Common Ground – Synergies Between TRIZ, Perception Mapping and Kansei Engineering

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Abstract

The paper reports findings of a programme of research to explore the benefits achievable through a combination of different innovative design approaches. The research has been completed over a six-year period, and has encapsulated a large proportion of the design and creativity tools available across the world. Particular benefits have been recorded by deploying a combination of three of these methods – TRIZ, Perception Mapping and Kansei Engineering. The paper discusses the common ground between the three from the perspective of the role they may be able to play in the systematic delivery of 'wow' design solutions.

Introduction

A key theme of this year's Research Into Practice is the role of the artefact in the design process. Perhaps a significant part of the debate centres around a contradiction: we want an artefact and we don't want an artefact. On the positive side, artefacts are helpful because they help designers to communicate their intention to an intended audience, allow that audience to connect with that intention, and then provide meaningful feedback to the designer. In a perfect world in which it was possible to instantly, cheaply and effectively create a true representation of design intent, in fact, there would be no debate over the need for an artefact. But this is not the case, and so the negative side of the artefact debate says that we don't want an artefact because their creation is time-consuming, expensive and often still only a partial representation of the designer's true intent.

One of the main under-pinning ideas behind the Soviet-originated Theory of Inventive Problem Solving method, TRIZ is that strong solutions eliminate contradictions. A strong answer to the artefact versus no-artefact debate, in other words, would be a situation where we have an artefact *and* we don't have an artefact. Elimination of contradictions means shifting from a Socratic either/or mentality to one that talks instead about both/and solutions. In the ideal situation in the artefact debate, we achieve the positive attributes of the artefact without the negative. The next big wave in manufacture technology is undoubtedly a powerful shift away from expensive mass-production machinery towards desktop artefact creation. The shift takes the form of a host of rapid-prototyping/3D-printing technology advances, several of which have already delivered practical solutions in several application areas.

Thus, TRIZ will suggest that eventually the artefact/no-artefact debate will come to be meaningless. Being the biggest study of innovation and creativity success ever conducted, it can also be expected to help accelerate the resolution of the contradiction. This paper touches on the possible role of TRIZ in helping to achieve this outcome. More importantly, however, it explores how TRIZ can help designers to re-think the way things are done during the period of transition to the ideal end result.

One of the main criticisms of the TRIZ methodology is that it's stated ability to deliver 'systematic creativity' makes it almost the antithesis of what every designer wants. The argument goes something along the lines, 'designers are among the most creative individuals on the planet, and so why would they want a systematic way of doing the creative part of their job?' The argument has some justification, albeit one that falls into yet another either/or trap. Should a designer use TRIZ or not use TRIZ? Answer; yes they should use it (when they want to) and no they shouldn't (when they don't). One of the reasons they should use it is that it is difficult to ignore a methodology built on the study of nearly 3 million successful design solutions, and the uncovered fact that there is an awful lot of re-inventing-the-wheel taking place across the world. Thus, at the very least, TRIZ allows designers to spend a lot less time searching for information and a lot more time doing the creative part of the job.

A related criticism relates to a belief that by 'reducing' the creative process to a systematic level, TRIZ is inevitably weak in terms of building the emotional aspects so important to the success of any design. There is some justification of this criticism. TRIZ handles it by adopting one of the founding principles of the method; 'someone, somewhere has already solved your problem'. In this case, the answer is not quite there, but clearly the world has done a lot of work to try and understand the emotional aspects of what makes one design successful and another – apparently almost identical other – not successful. Adopting a philosophy of integrating best practice into a unified whole, then, has been the single biggest under-pinning idea behind TRIZ. As suggested by Figure 1, the desire to incorporate elements of 'emotion' into the design science has seen inputs coming from all fields of design, psychology and the natural sciences.

