TRIZ Future 2012, Lisbon, Portugal

Establishing TRIZ in a global company

Pauline Marsh[a*], Karen Gadd[a]

[a] BAE Systems, United Kingdom
[b] Oxford Creativity, United Kingdom

Abstract

This is based on practitioners' experience of a 14 year journey establishing TRIZ in a global company – BAE Systems. The practitioners include the external TRIZ consultant Karen Gadd of Oxford Creativity and the customer – Pauline Marsh a director of BAE Systems
The real success stories (now published case studies) were critical for its acceptance but there were also false starts, dead ends and unexpected benefits which changed the way TRIZ was presented, practised and adopted.

This paper explores both what worked and what didn't work, highlighting the key ingredients for success and the unexpected benefits which TRIZ delivers beyond innovation and problem solving.

TRIZ in BAE Systems (the Consultants story)

It all started so long ago – in 1998 presenting TRIZ to an energetic Bob Robinson and open

minded Pauline Marsh was like pushing on an open door – they loved everything they heard

about TRIZ and in a few weeks we were running our first 3-day TRIZ Workshop in the

Directors Box of the Reebok Football stadium to a very mixed group of senior management,

engineering directors and innovation enthusiasts.

Since then we have trained over 1000 BAE Systems' engineers and run problem solving sessions (some 3 months long some only 2 days) on many subjects including:-

- Next generation submarines
- Detailed Functions needed for submarines
- Weapons systems
- Cabin air contamination from engine oil
- Redesign of drogue for mid air refuelling
- Escape systems from submarines
- Aircraft training systems optimum locations
- Flight measurement systems
- Inertia of aircraft
- Protection from debris on runways
- Location of airports in remote locations
- Management of airports

- Design of aircraft components
- Persuading UK Government to change/clarify the regulations for aircraft maintenance for Royal Air Force
- Innovation Culture change for processes and non-TRIZ toolkits
and many, many more....

Many ways of getting TRIZ into big companies

TRIZ gets everyone in different ways and enthusiasts all have their own solutions for how to teach it, how to problem solve and how to get it established in global companies. This is the story of 14 years of TRIZ in BAE Systems, which has taken some interesting directions for Oxford Creativity, often guided by the enthusiasm of influential managers within BAE.

One of the fundamental truths of TRIZ is that there are many, many possible and good solutions to most problems. Getting TRIZ accepted and embedded in large companies is just such a problem - there are many ways of succeeding and this BAE Systems story is just one.

The international and successful BAE Systems describe themselves as....... *'a global defence and security company employing around 100,000 people worldwide. Our wide-ranging products and services cover air, land and naval forces, as well as advanced electronics, security, information technology, and support services'*

BAE System's large technical population, containing some the world's top engineers, responded well to TRIZ and achieved a great deal. We at Oxford Creativity have always enjoyed working with such clever and motivated managers, engineers, scientists, new graduates and directors on a very wide range of issues which ranged from next generation submarines to top management problems, involving the company's future, to smaller challenges such as the design of individual components or decisions on proportions of make/buy.

TRIZ has been available to everyone in BAE Systems for over 14 years and was available to whole teams or individuals who can simply register for the TRIZ workshops. As a result a wide mix of BAE Systems people from all over the world learn TRIZ each year. The journey has been an interesting one and took quite a lot of perseverance and TRIZ success to get it all working. There were obstacles and pitfalls to overcome, some false starts and some surprises. Every company is unique and needs different approaches however, and in taking TRIZ into Global companies there are many difficulties which are common to all and we met these listed below initially at BAE.

How to meet the Challenges and overcome inertia

It is a big challenge to take TRIZ into a big company – there is resistance to ...

1. Adding to the more famous and well established toolkits
2. Accepting a little known Russian toolkit with poor PR
3. Reaching and persuading the right people to maintain the momentum (HR and Training departments don't initially understand the power of TRIZ)
4. TRIZ practices of taking time to define right direction to take, with the real problem. This is achieved by rigorously sharing (& developing with TRIZ) everyone's solutions - ideas from the whole team - and not just senior management's 'Bad Solutions'.
5. Getting the top management and the engineering population to appreciate the unique power of TRIZ for their challenges and commit to regular TRIZ training for everyone who wants it
6. Making it easily and quickly accessible to everyone once it has been shown to help the company solve their problems

