What's your problem?

Rather than scratching heads when faced with a seemingly impossible contradiction in a job, engineers could do worse than apply the Triz theory. **Neil Wilks** explains

There has been quite a buzz around Triz, the Russian theory of problem solving, for some time. Since it was fully refined in the mid-1980s its use has been slowly spreading as word gets round, much like the increasing popularity of a political movement.

Fans of Triz even talk about it almost taking over their lives: how they can’t help using its vocabulary all the time, how they use it to plan the family holiday and how, once you’ve got used to Triz, “you can’t shake it off”.

Of course, just because a few evangelists declare Triz the new rock ’n’ roll in engineering theory, it doesn’t necessarily make it so. But the growing band of companies using Triz, or at least undergoing training in it, and achieving positive results, is a little more persuasive.

It is based on the idea that much of the work in solving problems has already been done and that there are principles of creativity, common to all innovations, that can be taught. The word Triz comes from an acronym for a Russian phrase which roughly translates as Theory of Inventive Problem Solving.

The methodology unlocks the experiences of problems already solved by approaching a new problem in terms of its contradictions. In structural engineering, for example, where there is always a trade-off to be made between strength and weight. The intention behind Triz is to solve this problem without compromising either parameter.

Triz inventor Genrich Altshuller came up with 40 principles on the basis of known solutions to contradictions, which can be applied to any problem. These came from his analysis of many thousands of patent applications

during his time in the Inventions Inspection Department
for the Russian Navy in the late 1940s, although the theory was not developed further with colleagues until 1986.

The principles have to cover a lot of ground and so include what appear to be fairly commonplace topics, such as Mechanical Vibration, Copying, and Porous Materials, as well as the slightly more esoteric: Cheap Short-Living Objects, Nested Doll, and Beforehand Cushioning among them.

These 40 principles are put into a matrix for ease of use, along with 39 features for each one, lined up along one axis in order of worsening feature, and improving feature along another. These features are the aspects that typically need to be improved, such as productivity, ease of operation, weight, shape or speed. Cross-referencing these features with the principles should point you in the direction of a solution.

But what does industry think about it? Karen Gadd, of Oxford Creativity, which specialises in Triz training, claims to have some big names keen enough to send staff to find out about Triz, including Bentley Motors, British Nuclear Group, Rolls-Royce and BAE Systems. She reckons the defence and aerospace group has put up to 600 people through her courses.

Gadd puts the success of Triz down to it providing “a map for problem solving”. “It takes people a little while to wake up to it, but when they do they are so thrilled at the end of each workshop they dash off to use it. It’s a wonderful thing to teach,” says Gadd.

Using Oxford Creativity as a barometer of industry interest in Triz, it appears to be firmly on the up. The company will be teaching 800 people this year, up from 600 in 2006, and now employs six Triz trainers who can run detailed in-house courses as well as one-day introductions. Not bad for a training firm founded by Gadd with just one trainer — herself — in 1999.

One of her former students is Mike West, research manager of Leafield Engineering, makers of electro-mechanical defence equipment. “When you use Triz, it’s like a lightbulb coming on. It illuminates an enormous amounts of disparate data,” says West. Of the 40 principles, he says: “You realise you know many of them but it links them together and gives you the ability to use them.”

The Triz principle called The Other Way Round was very successfully used in the design of a press tool for Leafield, which West says is unique and gives the capability of a double-ended hydraulic press on a single-ended press.

Another user is Rob Sedgeman, a CAD designer and now Triz champion with drilling specialists Smart Stabilising Systems (SSS). This R&D and manufacturing firm provides expertise in highly accurate drilling, mainly to the oil and gas industries.

Sedgeman applied Triz to a genuine problem: stopping the build-up of swarf created when drilling through an aluminium collar. These collars are used to secure and line a hole before a narrower drill bit is used to go down even deeper, but the 'nesting' of the swarf slows the drill down and disrupts the rotary steerable tool, which guides the bit accurately to its location.

Logical solution: The Muncher Pivot, designed to clear swarf during drilling, was a direct result of the Triz principles

An extra catcher blade above the drill bit was needed to clear the swarf, but how to operate it only when required? By using Triz principle four (Physical Contradiction Separation Principles of Space, Time, Condition and Alternative Ways), Sedgeman and his team saw the problem contradiction was time. And through using the Triz matrix, they analysed their options under 17 of the principles. One of these, Blessing in Disguise, led Sedgeman to think about using the problem itself, the swarf, to operate the extra blade.

In normal operation this blade does nothing, but when the swarf starts to gather, it starts nesting. "The more it nests, the more friction we get and the drill starts to slow, creating a change in relative motion compared to the new blade. This makes the blade spin, so clearing the swarf," says Sedgeman. As a result of this work, SSS designed and tested its Muncher Pivot "with great success", and built a prototype which was patented in August.

"All that came from trying things with Triz. It doesn't give you the idea, but it gives you a great step in the right direction," says Sedgeman. He adds that it was also invaluable in allowing him to document the inventive procedure.

As a result of his experience, Sedgeman would recommend Triz to anyone and confesses that it's likely to be with him for the rest of his career. And, he says, development of the Muncher Pivot has been well worth the investment in training. "You spend so much on a new computer, why not spend some money on upgrading your brain?"

TRIZ CHANGED MY LIFE

Salmaan Craig is a research engineer using Triz in his Engineering Doctorate in Environmental Technology at Brunel University in London. His research, which he is carrying out while working for consulting engineer Buro Happold, began looking at eco-product development in buildings.

"Buro Happold said we're interested in developments in product design so, as long as it's sustainable, have a look for us. And on my way I bumped into Triz," says Craig. This led him towards a more detailed analysis, using Triz, of the contradictions in how buildings handle heat and light.

"It has changed the way I think and it's a powerful way of working, but it's not black and white. No matter how much people sell it as an algorithm that simplifies problem-solving, it still needs a lot of thought," says Craig. He reckons this is largely down to the abstract nature of the principles, which are, by necessity, out of context.

"It's a clever way of transferring solutions across engineering disciplines and is like learning a language," he adds.
One specific problem Craig has been working on, framing it in terms of contradictions tackled using the Triz principles, looks at heat transfer in buildings and ways of maintaining comfortable conditions inside a building structure, without use of mechanical heating or cooling.

One way of doing this is to run cold air through hollow concrete floor decks at night, so cooling the floor and roof slabs — and the living or office space between them — in the daytime. Craig is looking at how to form intricate internal voids using biodegradable starch foam that can be flushed out with water once the concrete has set.

But to create the internal structure, Craig came up against a weight problem. The starch has to be dense enough to support the concrete while setting, but not to the point where it cannot be effectively flushed out.

This contradiction can be resolved in Triz principle number three on Local Quality. "This focuses on taking something homogenous and making it heterogeneous," says Craig. "Structure gives the foam the required strength and allows water to flush through in contact with a greater surface area of the foam — hence both functions improve," he adds.

Craig describes this application of Triz as a "success, in principle," simply because it is impossible to prove that he would not have come up with the same answer without Triz. "I gave up a long time ago trying to show people that Triz works. You can't prove it does. I can only say that I've taken this approach and it works for me," says Craig.