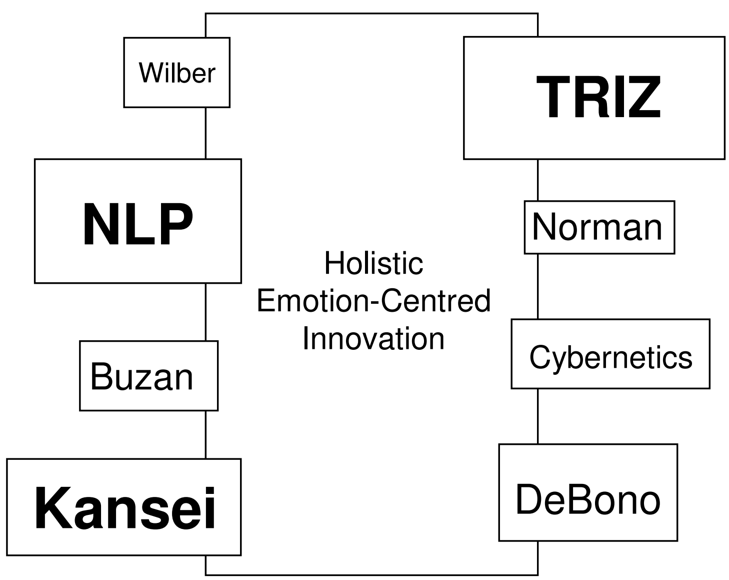

Figure 1: Unified 'Emotion' Design Methodology Framework

Of the various methodologies explored, the Japanese Kansei Engineering method appears to offer the most immediate application benefits. Kansei Engineering is an attempt to correlate human sensory perceptions, brainwave patterns and stimulus dimensions in order to help identify what attracts and what repels an individual when they are looking at, visualising, touching, using or, more generally, 'experiencing' an artefact.

In essence, Kansei starts with a diverse set of product artefacts that will provoke a wide range of different emotional responses. These subjective responses are typically assessed using sets of bipolar attribute rating scales against which participants are asked to indicate where they think a product falls relative to the two attributes in question. While useful, the technique is limited by the fact that it is both interpolative – in that the recommended output must come from a combination of things found within the range of possibilities examined – and is fundamentally built on the principles of optimisation and trade-off. At this point, it appears that Kansei travels full circle and returns to one of the main ideas of TRIZ; that of seeking to eliminate conflicts and contradictions.

The paper thus takes as its theme the significant common ground between the knowledge codification and abstracted artefact aspects of TRIZ and Kansei, and examines some of the synergies that emerge when the two different philosophies are utilised in an integrated fashion. The paper further demonstrates that by adding elements of the Perception Mapping technique evolved from a tool first devised by Edward DeBono, a significantly enhanced design methodology emerges. We begin, however, with a brief review of the individual methods as a means of introducing the integrated whole.

TRIZ

Research into the TRIZ method (Reference 1) began in the former Soviet Union in 1946. The initial work was based on the study of the global patent database, and the belief that it was possible to distill the strategies of the world's finest inventive minds into a practically deployable methodology. The belief emerged from the discovery that different industries spend a large proportion of their time re-inventing what someone, somewhere else has already invented. Hence one of the first outputs of the method was a series of 'Inventive Principles' that, in an abstracted form, encapsulate the inventive strategies used by all inventors. Other key discoveries of the research are:-

a) all systems evolve through very predictable discontinuous evolution jumps that repeat across different industries
b) the strongest design solutions eliminate rather than accept trade-offs and compromises
c) the strongest design solutions use existing resources and therefore tend to make systems simpler rather than more complicated
d) the strongest design solutions have taken a holistic perspective of space, time and the way that systems interface and relate to one another.

At its simplest level, TRIZ may be thought of as an abstracted database of the world's most successful design strategies. On the other hand, experienced users will appreciate that there are many philosophical elements of the whole that make it more of a 'strong thinking' creativity framework than simply a database. TRIZ is being widely used (although not being publicly talked about) by a large number of the industries of the world.

