles were recommended the most. This analysis resulted in the findings illustrated in Figure 4:

Manufacturability	System Complexity	Level of Automation
1) Segmentation 2) Parameter Changes 3) Cheap Disposables 4) Mechanics Substitution 5) Other Way Around	1) Taking Out 2) Segmentation 3) Copying 4) Other Way Around 5) Prior Action	1) Parameter Changes 2) Mechanics Substitution 3) Other Way Around 4) Taking Out 5) Copying

Figure 4: Inventive Principles Most Commonly Used to Challenge 'Trimming'-Type Problems (Reference 1)

The most evident feature of the Figure 4 list seemed to be the frequency with which Principle 13 'The Other Way Around' was present. The feature was initially intriguing because of its apparent lack of relevance to the CCTV problem at hand. Nevertheless, its regular appearance appeared to demand at least some consideration before dismissing it.

The key to the successful use of any of the Inventive Principles is the identification of features in the existing system that the solution trigger could be applied to. In the case of 'The Other Way Around' this means finding either spacial or temporal features or interfaces that could be 'turned around'.

After identifying a number of such features within the camera (turning the axes of rotation around, switching the sequence of motors, mounting the camera 'upside-down' (to take advantage of gravity!), and several reversals of geometric features among the sub-system components), we used the system operator tool to re-focus us on the super-system.

This focus shift was the trigger for the idea to keep the camera fixed and move something else. Of course, keeping the camera fixed meant that it could no longer 'see' all of the required environment around the camera. Except, we quickly realized, if we could somehow manipulate the light in some way such that light from everywhere could somehow find its way in to the camera. The basic concept in action here we later surmised was that light was easier to move than a physical object (i.e. the dynamisation trend shift towards use of fields was coming in to play).

So, we now had a concept that, although it looked fundamentally attractive, we didn't know how to turn it into a practical reality.

At this point, we decided to take a look at the patent database in order to see if anyone else had adopted this 'move the light, not the hardware' philosophy. The speedy answer was, yes they have. Several times. Figure 5 illustrates one such solution – using curved mirrors to obtain the necessary range of viewing angles and perspectives (in retrospect, we could have arrived at a very similar concept if we had performed an evolutionary potential analysis of the current system and transformed plane surfaces into curved ones!)

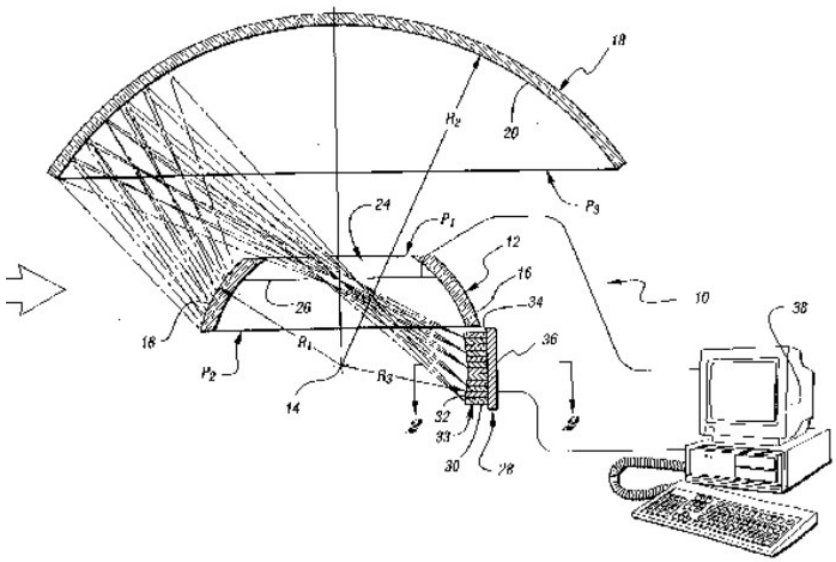


Figure 5: US Patent 6,003,998 – Panoramic Imaging Camera

Through some simplification of this design and introduction of another novel feature (that we won't detail here), we felt that it was possible to reduce the manufacture cost of the existing camera system by around 60%. Or double the initial target. The downside was that some of this saving required the use of a more sophisticated image processing software capability to reconstitute a 'curved' image of the objects under surveillance into a 'planar' TV screen image. We felt this job required configuration of a very simple algorithm.

Unfortunately, the client did not like the idea of writing software (or even having us do it for him). Or the idea that the camera wouldn't need to move at all. Or that the clever (in-house developed) slip-ring would no longer be required. And thus lies the basis of our failure – for, although we spent some considerable time listing constraints with the client, we failed to capture these important issues. Firstly we failed to record the reluctance to use software instead of hardware. Secondly, we failed to record the emotional attachment to a part of the existing design.

Thirdly, having generated what looked like an excellent result in terms of reduced manufacture cost, we failed to generate 'ownership' of that result.