The last four of these were overcome, the first two are a little harder, more general, long term and more problematic. The more famous and well established toolkits have their devoted champions and occasionally a newly promoted manager will announce to his department something like "the only toolkit we need is Kepner-Tregoe" and only use such an RCA tool for everything despite its limited scope of only uncovering problems and its lack of any problem solving content. These mangers come and go but while they stay they can stop TRIZ for their whole team. In the meantime the reputation and accessibility of TRIZ will continue to grow, and I hope we have helped a little with this with the OC approaches, cartoons and publications.
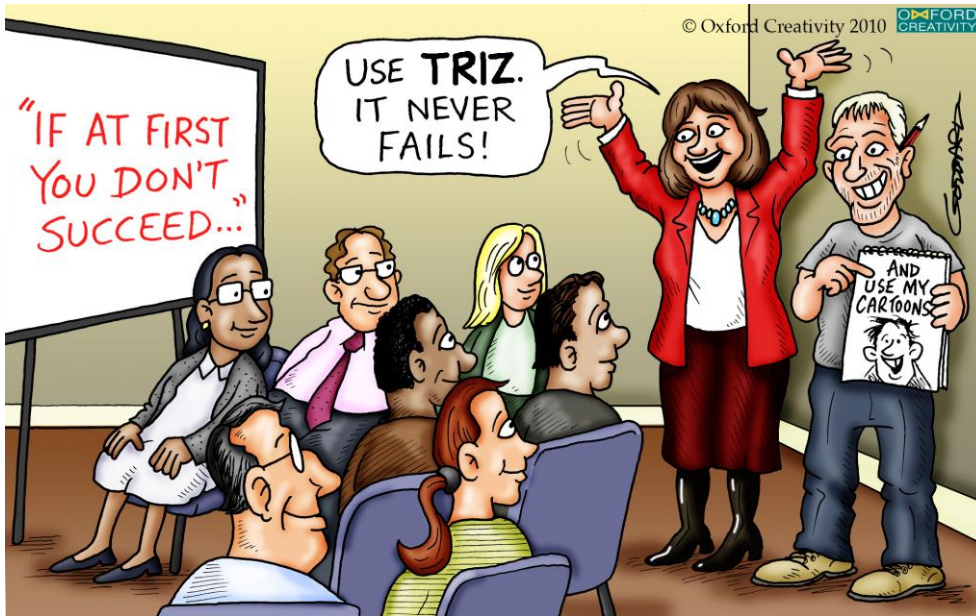
Who uses TRIZ and Why?

Persuading BAE Systems to take on TRIZ globally required proof of its power as a problem solving kit, and demonstrating in practical terms just how TRIZ could release that power to its engineers in only 5 days of training. For good engineers TRIZ offers the best of all worlds: the individual tools are straightforward, the problem-solving process is systematic and repeatable, and when we move fast with TRIZ we can uncover all the possible solutions and maintain and use our brains at their most creative. Teaching that in five days requires great efficiency and effectiveness and we developed the five days training especially for BAE, and although the training was designed for engineers we found it worked well for everyone who attended. It must be said however that engineers understand TRIZ better than anyone else because it comes from engineering success. It was developed by engineers for engineers, and although TRIZ works well on anything, it seems to work best on engineering problems.

When first hearing of TRIZ, however, most engineers resist it, perhaps because it sounds too good to be true; but also maybe because it is new to them, not-invented-here and counter-intuitive to the way they approach problems. Unfortunately TRIZ is also seen as just another part of the overcrowded market in corporate toolkits (which range from excellent to trivial).

Taking on a new toolkit makes demands on their brain power, company time and money and other hard-pressed resources, and this requires belief in its efficacy and power. Six Sigma and Lean are both promoted to improve efficiency and deliver cost savings and therefore widely adopted – TRIZ also delivers efficiency and similar cost savings plus innovation, fast problem solving and clear thinking.

It was essential that we could demonstrate that TRIZ is a unique addition to all the other toolkits used within BAE Systems, as it supplements and complements them all and fills in their missing essentials – the big hole they all possess of no directed problem solving to relevant solution concepts. TRIZ & Lean, TRIZ & Systems Engineering, TRIZ & TOC, TRIZ and Managing Requirements, TRIZ Quality and Innovation, these and other papers were presented as required and published by our consultants to show how TRIZ fits with and completes the toolkits.