Kansei

Kansei Engineering – also sometimes referred to as 'sensory engineering' or 'emotional usability' – is a technique involving the determination of design attributes that elicit particular subjective responses from people, and then using these attributes to design products that produce the desired responses. Although considerably less researched and therefore less mature than TRIZ, Kansei is beginning to be deployed experimentally in a number of organisations. A simple method of using Kansei involves starting with a diverse collection of artefacts aimed at provoking a wide range of different emotional responses in viewers. By then asking viewers to assess these artefacts, their subjective responses can be assessed using sets of bipolar attribute rating scales. A typical bipolar attribute rating scale uses a pair of opposed terms, such as simple *vs.* complex or feminine *vs.* masculine, placed on a continuum represented as a line. Participants are asked to place a mark on that line to indicate where they think a given artefact falls relative to the two attributes in question. Each artefact is rated on each attribute scale, and these ratings are statistically compared to provide a distribution of products across the different rating criteria. Analyzing all artefacts rated highly on a particular characteristic is then supposed to allow the designer to draw conclusions about which perceptual elements are responsible for eliciting this subjective judgment.

More recent Kansei research is trying to translate this subjective analysis approach into something more scientifically code-able. Reference 2, for example reports work to correlate how much we are attracted to or repelled by an artefact to mappable brain apha wave functions. Initial results from this work seem to indicate that the inordinate mysteries of what humans find attractive or un-attractive are in actual fact eminently identifiable. Reference 2, in turn builds on the neuro-science research foundations laid down in Reference 3.

In the meantime, what if we wish to make practical use of Kansei ideas in the design process? Scientific experiments to tap into brain-waves aside, the current version of Kansei requires the presence of a range of artefacts for participants to rate against the pre-defined bi-polar attributes. In theory, what the resulting ratings tell the designer is how to connect attributes of an artefact to whether people find it, say, ‘simple’ or ‘complex’, ‘masculine’ or ‘feminine’, etc. Consequently, once we know these connections, and our target market we are theoretically able to match the two together and achieve a design that evokes the desired responses in the target audience.

There are two big problems with this basic concept; firstly, although it segments a series of complex emotional aspects into manageable segments, it makes no attempt to understand the relationships between the individual segments. Thus, for example, how do we know whether and how the perception that an artefact is ‘feminine’ influences our judgement of its complexity? Is there a positive correlation? A negative one? Within Kansei, the answer is that we simply do not know. This is important since ultimately, a designer has to make judgements over which attributes are more important than others, and then ultimately decide how each should be incorporated into the final artefact. Secondly, the process of scoring artefacts along a bi-polar scale fundamentally pushes the designer towards compromise solutions. Ultimately, of course, a compromise represents the best of a bad job, and is unlikely to completely satisfy anyone.

The second of these concerns, as we have already stated, returns us to the TRIZ methodology. We will examine how TRIZ can help us to resolve the compromise dilemma shortly. In the meantime, we focus our attention on the first of the two Kansei concerns, and explore how a tool known as Perception Mapping can help to make sense of the complex web of inter-relations between different design attributes:

Perception Mapping

The roots of the Perception Mapping tool derive from the work on 'flow-scaping' done by Edward DeBono (Reference 3). The tool is a simple yet powerful way of making sense of the relationships between the different attributes of a design. The first stage of the process involves defining the bi-polar attribute pairs thought to be relevant to a given product. Figure 2 describes a possible list for a typical consumer product.

Rough/Smooth	Acute/Obtuse
Gloss/Matt	Hard/Soft
Feminine/Masculine	Plain/Decorative
Symmetry/Asymmetry	Delicate/Robust
Curved/Angular	Slim/Broad
Delicate/Robust	Romantic/Practical
Modern/Classic	Big/Small
Sensual/Non-sensual	