We record this failure not just to provide another case study of how TRIZ can be deployed, but to point out:

1) that the recording of constraints – both tangible and intangible – is a very important part of the problem definition process. It is a part that requires some difficult and

often emotional decisions to be made, and it is a part that has a common tendency to not be done well enough

2) that the application of constraints to a problem can transform a problem that is 'solvable' into one that is not. In this regard we now tend to think of our often used Edward DeBono analogy of problem solving as digging for treasure in a field, where now the constraints are represented by fences marked 'keep out' and 'do not enter'. Sometimes the 'keep out' signs are useful, but if they prevent us from digging our hole in the best places, we perhaps need to think about finding a way around them.

Reference

1) Mann, D.L., 'Integration and Application of TRIZ and DFMA', paper presented at DFMA Conference, Newport, RI, June 2002.

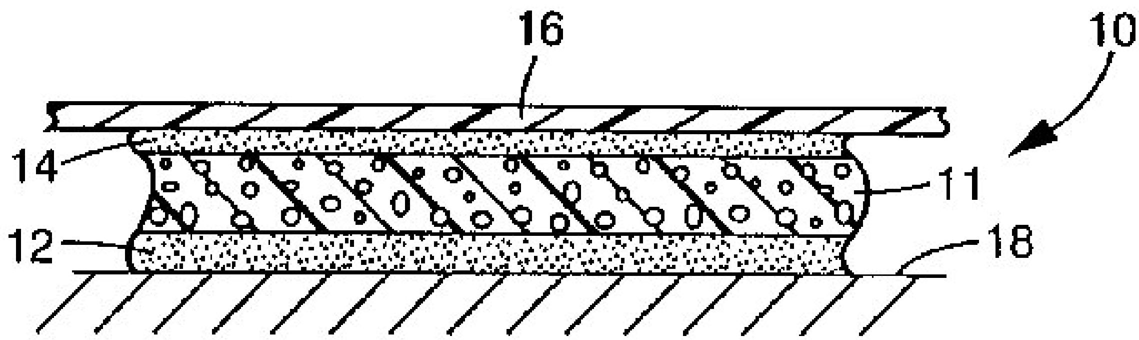
Humour

Back to basics this month, with our old favourite, Principle 35 – Parameter Changes. Principle 35 is the basis for the great majority of all jokes based on puns – those jokes where we play on the different possible meanings of words – first sending the receiver in one direction while we go down a different direction.

Our example is the 'cat-scan' medical monitoring method. The following images come from the most excellent 'catscan' website.

Patent of the Month

Patent of the month this month goes to a 3M invention for a removable foam adhesive tape awarded US patent number 6,403,206 on 11 June. The main image from the invention disclosure is illustrated below:



As described in the abstract, the invention covers '*conformable pressure-sensitive adhesive tapes which comprise a layer of polymeric foam in the backing and may be adhered firmly to a substrate and thereafter removed therefrom after only being stretched at an angle no greater than about 35.degree. from the surface of the substrate. Articles for mounting an object such as a picture to a surface such as a wall comprising a pressure-sensitive adhesive tape of the invention are also described*.'

We were initially attracted to the invention because of its evolution along the space segmentation trend to incorporate a foam. As stated in the TRIZ trend rules, 'somewhere there is a benefit in evolving to the right along the trend'. In the case of this design, that advantage appears to offer the opportunity to solve an interesting physical contradiction – that of I want the tape to be adhesive and not adhesive. In the tape application described in the invention, we want the tape to be adhesive when we want to stick something – like a picture to a wall – and not adhesive when we want to remove the tape from the wall. According to the invention, we can solve the contradiction (upon condition – for which one of the Inventive Principle suggestions is 31 Porous Materials!) by using the conformal and extensible nature of the foam:

'The present invention still further provides a pressure-sensitive adhesive tape comprising a multi-layer backing and a first layer of a pressure-sensitive adhesive composition coated on at least one surface of the backing, the backing comprising a layer of a heat laminated or coextruded polymeric foam/polymeric film and either an additional layer of solid polymeric film or an additional layer of polymeric foam adhered to the polymeric film of the heat laminated or coextruded polymeric foam/polymeric film, the backing further having a lengthwise elongation at break of from about 50% to about 1200%, the tape being capable of being firmly bonded to a substrate and thereafter being removable therefrom after being stretched at an angle no greater than about 35.degree. (preferably no greater than about 10.degree.) from the surface of the substrate without the backing rupturing prior to the removal of the tape from the surface.'

Very elegant. Something we'd like to see in sticking plasters – which can be very painful when we want to remove them from skin. In the meantime, you might like to think about the fifth and final stage of the space segmentation trend and speculate on the possible benefits of adding an active element within the pores of the foam.

Best of the Month

No contest in selecting a best of the month this month following the arrival of a new TRIZ book – 'Simplified TRIZ' by Kalevi Rantenan and Ellen Domb, published by St Lucie Press in the US. The book sets out to dispel the myth that TRIZ is fundamentally difficult to learn and apply. We devoured our copy within a couple of days of receiving it, and have no hesitation in saying it has successfully met its aim.

You could find out a little more about the book here. Or, you could save yourself a little time and purchase it from here.

