Seeking innovation in a Six-Sigma Project

by applying TRIZ theory

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Six-Sigma is famous for its rigorous logic based on data, which is also the reason why R&D engineers cast doubts on Six-Sigma: does data give birth to everything? For example, How to generate a good idea in the phase of Improvement? If data analysis shows that the key factor is the inappropriateness of parameters, adjusting them will be exactly the right solution. But if data doesn't self-evidently show how to solve the problem although we have known what's wrong, what can we do? Maybe brainstorming? Needless to say how inefficient brainstorming is without a definite target. "Well, what we need is inspiration", says someone. What is "inspiration" then? That is, innovation.

The embodiment of innovation appears in the Analysis phase of DFSS as a kind of methodology called TRIZ. We cannot reconvert the acronym to a meaningful English phrase because of its Russian origin, and it's seldom heard in China before. Its mystery arouses our attention. Owing to the Internet, which is always a good database to get to know up-to-date art, TRIZ not only uncovers its mysterious veil, but also leads us into a wonderful new world.

What's the TRIZ Theory? It is the evolutionary trend of the technological system summarized from 2.5 million technical patents all over the world. Its theoretical basis is that the evolution of technological system is not a random process, but conforms to some certain rule. Interestingly, this rule in technical world seems identical with the Natural Selection in biological world. The individual technologies also compete with one another for resource, and the evolutionary trend describes the winners' typical features. That's why TRIZ works well. What can make your enterprise outstanding from numerous rivals? It is to perfectly settle the conflicts competing for resource caused by different technologies while rivals cannot. Hereby, if there are conflicts in the technological system, that's where TRIZ can play an important role, and it is a good opportunity for you to surpass the competitors as well.

Classical TRIZ theory which is basically founded by Altshuller includes three parts: four tools for settling the conflicts, eight evolutionary laws of the technological system, and the algorithm called ARIZ for inventing. According to TRIZ, conflicts are abstracted as different models resolved by relevant tools. Say, if a conflict in the technological system is described as a contradiction of two parameters, Altshuller's Matrix should be applied; if described as a contradiction of two characteristics of the same parameter, it's the objective of Separation Rules; if depicted as the Su-Field model, it could be resolved with 76 Standard Solutions. At last, if conflicts cannot be described as the above well-structured models, you can turn to the Solution Base. The Eight Laws describe the evolutionary trend from different aspects. As other objective rules in the world, knowing these laws full well will enable people to forecast the right developing direction of the technological system and to make right choices so that their enterprises can save a great deal of time when competitors are oscillating. ARIZ is a method which integrates all of the

fore-cited tools. However, it is seldom applied as a full one due to its complexity.

Figure 1 shows how to apply TRIZ in practice. The path from “Generic Problem” to “Generic Solution” has been well founded by TRIZ theory itself. The work left to engineers is translating the specific problems in the real world into TRIZ language, i.e., modeling them as accurately as possible, applying the fore-cited tools to get hints or cases patented which are provided by TRIZ, then brainstorming for optional solutions, screening out several feasible ones according to a certain evaluating rule, at last taking them on trial to confirm which is the optimal one.

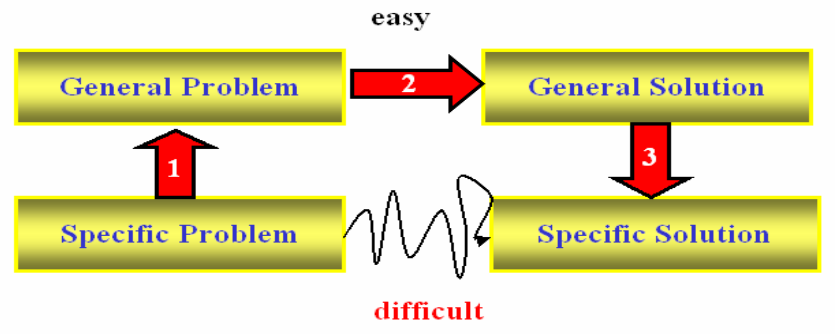

Figure1. Applying TRIZ to solve practical problems

The thinking way above is pretty similar with one methodology in Six-Sigma, as shown by Figure 2. Not only the two diagrams are similar, but the intrinsic logic of TRIZ and Six-Sigma are alike as well. Both of theories analyze human’s existing experience and solutions that have been implemented already by statistical methods to provide human some help for learning the unknown world.