Figure 2: Typical Bi-Polar Attribute Pairs For A Typical Consumer Artefact

The next part of the process then asks the simple question 'which of the other attribute pairs does this one lead to?' The question is posed for each and every listed attribute pair until we obtain a complete list of 'leads to' connections. By definition, then, if we take the perceptions and translate the 'leads to' connection into an arrow connecting one perception to another, the resulting perception map must contain at least one closed loop – a system where one attribute-pair leads to another, leads to another and so on until one leads back to the initial pair. According to the process, these loops are significant. Another possible phenomenon contained within the maps is that, even though each attribute-pair may only have one connection arrow pointing *from* it, it may be the case that several other pairs point *to* it. Pairs that several other pairs 'lead to' are known as 'collector points and, according to the method again, are also significant. Conducting the 'leads to' analysis for the attribute pairs detailed in Figure 2, might get us to the perception map illustrated in Figure 3.

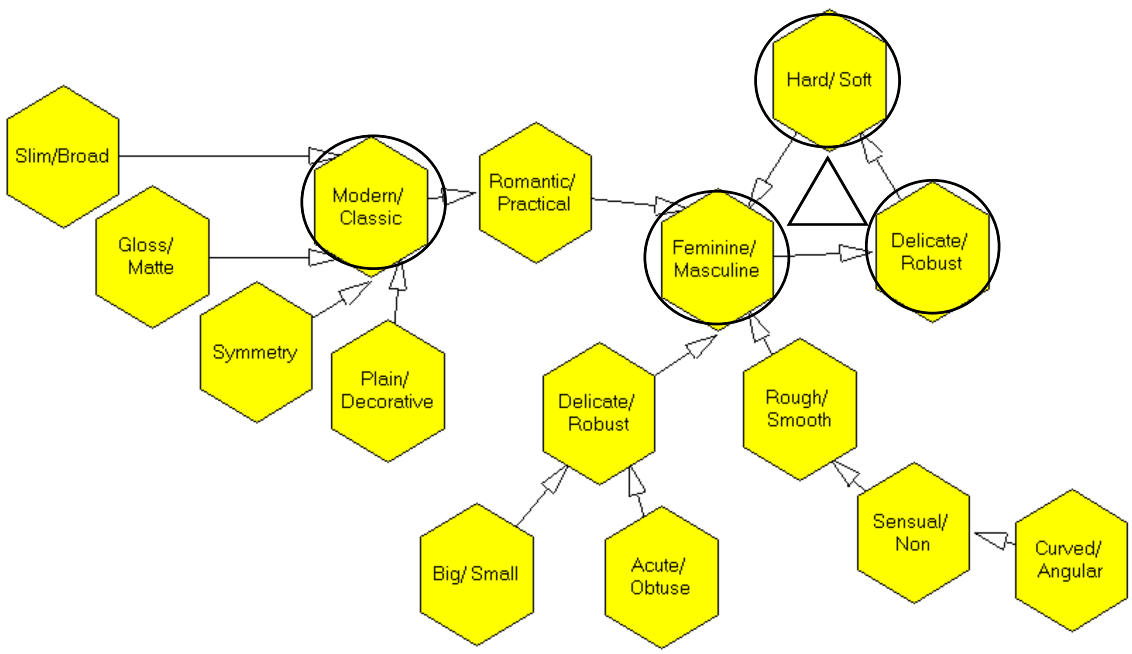

Figure 3: Typical Perception Map Of Bi-Polar Attribute Pairs

One of the main underlying principles behind the perception mapping technique is that, by asking the open, divergent 'leads to' question, the creative modes of the brain are engaged instead of the closed, convergent analytical side. By forcing the user to select one and only one of the other attribute pairs for the one under evaluation to lead to, the process also recognises that the brain is an extremely powerful parallel processor and engages these capabilities in order to identify how the various small elements of the whole connect to one another. Reference 4 discusses the psychological foundations of the process in more detail. Reference 5 then goes on to detail the process and describes a number of case study applications – from design to human relations mapping to ethical problem solving.

