Contradiction Chains

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INTRODUCTION

We often hear talk about ‘design without compromise’ and ‘contradiction elimination’ in papers about TRIZ. Both terms carry the implication that TRIZ offers some kind of a panacea to the ills of the engineering and design worlds. While this is clearly not the case in practice, the Contradictions tools and methods contained in the TRIZ schema are nevertheless still very important paradigm changing tools that offer much to help design better products, processes and services.

This brief article examines some of the underlying truths behind the Contradictions methods in order to perhaps begin to establish what we really mean when we talk about ‘elimination’ of contradictions.

TWO CONTRADICTION SCENARIOS

A technical contradiction can often be usefully drawn as a graph of the type illustrated in Figure 1.

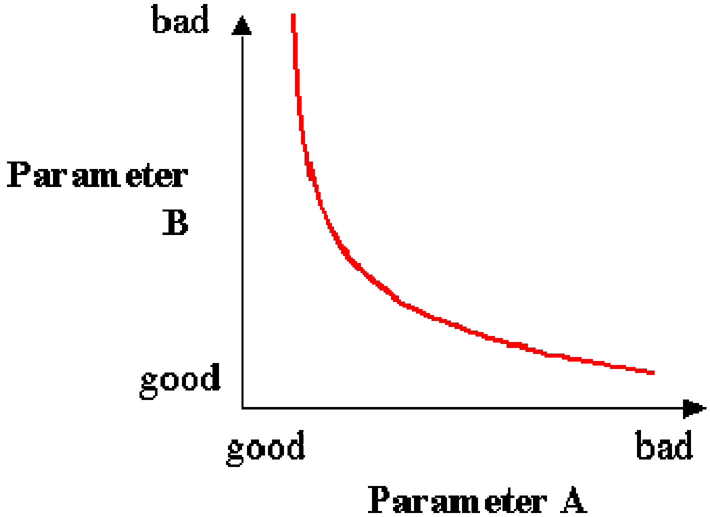

Figure 1: Graphical Representation of a Technical Contradiction

On the graph, the red line may be seen as a 'line of constant design capability', or as a representation of the current design paradigm. For example, referring back to an earlier article concerned with the design of flange joints (Reference 1), we might see Parameter A as 'leakage performance' of the flange, and Parameter B as the number of bolts around the flange joint. Traditional flange design – where, incidentally, the designer may only be sub-consciously aware of the Figure 1 graph characteristic – sees the designer trying to find a balance between adequate leakage performance and minimum number of bolts. This generally means the flange is designed such that it 'just' doesn't leak (which, in turn probably explains why most flange joints leak). Or, with reference to Figure 1, the designer finds the point on the red line where the 'best' compromise is obtained.

When we talk about design solutions in which we 'eliminate' contradictions we can mean one of two things: Firstly we can mean that we have **really eliminated** the contradiction, and secondly we can mean that we have **improved** the contradiction scenario. For arguments sake, we will call these two solution types 'discrete' and 'continuous' respectively. The main difference between the two types is best examined through a pair of examples:

Discrete

A good example of a 'discrete' contradiction solution scenario is the bicycle seat case discussed in Reference 2. In this case, we could draw a figure like Figure 1 above, in which the width of the current saddle is drawn along the x-axis, and a parameter like 'shape' is drawn up the y-axis.

In the saddle case study, the contradiction was stated to be 'eliminated'. In 'eliminating' the width-shape contradiction, the Figure 1 graph is no longer relevant – i.e. the axes of the figure no longer make sense because width and shape are no longer in conflict. This is a discrete contradiction solution scenario. It is discrete because the **particular** technical contradiction under consideration **has** literally been eliminated; we had a contradiction, and then we didn't.

Continuous

Continuous solution scenarios are generally more common. The above flange joint example may be seen as a continuous contradiction in that while we managed to halve the number of bolts around the joint, the contradiction between leakage performance and number of bolts still exists.