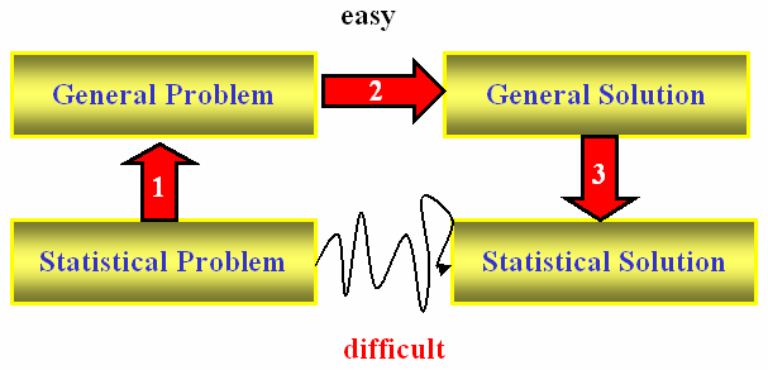

Figure2. One methodology of Six-Sigma

For this reason it is inevitable that TRIZ has been combined with Six-Sigma. A practical problem might be defined, measured and analyzed according to the Six-Sigma principles, but in the improving stage we absolutely can apply TRIZ to pursue breakthrough and validate that. For a newly designed product, we can certainly predict the developing path according to TRIZ and advance more rapidly by skipping some unnecessary phases to win the leading position in the industry.

However, it is not justified that the solutions hinted by TRIZ are the best ones. TRIZ always stresses that its “optimal” is only meaningful in the sense of statistics because what it can provide

are the solutions that used to appear with the highest frequency but not perfectly the best ones.

Besides the stuff that classical TRIZ theory offers, modern TRIZ theory has absorbed a lot of new ideas, such as more novel tools for better depicting problems and for thinking creatively. Among these, the Function Analysis is a special one that is more worthy of mention. This approach decomposes a complicated system hierarchically according to diverse models such as Components Model, Structured Model, Functional Model, Idealization Model, and focuses on the dominating functions of the technological system and the essential cause of its conflicts. Given the essential cause, TRIZ will make miracles true. This analyzing approach enables the technical staff to start understanding an issue from the qualitative angle of view, from functions and principles, but not only the data, so it is more acceptable for engineers. Data only play a secondary role when you cannot make sure what choice should be made. This approach is similar with another methodology of Six-Sigma, the funnel-like process of filtering the dubious causes stepwise, as shown in Figure 3.

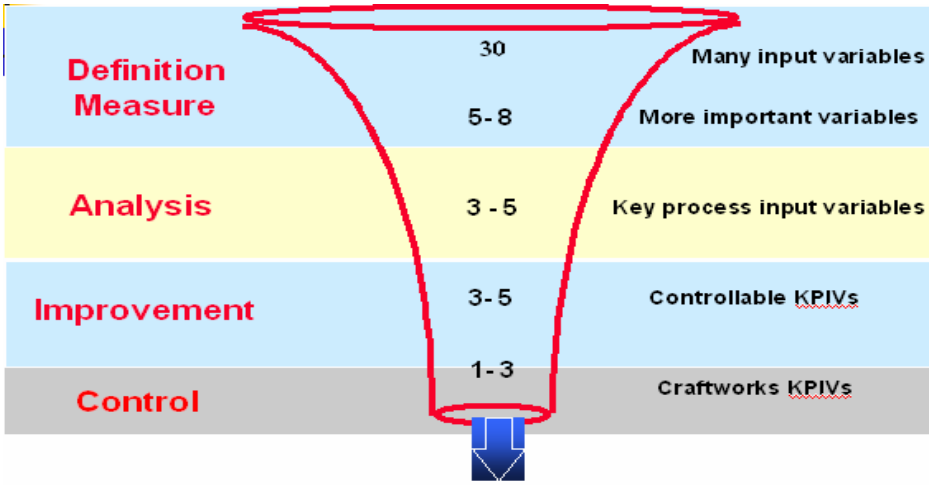

Figure3. Another methodology of Six-Sigma

The following figure might be able to give us some enlightenment about how to solve problems with the combination of TRIZ and Six-Sigma.

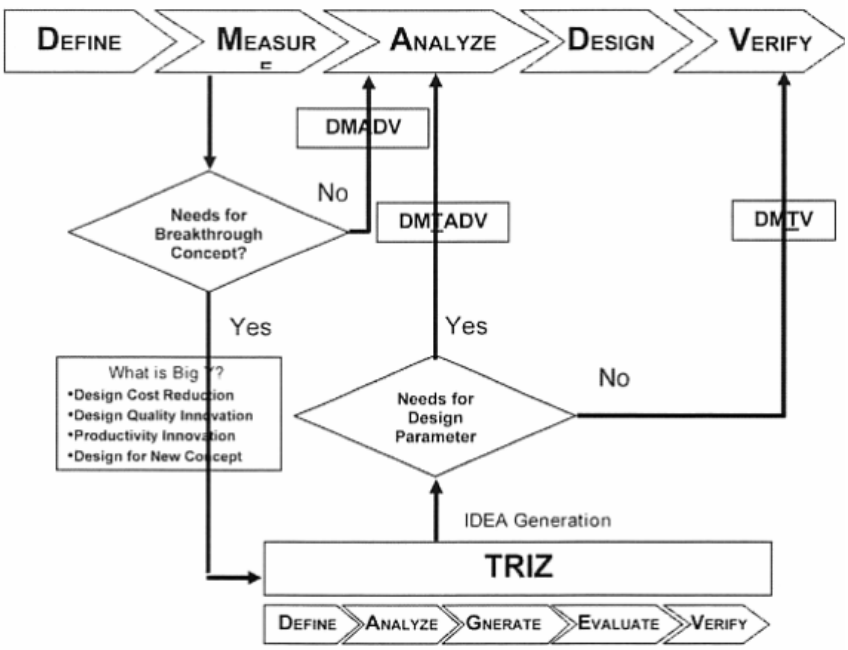

Figure 4 the diagram of combining TRIZ with Six-Sigma to solve problems

As follows, we'll talk about a practical case which shows how TRIZ was applied to a 6-sigma project.