Making TRIZ easily, consistently & quickly accessible to everyone (100,000 people) in BAE Systems

The challenge of how to make TRIZ available to everyone from one source without adding anything (and with no new complications, extra costs or problems) is very simple and is answered by TRIZ as 'Use the resources you've got'. The resources at BAE Systems were the Life Cycle Management System (LCMS) and the BAE Systems training portals which were run by Xchanging.

LCMS explicitly mapped which tools to use when and TRIZ appears several times particularly when innovation, problem solving and new concepts are required. The TRIZ workshops were registered on the BAE Systems training systems. Xchanging publicised the dates of the TRIZ workshops, handled bookings, payments etc, and ensured that the global but very disparate and uneven demand for TRIZ was recorded and satisfied. Oxford Creativity did everything else from booking the rooms to individual accommodation as well as the Workshops themselves.

The system worked fairly well for many years (a new one has been put in place recently as Xchanging lost their contract with BAE Systems). Therefore one great element of consistent success was that TRIZ was the BAE Systems chosen solution for innovation, problem solving, concept generation etc. This meant that no one had to explain' what is TRIZ' in order to register for training or request problem solving. TRIZ training was available to anyone through the company wide training portal.

Looking at available resources there was a system of internal intranets and we created a BAE Systems TRIZ Intranet for the BAE Systems. This helped the TRIZ population to share solutions, problems, and work together even though they may not know each other through distance, expertise, department etc. This lead to some wonderful cross sharing of ideas including one lively week in Barrow when Air Systems and Submarines got together to work on each other's problems – and once they had overcome their disbelief at each others' approaches everyone enjoyed and benefitted from sharing knowledge from their very different worlds. The Intranet informed basic TRIZ to the novices, enabled TRIZ revision, and contained a template to write case studies from TRIZ problem solving sessions, and details of TRIZ activities (problem solving as well as training) across the company. This meant that TRIZ enthusiasts could volunteer to join in with TRIZ problem solving outside their own areas which helped build the internal TRIZ expertise. The opening page contains the ways to find out about:-

- TRIZ Training
- TRIZ Facilitated Problem Solving
- TRIZ systematic approaches to New Products
- Management issues
- Innovation Projects
- TRIZ for Process Improvement

This provides a great way of finding out about TRIZ without leaving your desk.

Although Oxford Creativity has undertaken all BAE Systems TRIZ learning and problem solving when there has been a demand for a big project - training many people and involving much problem solving – then other TRIZ providers were invited to bid and were considered. In

the last 14 years Oxford Creativity were always selected, except on one occasion, when both Oxford Creativity and a Barrow Consultancy were both given the same problem to work in parallel to see how they compared and TRIZ added value. Oxford Creativity and TRIZ came out on top with better solutions, faster results and considerably lower budget despite the cost being in five figures for OC alone. This project involved training over 100 people in TRZ and then running TRIZ sessions which enabled them to find the best possible solutions themselves. Results were innovative, useful, relevant and at times groundbreaking.
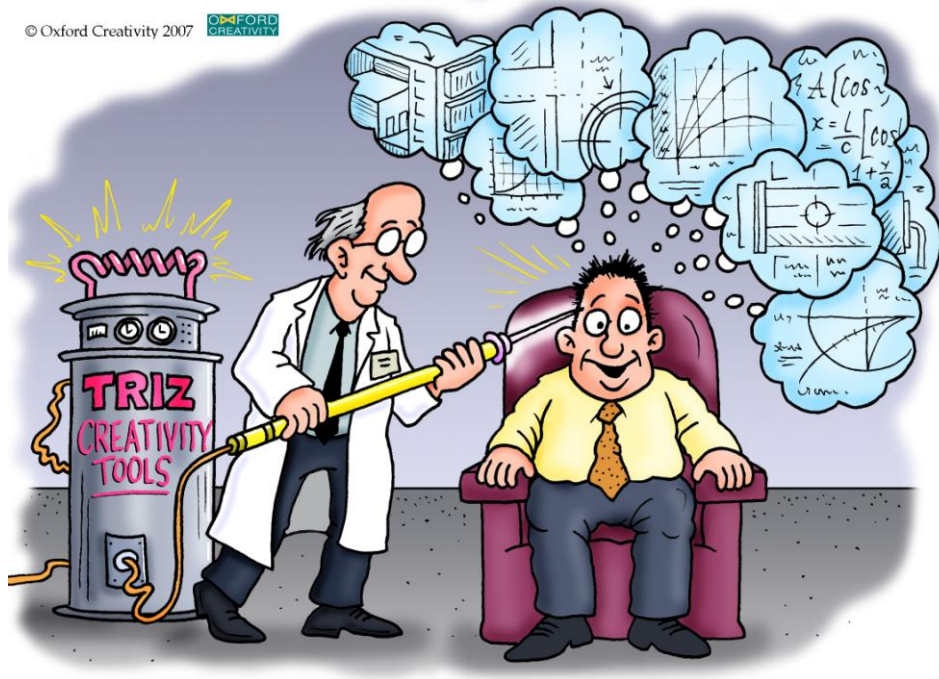
Getting top management & the engineers to appreciate the unique power of TRIZ & commit to regular TRIZ training for everyone who wants it