Conference Report – Axiomatic Design, MIT, 10-11 June

We presented an updated version of our ‘Axiomatic Design and TRIZ: Compatibilities and Contradictions’ articles from TRIZ Journal at the home of Axiomatic Design in Boston, MA during June. It would probably be fair to describe the reception as somewhere between ‘cool’ and ‘hostile’.

Applying TRIZ trends to the evolution of TRIZ would appear to suggest an integration between different methodologies and philosophies. This belief was in fact the basis for our attendance at the conference. Unfortunately the majority of Axiomatic Design aficionados did not appear to share the same viewpoint. And so despite an introductory slide describing the importance of shifts away from ‘either/or’ thinking to ‘and’ thinking, there was a strong inclination from the part of some people to think there was some kind of ‘TRIZ versus Axiomatic Design’ competition taking place.

Here are some of the ‘highlights’ of the resulting debate:

From a TRIZ ideality perspective, Axiom 1 of Axiomatic Design ‘functional requirements should be made independent of one another’ is not an axiom. But it is nevertheless a useful deign guide at certain stages of the evolution of a system, and in any event, the focus on ‘function’ inevitably means there is significant common ground between AD and TRIZ. Despite the fact that the opening paper of the conference presented a highly intriguing case to suggest that nature (an example of ‘good design practice’) didn’t appear to pay much attention to following Axiom 1 by achieving independence between functional requirements – think of the number of interlinking functions of a bird’s wing for example – there was a strong reluctance to even contemplate that one of the cornerstones of AD might be incomplete.

The spread of AD has been significantly hampered (in our view) by the abundance of matrix algebra. The conference appeared to bear out this belief with the distinct absence of any case studies where the matrix part had been applied (actually, there were only two real case studies in any case – which in itself was quite revealing). The CREAX suggestion that probably around 10% of designers would be familiar with matrix algebra, and probably 10% of them would willingly use matrix algebra went down like the proverbial lead balloon. Our message was – if you like matrix algebra, then great, but if you don’t, you can obtain exactly the same information that a matrix definition of a design would provide by drawing a function and attribute analysis model.

Our even bigger faux-pas came when we suggested that AD was strongest when applied in a solution evaluation as opposed to idea generation manner. Nam Suh appeared to take particular offence at the suggestion and went on to claim that he has made several inventions using Axiomatic Design. It is a pity that we provoked such a defensive response. Invention can come from many sources and TRIZ makes no claims to the contrary. Focus on function can be an excellent invention trigger – particularly in technology areas where no-one else has already made a similar connection – and so it should be no great surprise that AD can help in the process of inventing something. Axiomatic Design is a very useful tool in certain situations, and it is one that we will continue to bring to bear in the work that we do. When that work calls for the generation of new product ideas, however, our experience suggests that TRIZ will be the more helpful tool. When digging a hole for a swimming pool, one can opt to use a teaspoon or a mechanical digger; we usually opt for the latter.
Professor Suh’s new book on Axiomatic Design can be obtained from Amazon.

Investments – 'Cryotech Ice-Chuck'

Our investment of the month this month is another rather specific one. We like it because the system that has been developed solves a very common physical contradiction – I want to grip something and not grip it – using a resource that is highly plentiful and very predictable in its behaviour - water.

The company Axis Controls Ltd (**http://www.axis-controls.com/index.htm**) has developed the 'ice-chuck' as a means of holding components during machining operations.

How does it work ?

Nature provides a perfect example for this revolutionary work-holding technology. If you touch a frozen metal surface with your bare hands you know that your fingers will stick firmly to the surface. The Ice-Plate works on exactly the same principle. A work-piece is placed on the plate and the contact surfaces are frozen together allowing the work-piece to be machined without further clamping. The holding force is approximately 15kg/cm2.

Axis Controls Limited developed the processor based Ice Chuck Controller capable of powering single or multi-chuck systems in a variety of size configurations. With a 'twin' system two ice chucks are controlled independently allowing two work-pieces to be worked at the same time. Alternatively, one work-piece can fixed for working while another is pre-cooling or being heated for disengaging and relocation of a new work-piece increasing turnaround time on a single machine.

The Ice Chuck uses water's natural ability to freeze and hold components to facilitate machining. The technique of holding by freezing is not only economical but also perfectly ecological since it only requires water.

Work pieces are placed on the Ice Chuck , which is covered by a thin film of water and then frozen. The holding force is sufficient to accommodate both large and small work pieces, which can be drilled, milled, turned, ground, polished and engraved.

Freezing and thawing does not exert any stress on parts which makes this method particularly suitable for fragile, thin, non-magnetic and complex shaped work pieces manufactured from plastics, ceramics, honeycomb structures, graphites, porous and ferrous materials.

Environmental awareness does not favour the use of holding-media such as wax and glues as they are messy to use and the solvents required to disengage the parts are often unacceptable to the operator and the environment. The Ice Chuck uses only clean water and holds with equal efficiency without the associated environmental risks. Parts traditionally difficult to hold using magnetic and/or vacuum chucks are far better served with an Ice Chuck.