Likewise, we might see the well known contradiction between physical size and the fuel burn efficiency of the internal combustion engine – Figure 2 – as another example of a continuous solution scenario. The correlation between size and efficiency is very well established for most if not all internal combustion engine types, and in selecting a particular engine for a given application, when constrained to work within a traditional design approach, the designer has little scope for improving on the red-line characteristic. I.e. selecting engine size more or less simultaneously fixes engine efficiency for a given engine configuration.

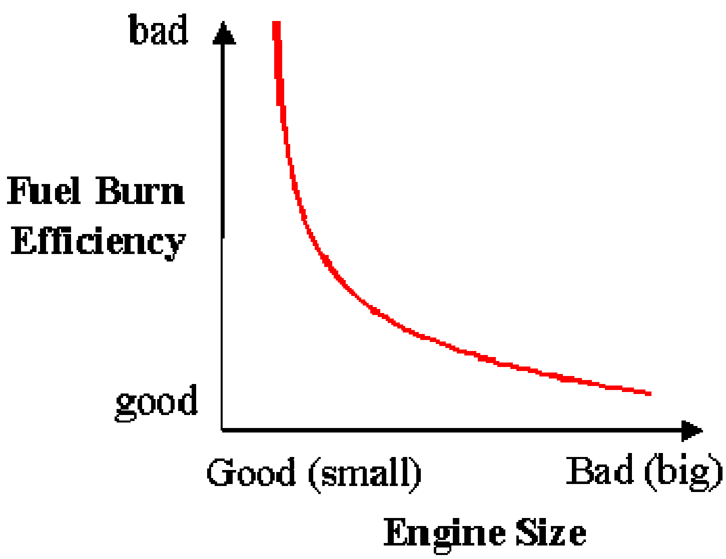

Figure 2: Typical Size versus Efficiency Contradiction for an Internal Combustion Engine

The exception to this rule occurs when the designer is able to change the design paradigm. Using the Contradictions tools in TRIZ is a good means of achieving this design paradigm change. For example, the size-efficiency relationship is changed – i.e. a new red-line is drawn – if the design paradigm shifts from, say, a conventional eight-valve to a sixteen valve porting configuration.

The size-efficiency relationship may be seen as a continuous contradiction solution because even if the designer is able to employ TRIZ to change the design paradigm in this way – 'to eliminate the contradiction' to use the incorrect terminology – the size-efficiency conflict still exists. The only difference now is that it exists on a new (hopefully better) red-line – Figure 3.

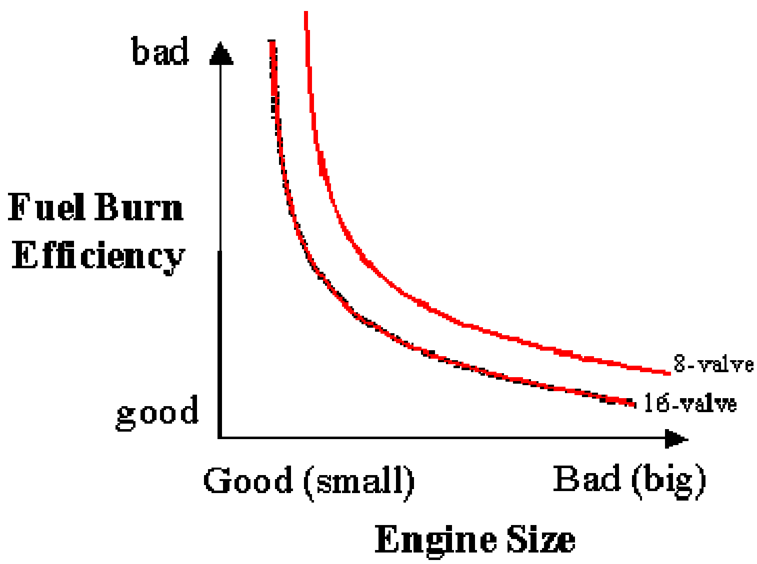

Figure 3: Design Paradigm Change Shifts Contradiction Characteristic Position

CONTRADICTION CHAINS

The continuous solution scenario may be seen as a chain of contradictions. A chain in that successive paradigm shifts will gradually move the characteristic line closer and closer to the optimum. Using Contradictions to assist in creating these paradigm shifts is one of the great strengths of the TRIZ methodology.