The challenge of persuading the budget holders, the decision makers and those who have to organise the training is harder with TRIZ than say Six Sigma which encourages everyone to claim huge savings as a result of any Six Sigma activity. TRIZ does not have this culture (although solved problems always save money), quantifying this perhaps needs some development for everyone in TRIZ.

So how did it work so well in BAE Systems? Probably helped by the following:-

- OC TRIZ trained for practical problem solving not for theoretical TRIZ
- Workshops were made available regularly and completely organised by OC putting no burden on anyone in BAE Systems (except for marketing and booking for which a system already existed and was simply slotted in)
- TRIZ Workshops were consistent and flexible (opting in for anything from one day to five days was always possible and often happened)
- Oxford TRIZ demands full participation from everyone with several big exercises each day, carefully designed and organised on large A0 pre-printed sheets for groups of 3-5 people
- All TRIZ material was clear, fun easy to use and seen on desks for many years after the training and worked for international groups
- Feedback was always enthusiastic
- OC were flexible and available at short notice – we have over 12 experienced consultants – so when work was suddenly needed in Saudi Arabia (many workshop there) – or next day problem solving – we nearly always able to help
- TRIZ training led to problem solving abilities especially when teams worked together
  ... and much more as explained below

Getting top management and the engineering population to appreciate the unique power of TRIZ for their challenges

There is English saying *'The proof of the pudding is in the eating'* – we might say that *'The proof of TRIZ is in the problem solving'*. Whenever Oxford Creativity want to establish a new relationship we offer to help a team solve their most difficult problems – as we find that only this truly convinces people of how TRIZ will transform their thinking, their problem solving abilities and their achievements.
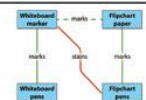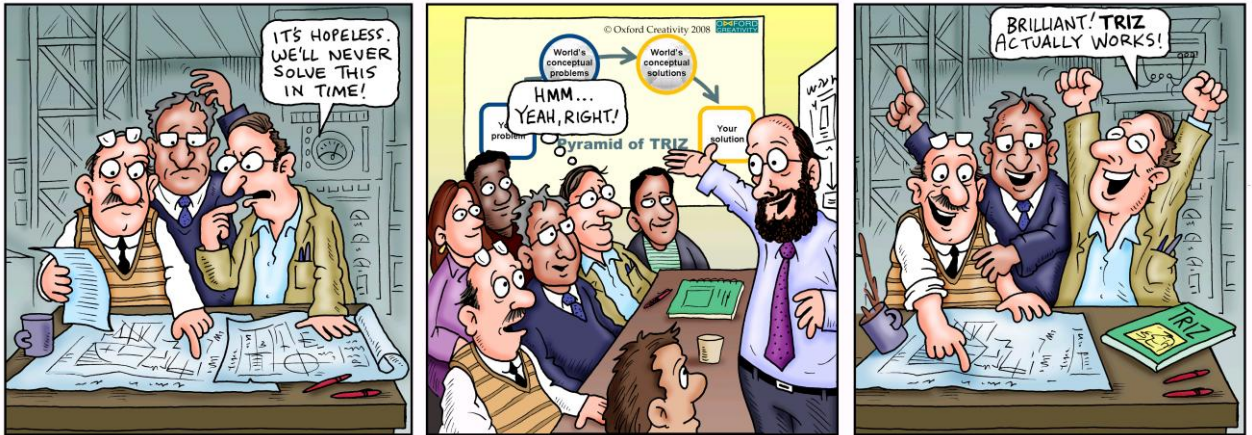
In BAE Systems Pauline Marsh invented a very ingenious, quick and efficient method for sampling TRIZ problem solving – **the TRIZ Master-Class**. This involved TRIZ trained engineers attempting to solve their most challenging problems with TRIZ, on returning to their offices after their training, and then 4 or 5 groups of problem solvers presenting their results to Oxford Creativity and BAE Systems top management. These sessions had enough time allotted to not only judge their results, but also revisit the problem solving and improve, expand and extend it as necessary. This proved to be very successful, very motivating, good for solving difficult, previously 'unsolvable' problems and great fun. Several problems were solved in this way including the problem described in the **Flight measurement systems Case-study.**

