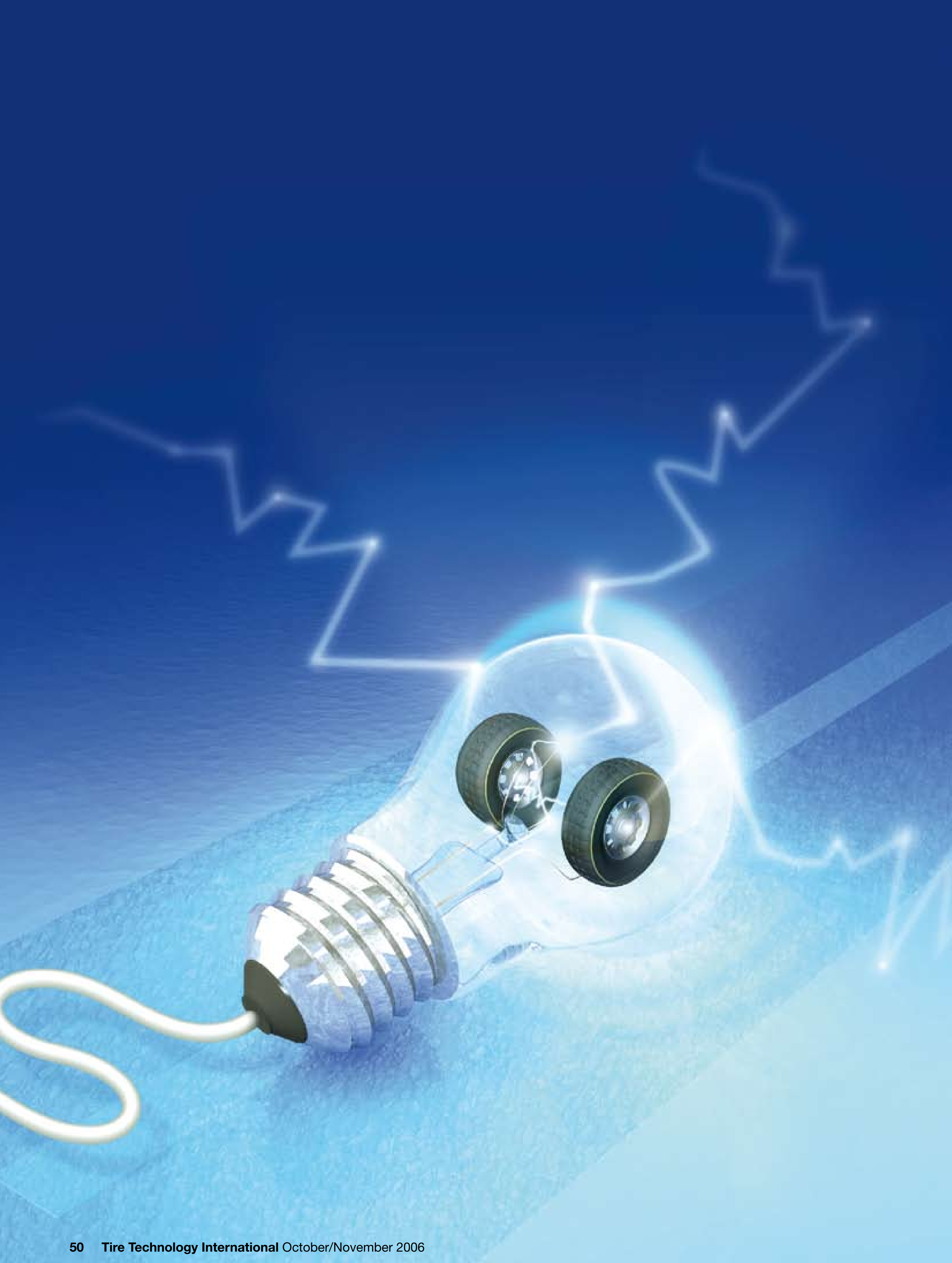

by Dr Paul Filmore, University of Plymouth, UK and Dr Pete Thomond, the Insight Centre, UK

Why reinvent the wheel?

TRIZ, a systematic problem-solving method, has been developed by the University of Plymouth, UK to bring innovation to engineers. Its application by Michelin has already hit the headlines in the form of the Tweel

There is evidence that many organizations pursue incremental innovation, expending great effort to produce slight efficiency gains, minor component reduction, style change, etc. TRIZ is a systematic problem-solving method that gives engineers and managers a range of new innovation tools and has the potential to break problem-solving mindsets, a successful application of which is Michelin's Tweel. Spearheading the method are Dr Paul Filmore of the University of Plymouth, UK and Dr Pete Thomond of the Insight Centre, UK.