The difference between the TRIZ Contradiction design philosophy and the traditional 'design is a trade-off' scenario may thus be illustrated by the graph shown in Figure 4.

The term 'contradiction chains' is appropriate in the continuous solution context because each paradigm shift serves to improve the relationship between the two conflicting parameters in question, and thus increases the net value to the customer, even though the conflict still exists to some extent.

But then, what about the discrete contradiction solution scenario? What about those cases where we **actually** do achieve an elimination of the contradiction?

Again the bicycle seat case study holds a number of clues. In this example we see that a width-shape contradiction has literally been eliminated. However, this is not the same thing as 'design without compromise'. This is evident because the new seat continues to contain other contradictions. More specifically, it contains new contradictions that weren't present in the original scenario.

In this context, the term 'contradiction chains' continues to be relevant. Elimination of one contradiction has created others. If the designer has done a good job, there has been a net benefit to the overall system – i.e. the overall design paradigm has been changed for the better – but as with the continuous solutions scenario, there remain other possibilities to improve the design.

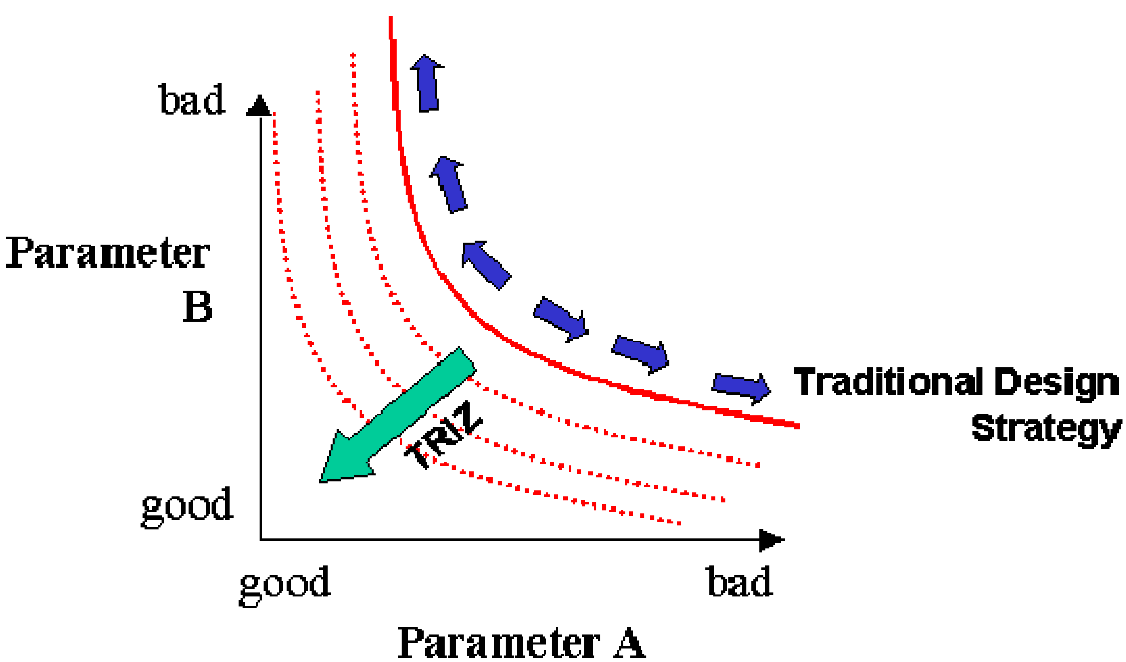

Figure 4: – Comparison of TRIZ and Traditional Design Strategies

Again, the idea is perhaps best seen through example. The split bicycle seat that eliminated the width-shape contradiction (Figure 5), creates a new contradiction resulting from the fact that the moving seat components create new problems when the cyclist tries to turn a high speed corner. So whereas with the original saddle design, the cyclist is able to press his or her leg against the side of the saddle to help turn the corner, with the new seat design this is no longer possible. A new harmful side-effect versus force (i.e. the stiffness/resistance of the seat motion) contradiction has emerged. And so, although there is a net benefit (to most users!) with the new design, there is still much potential for improvement.