In many other areas there was much TRIZ problem solving in a more traditional and thorough TRIZ manner directed and assisted by OC TRIZ consultants – these solved many problems and varied in time from a few days to a few months. Granting sufficient time to problem solving is always seen as a luxury no matter how important or urgent the problem, and BAE Systems is no exception to this, but once TRIZ was accepted as useful and shown to be very time efficient it became easier to achieve.

One important aspect of persuading anyone (particularly engineers) that TRIZ works is to show them its simple logic. Each tool has its own straightforward algorithm and in Oxford TRIZ we strive to keep everything both simple and rigorous. Our flow charts for problem solving helps everyone understand where they are going, where they have been and how to go there again

(leaving a good audit trail). This builds confidence and self efficacy which helps build happy and creative teams.

Problem Solving Steps

| **i. BAD SOLUTION PARK** |
| Set the rules / the culture of the session. All ideas to be recorded no matter how wacky, unobtainable, the contradictions. |

| **ii. Describe Problem** |
| With no 'solution' contained in description |

| **iii. Primary Output** |
| The system exists to deliver this |

| **iv. 9 Box Context Map** |
| This may include causes of problems |

| **v. Ideal Outcome for defining Benefits** |

| **vi. Ideality Audit** |
| Define 'System we've got' and 'System we want' |

| **vii. System Description & Function Analysis** |

| **viii. Problem list** |
| Match each Problem to an Ideality Tactic |

Technical Contradictions	Physical Contradictions	Trimming	Harms	Increase Benefits	Trends of Evolution	Invent	Ideal Problem Solving
Resolve Conflicts	Deliver Opposite Benefits	Reduce part Count	Reduce harmful functions	Improve Insufficiency	Next generation systems	New Systems	Benefits Functions Resources

| **ix. Apply Ideality Tactic to find solutions** |
| With available resources |

| **x. Map Solutions in 9 boxes** |

Using simple maps such as the one above helps newcomers get started. Once problems are solved with TRIZ then confidence begins to build, in finding solutions every-time. TRIZ problem solving sessions can produce brilliant and retrospectively obvious solutions, which

invokes incredulous comments like 'this was always right in front of our noses 'and 'we had this possibility all along but couldn't see it'. When less thrilling but still very good solutions are produced, but with no obvious winner, the TRIZ tools such as an Ideality Audit simply help us rank the solutions.

**Problem Solving- often has insufficient time allocated & is not audited or understood**

In many major companies minimum time is given to the actual problem-solving stage despite its critical importance often to the future of the company and its outputs. This is curious, but it seems that without a systematic approach like TRIZ, the rare, very rationed and valuable problem-solving time may only be productive for a short period and may not be yielding much, once the initial bursts of mental energy and the sharing of ideas /solutions have petered out. Comments from new TRIZ users often include 'Before we would have managed half a day and then stopped with some goodish ideas, but TRIZ kept us busy and usefully engaged for much longer and we have produced so many more and much stronger solutions'. TRIZ helps everyone fully use real problem solving time effectively, and keeps team members engaged and mentally alert throughout (which stimulates the best thinking power, creativity, knowledge and experience).

With TRIZ we can also audit and track the investment of innovation and problem solving time, detailing all processes followed; without such systematic tracking problem solving time may become patchy, hard to measure, use, maintain, assess and recapture – making much needed future sessions harder to justify, especially on occasions when the true success is only retrospective, and the effectiveness of the solutions can only be proved much later. In BAE some solved problems are so secret we can never reveal them (even within OC) and some we can reveal after many years. The complete confidentiality OC has maintained is part of our success – we have the right consultants and we are trusted.

Unexpected Benefits of TRIZ -
Happy, communicative and effective teams

The unexpected benefits of team building came about through the Oxford TRIZ culture of the BAD SOLUTIONS (essential for fast uncovering of contradictions, full participation of the whole team and idea sharing). Bad Solution Parks also overcome the difficulty of introducing TRIZ to those who think Brainstorming = Problem Solving. Convincing confident managers that TRIZ offers so much more than brainstorming is essential to extend and improve the problem solving sessions.