TRIZ is the Russian acronym for the 'Theory of Inventive Problem Solving'. The method was initially developed in 1946 by Genrich Altshuller, who was a patent investigator for the Russian Navy. Through his work, Altshuller identified solution patterns in innovative patents to categories of problems (which TRIZ calls contradictions). He also found that these solution patterns existed along repeatable lines of evolution over many different industries. To date, over two million patents have been investigated to validate and refine the knowledge base, and to develop tools to access this knowledge. TRIZ leads to solutions that often could not have been thought of by that person or group. It is thus different to many creative and problem-solving techniques that lead practitioners to solutions they are having problems accessing.

Recent research has moved the tools and adapted the knowledge base, from the technology/science-based application, to business and organizational innovation, which is supportive to managers from engineering backgrounds.

In terms of creative step-change innovation, two of the TRIZ tools have the potential to lead engineering teams to breakthrough thinking. These tools are: the Ideal Final Result; and Trends of Evolution. Other tools such as Function and Attribute Analysis can also underpin the problem definition phase.

The Ideal Final Result (IFR) tool challenges engineers and managers to break out of continuous improvement/incremental-change thinking, to which most organizations are prone. The IFR is defined in terms of 'ideality', towards which the technological evolution migrates. The definition has been adapted from the value equation of Value Analysis and Engineering created in the early 1950s:

$$\text{Ideality} = \frac{\text{(Perceived)} \sum \text{Benefits}}{(\sum \text{Costs} + \sum \text{Harm})}$$

An ideal system would then have all the ($\sum$ = sum of) benefits without any cost or harmful effects. Features could include: being free, self calibrating, self cleaning, self regenerating, self regulating, self repairing, self aligning, etc.

Figure 1: The Tweel is TRIZ's best-known tire project

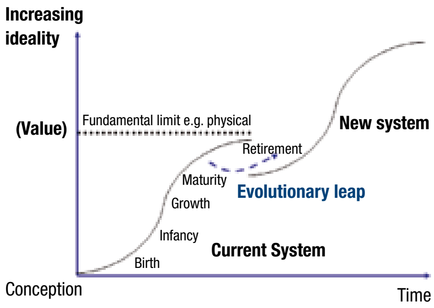

Figure 2: S-curve of performance and functionality

The Tweel development can be classified as a breakthrough rather than incremental development, which came about after a Michelin team undertook a course in systematic problem-solving based on TRIZ. Questions were asked, such as: "can an ideal wheel have no air?" This would eliminate blowouts, which are an example of a 'harm'.

TRIZ research has identified 35 technology trends, which technological progress follows across a wide variety of industries. The s-curve is well-known in technological forecasting where technology approaches the more ideal/greater value with time, by going through stages often labelled as conception, birth, infancy, growth, maturity and retirement (see Figure 2). What is known is that industry puts more and more energy into progressing the move towards the ideal, with only incremental change. The 'trends' tool (concept) focuses the engineer into looking for the evolutionary jump to the next s-curve, which bypasses the (often physical) limitation of the present s-curve.

For the wheel, one of the evolutionary trends that has relevance is 'Space Segmentation' (Figure 3). With this trend, monolithic solid things evolve into hollow things, which evolve further into structures with multiple hollows, to structures with capillaries/porous structures, and finally to porous structures where the cavities are filled with some kind of active element. In the case of the wheel, in the past we had solid tires, at present we have tires filled with air (hollow structures), and with the development of the Tweel, we could argue, we have a structure with multiple hollows.

Another trend 'Webs and Fibers' (Figure 4) has an evolution from 'homogenous sheet structure' (if we think of a cross section of the first tires), to '2D regular mesh structures' (steel wires embedded in the rubber), to '3D fiber, alignment according to load conditions'. The latter is similar to the Tweel, with the rubber 'not now needed', and the 3D structure designed to 'support' in different ways at different angles to the axle, for different applications/road usage.

"It can be argued that the TRIZ method has greatly influenced Michelin's innovation potential/profile"

TRIZ tools such as functional analysis also question fundamental assumptions. Examples include the question: "what is the function of air in a tire?"

To help substantiate the effectiveness of TRIZ, a questionnaire was developed. It was based around the model proposed by Darrel Mann, that a company's innovation potential is based around the three areas of company knowledge, creativity and action: Innovation = Knowledge * Creativity * Action, split into sub areas, called innovation parameters.

A simple, single-question questionnaire was developed for each of the innovation parameters. The questionnaire wording was influenced by the Creativity Model of Baille, et al, where internal (personal) and external (organizational) barriers to creativity are identified.