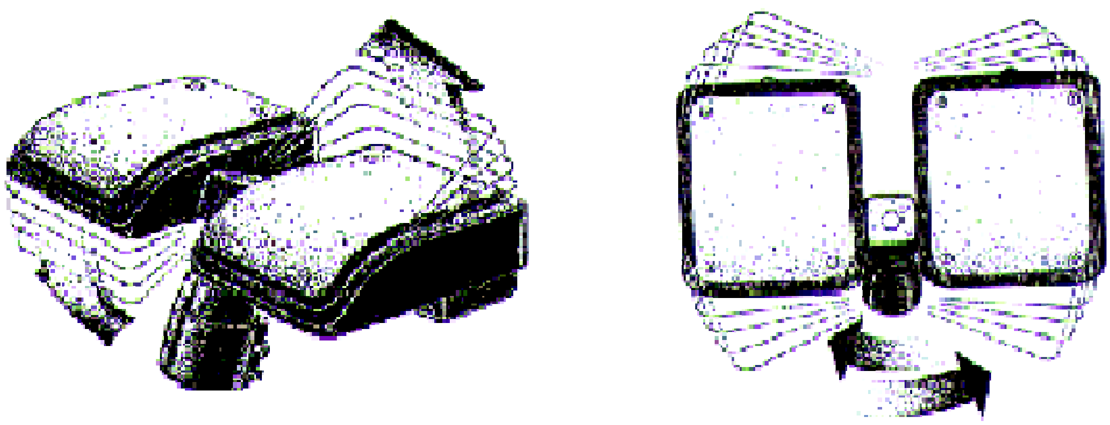

Figure 5: ABS Sports 'Dual Action Seat' (from Reference 2)

In most cases, the designer then has to make decisions on just how far to take the contradiction chain. Is it appropriate to launch the product in its Figure 5 form, or would it be better to continue challenging the design paradigm by attempting to eliminate further design contradictions. This can only be done on a case by case basis, with due consideration of commercial and marketing issues. In the specific case of the Figure 5 bicycle seat, it now appears that it would perhaps have been more prudent to extend the contradiction chain to 'eliminate' more contradictions before product launch.

CONCLUSIONS

1) The TRIZ 'Contradictions' tools and methods are extremely potent design paradigm changers.

2) Solutions to technical contradiction problems come in both 'discrete' and 'continuous' types.

3) 'Discrete' solutions – where we literally eliminate a contradiction – usually give rise to other –hopefully lesser – contradictions.

4) 'Continuous' solutions do not literally 'eliminate' a contradiction (even though we often say that they do), but if successfully deployed, do change the design paradigm for the better.

5) Contradictions come in chains. How far along a given chain a designer travels before a decision to launch a new product, process or service is made can only be reliably made on a case-by-case basis, taking due account of all time, cost, risk and specification issues surrounding the basic technical design circumstances.

REFERENCES

1) Mann, D.L., 'Case Studies In TRIZ: Halving The Number of Bolts Around A Flange Joint', TRIZ Journal, November 1998.

2) Mann, D.L., 'Case Studies In TRIZ: A Comfortable Bicycle Seat', TRIZ Journal, December 1998.