For the particular example illustrated in Figure 3, the loop and collector points on the map indicate that, for this particular example, out of all the mapped attribute pairs, the masculine/feminine, hard/soft, delicate/robust and modern/classic are the most important ones. Thus, the process has provided a steer towards those attribute pairs that are the most significant. Important to note here is that we focused this particular analysis on a generic consumer artefact; as we focus on more specific artefacts or designs, the perception map may change its form considerably, and different attribute pairs may emerge as significant.

One of the uses of the perception mapping, relating to the earlier debate over artefact versus no-artefact, is the idea that we use the mapping process to identify the significant attribute pairs before we are forced to construct anything. In this way, we are able to reduce the potentially large numbers of prototypes required to much more manageable levels.

The perception mapping tool is a 'complexity management' tool. Its primary aim is to distill sense from highly complex, inter-related situations. As such, it can play a useful role in the early stages of a holistic design process. When we begin to integrate the outputs of the process with TRIZ, the influence on final design outcomes can become pronounced:

Design For Wow

Reference 6 describes an early attempt to be able to systematically create design solutions that elicit a 'wow' response in viewers. The ability to systematically generate breakthrough design solutions sounds like a physical impossibility to most people, and at the very least unlikely to others. Some successful designers may even take offence in the idea that the x-factor designs they are able to occasionally achieve may in fact be achievable in a systematically reproducible manner. Difficult to believe/accept as it may be, one of the main findings of the TRIZ research is that all studied breakthrough design solutions possess one significant common feature. As already hinted at, that common feature is the fact that the designer has resolved a trade-off or contradiction that other designers have not. The research has further shown that the 'wow' effect on consumers of a breakthrough solution is massively greater than the effect generated by any 'conventional' design strategy. A recent study of successful advertising campaigns, for example (Reference 7), showed that 85% of the most successful advertising campaigns ever successfully challenged a contradiction, compared to the average of 6% of advertisements present in the media at any given point in time. Ongoing research into the world of fine art reveals a similar correlation between the historical importance of an artist and their ability to resolve important contradictions (Reference 8).

Solving a design contradiction, in other words, is an extremely potent means of getting consumers to want to buy the solutions that designers create. Put another way, the net effect of a contradiction-breaking design solution is highly likely to be a much greater success factor than the presence or otherwise of an artefact, or the fact that a design may have successfully engaged a 'feminine' or 'sensual' or any other emotional response.

This is not to say that the presence or otherwise of an artefact is not relevant, or that trade-off and optimization design strategies are 'wrong', but merely that in the bigger scheme of things they are secondary factors compared to the first order benefits generated by the successful challenge of an existing paradigm.

The link here with the preceding discussion about Kansei and Perception Mapping is that both can lead the designer towards knowing which contradictions and trade-offs are more important than others. Thus in the Figure 3 analysis there is the indication that the feminine/masculine, hard/soft, delicate/robust and modern/classic conflict pairs are the most significant for the case analysed. A breakthrough design solution in this case would successfully challenge one or more of those conflict pairs – it would be simultaneously masculine *and* feminine, hard *and* soft, delicate *and* robust, or modern *and* classic. Clearly resolving such conflicts is not going to be easy, but then again according to TRIZ, someone somewhere has already solved your problem. Creating a design solution that is both 'hard and soft' (not a typical design brief) sounds highly implausible. Or at least it does until you become aware of the capabilities of rheopexic gels, or magneto-rheological fluids – both of which exist and are very readily capable of resolving the conflict. Allow a consumer to put on a shoe with a rheopexic sole, or handle a cooking implement with a rheopexic handle, and they are highly likely to want it irrespective of any other attributes that it may or may not possess.

One of the most powerful tools within the TRIZ armoury takes these kinds of contradiction-breaking solutions and abstracts them into a form that allows others to access the good solutions of others. This is done in an abstracted way in order to ensure that the creative abilities of the designer are still a necessary part of the process. Reference 9 details the latest version of the so-called 'Contradiction Matrix'. Now built from the analysis of over two million successful design solutions, the Matrix has recently been expanded to include many of the emotional aspects of a design absent in previous versions. The basic form of the Matrix is illustrated in Figure 4.