For each parameter, the question asked for a company evaluation both before the TRIZ course and at the present time (i.e., when using TRIZ). The degree of influence of TRIZ on any perceived change (before and after the TRIZ course) was also requested, to ascertain whether the change had anything to do with TRIZ, or whether it was due to some other influence/factor.

One of the uses of an innovation questionnaire is to compare your present position to those in other industries. In the radar plot results of the company innovation audit shown in Figure 6, Michelin shows up well in all aspects of the innovation scan in comparison to other companies. The generic data is taken from the results of a more detailed questionnaire.

What is really useful is to use the questionnaire pre- and post- innovation training. Figure 6 shows how the Michelin TRIZ course has improved/strengthened nearly all of the innovation parameters, most noticeably in the creativity areas.

Finally, the perceived influence of the TRIZ course on each of the parameters was found from the questionnaire. Again it can be seen that the creativity parameters are considered to have been strongly influenced by the TRIZ course. A number of other areas have also been slightly influenced. From all the results, it can be argued that in the perception of the respondents, the introduction of TRIZ has greatly influenced Michelin's innovation potential/profile.

The value of an innovation scan based solely on people's perceptions can be questioned. Certainly hard facts can be identified in many areas to strengthen results, such as the number of creativity tools used in the organization, or the number of risk management tools/amount of time allocated per project.

Three real benefits do, however, stand out. The first is the use of a perception questionnaire to benchmark the present

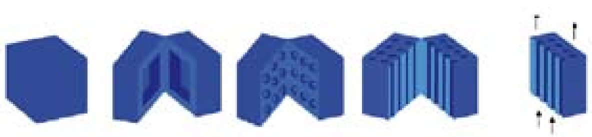

Figure 3: The space segmentation trend sees hollow structures evolve to porous

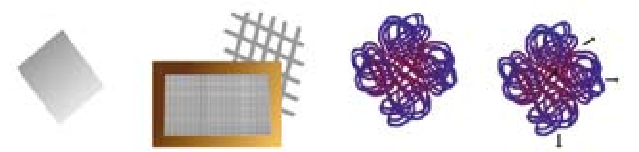

Figure 4: The webs and fibers trend from a homogenous sheet to a Tweel-like structure

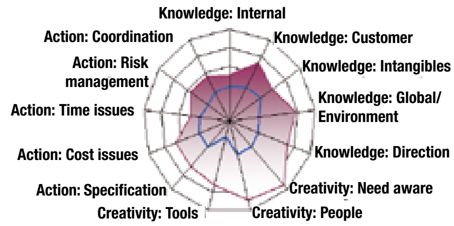

Figure 5: Radar plot comparing Michelin's innovation potential with that of other, rival, companies

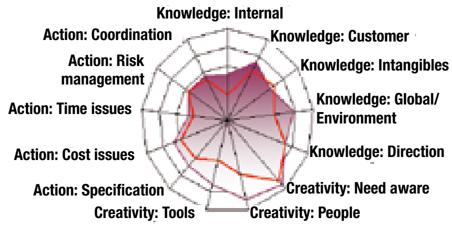

Figure 6: Radar plot comparing Michelin internally, pre-TRIZ course, and with the present situation

situation against the past, or against competitors or other business sectors. The second benefit is as a means of informing management of the perceived innovation potential, highlighting any developing issues or areas ('parameters') of weakness. The third is as a way of feeding back their perceptions to the workforce, to motivate for change, and to reduce creative inhibitions. Referring back to the creativity model in Figure 5, it can be seen that there are many areas of both personal and organizational issues that the results can be used to address. Central is the need to develop a climate of creative potential, where staff are not humored (or worse) for suggesting 'out of the box' ideas, but are valued and rewarded (praise, suggestion scheme awards, etc) for innovative ideas. In addition there is growing recognition that innovation methods such as TRIZ need to be taught in a planned way.

TRIZ is a means to assist inventive problem-solving that has achieved success in many areas and is still being discovered by the engineering community. Anyone in the area of engineering management must be struck by Altshuller, the father of TRIZ, finding that 95 percent of 'new problems' have already been solved, probably many times over. This leads us to ask the obvious question: Do we need to spend most of our time 'reinventing the wheel'? ***tire***

Dr Filmore is interested in hearing from companies who are interested to see if their innovation potential can be enhanced by TRIZ. He may be contacted at: ***pfilmore@plymouth.ac.uk****. Further information and the background research paper on TRIZ can be found at:* ***www.insightcentre.com/triz.html****.*