When tracking the quality, we found that a kind of card presented an exceptionally high return rate. Therefore an investigation team came into existence for improving its quality. Analyzing the causes of its returns in recent months by applying Pareto Chart, we found that one cause accounted for about 85%. According to the designing principles, appearance of this cause is equivalent to the input power of one certain module, so we treated this input power as Y.

During the measurement phase, after we analyzed the measuring system and made sure its reliability, statistics showed that the short-term capability of the input power was 2.65sigma. Hence we decided the improvement target was 4sigma.

In order to find the root cause of the low input power, we started with the process chart of designing, manufacturing and installation. Listing all of the possible causes, team members selected four potential Key Process Input Variables by utilizing FMEA (Failure Mode and Effect Analysis):

1）Temperature of Module 1;

2）Output voltage of Module 2;

3）Strangulation voltage of Module 2;

4）Resistance of the adjusting resistor.

For the sake of confirming which the key variables were indeed, we took the full factorial experiment. Results indicated that only "Temperature of Module 1" had distinct influence on the input power.

Here, if according to 6 sigma, improvement could start from how to control Temperature of Module 1. We could carry out Response Surface test to make sure how the temperature affected the input power. Then we could control the input power in the effective range by adjusting the temperature. Certainly we should establish a long term scheme so as to observe and control the temperature for a long time during the controlling phase.

However, TRIZ never stopped here but kept on going forward: in principles, why Temperature of Module 1 could result in large fluctuation of the input power? Utilizing Function Analysis Approach, we found that the temperature attribute turned worse when the circuit of that module executed its normal functions. And this resulted in interference of the input power so that the reliability of the whole card depressed. Thus we confirmed the root of the problem lay in the side effect of the temperature. After that we obtained four theoretical hints by searching the Altshuller's Matrix:

22）Harmful in disguise；

35）Physical or chemical properties；

2）Separation or extraction；

24）Intermediary；

According to these hints, brainstorming was taken and hints 22, 35 and 24 fell into disuse one by one because of the practical property of the circuit. By referencing the thinking way of **TRIZ** and hint 2, we hoped to find a solution which could reserve the normal functions of Module 1 but not aroused the bad effects. Potential solutions were:

1）Redesign Module 1 to achieve the objective at the micro level or subsystem level;

2）Extract the useful functions of Module 1 and realize them in other components which will not incur harmful effects;

3）Extract the useful functions of Module 1 and realize them in components of the super-system which will not incur harmful effects;

Considering the difficulty, cost and time of implementing the solutions, we chose solution 2 in the end. After experts' evaluating this solution, we designed a new sub-card for it, and took an experiment for verifying. Results showed that the process capability reached 6sigma, which exceeded the former improvement target greatly. The pictures of the original card and the new sub-card are as figure 5:

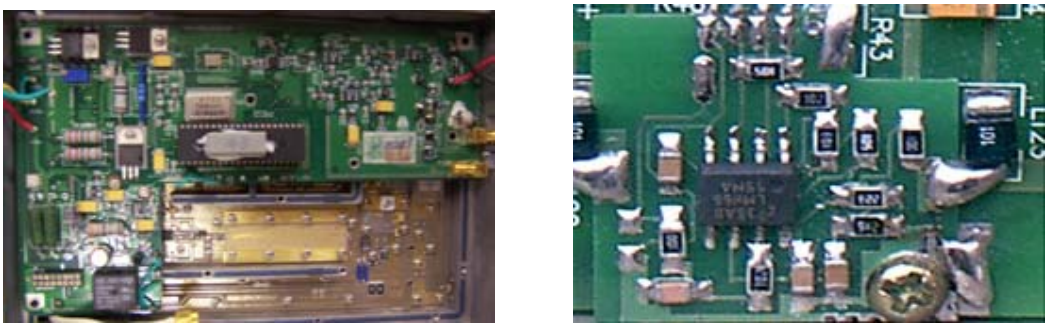

Figure5 the left is the original card, the right is the new sub-card

In this project, after the defect component and its attributes were diagnosed with 6sigma tools, TRIZ was applied to analyzing and ascertaining the primary designing problem. Finally a feasible solution was found in this innovative way and it worked very well.

As a concluding word, TRIZ is still quite a fresh thing for domestic industries of China. It needs more attention and more studying if you are expecting to build a leading role for your enterprise by applying this theory, whose miraculous effect has been attested in Russia.

About the authors:
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