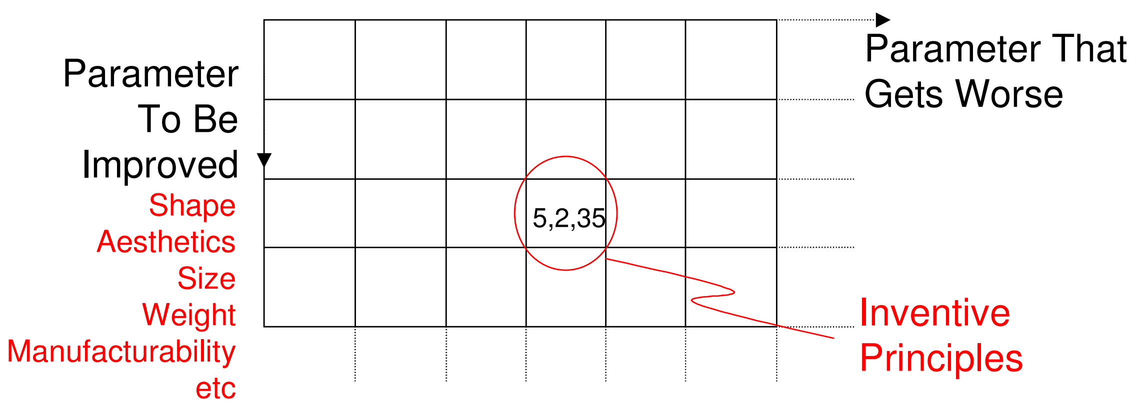

Figure 4: Contradiction Matrix Structure

The basic underlying idea, then, is that the user identifies attributes of a design that they would like to improve, and then things that either stop them from making the improvement, or get worse as respectively a row and a column in the Matrix (e.g. most designers would like to improve aesthetics, but manufacturability considerations prevent them from doing what they would like to do would be a typical conflict pair). At the intersection between row and column is a list of the inventive strategies used by designers and problem solvers that have successful overcome such contradictions. Each of these inventive strategies is numbered. So far, looking across literally every field of human endeavour, only 40 such inventive strategies – or 'Inventive Principles' – have been uncovered. There may be more out there, but to date, these are the only known ones. It is unfortunately beyond the scope of this paper to go into details of the Principles. All that can be hoped for is that readers are interested enough to check out one of the many Principles resources available at Reference 10, and to explore the possibility that they may indeed be deployed to create contradiction-challenging, breakthrough design solutions.

Summary – TRIZ/Kansei/Perception-Mapping and Artefacts

In several ways, this paper has fudged the main topical issue of the role of the artefact in the design process. This is because, according to TRIZ, this kind of artefact/no-artefact debate is merely the definition of a contradiction that has not yet been totally solved.

The artefact is clearly a central element in any design process that involves a recipient of the design. It is very much easier to communicate design intent through a representative entity, and the closer that entity is to the actual end result, the more useful it may be expected to be. It is simply very difficult to evoke an emotional response in anyone by describing products in the abstract.

Artefact creation is still a cost in the design process, and hence the less of it that we have to do the better from an economic standpoint. Very few organisations have either the time or resources to any longer adopt a trial and error artefact creation strategy. Both Kansei and Perception Mapping offer means by which the most important attributes of a design may be identified. As such it is believed that they offer a valuable contribution to the designer's toolkit.

Likewise, TRIZ – whether designer's wish to even hear the words 'systematic' and 'creativity' in the same sentence or not – is also difficult to ignore. If it really may be true that someone, somewhere has already solved your problem, then you need to know about it. Maybe not from an ego perspective you don't, but from an intellectual property point of view, you absolutely do. One of the worst things for a designer to ever discover is that someone, somewhere has already patented a solution that they have just spent several months sweating to create. The smart designer, therefore, is increasingly looking at TRIZ first, before they get creative.

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