Brainstorming is wonderful and an essential **first stage** of the TRIZ problem solving. However it has its pitfalls and often throws up solutions which intoxicate their owner and can set us off in the wrong direction – such situations have often been much helped by the cartoon below.
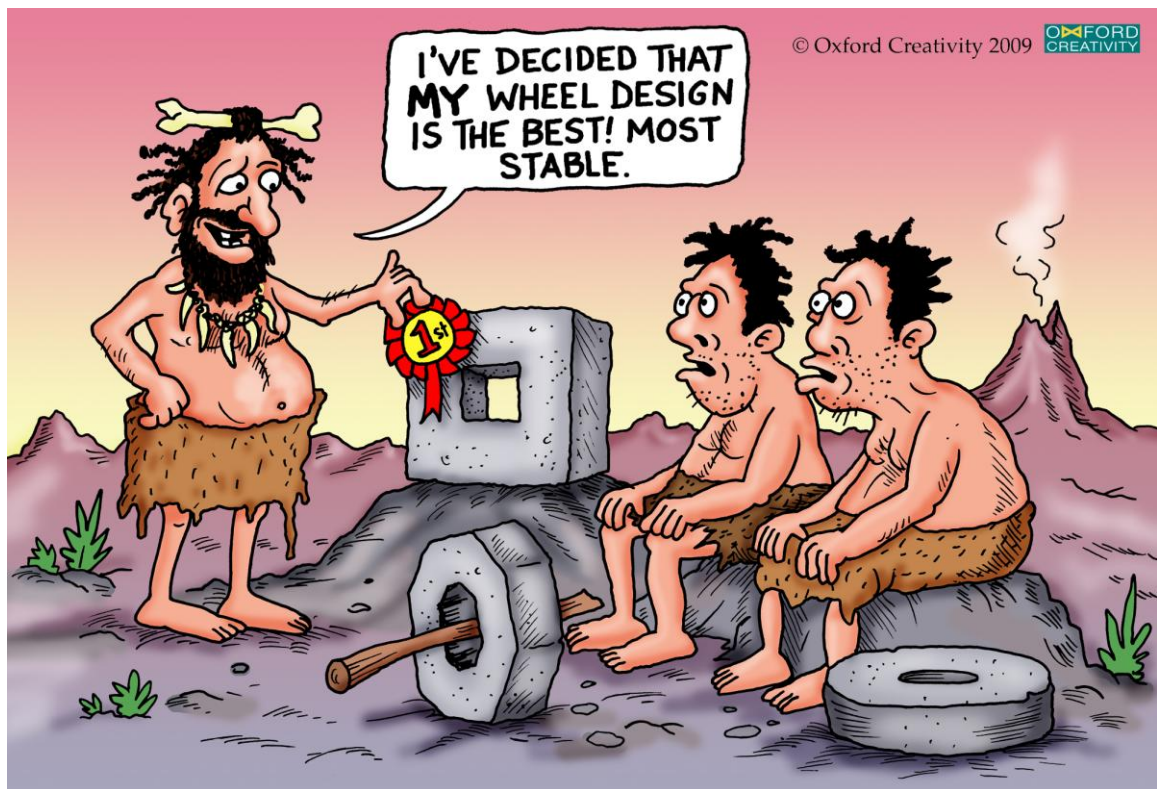
Persuading any company to have a consistent policy for problem solving is difficult. For major companies such as BAE Systems problem solving is both complex and varied. It defies most simple attempts at categorization as it is needed in all areas of business and decision making and at all stages of creating and using systems. Problems can range from simple (easy to solve) to very difficult (require innovative solutions) and furthermore different problems need different experience and knowledge to match them to the right solutions.

Brainstorming on its own often works on simple problems and sometimes works on difficult problems. Our challenge in big companies is to show how TRIZ consistently works on both, with a focused brainstorm as the first step of its systematic process, taking us much further until we are able to uncover most, if not all, of the relevant strong solutions.

TRIZ helps us solve many different kinds of problems, as it offers a variety of approaches according to the type of problem and level of complexity and difficulty. Therefore the first achievements in big companies should involve helping them solve as many and as different types of problems as possible, from director strategic problems to shop-floor problems and everything in between. This is what we did at BAE Systems in many different areas and over many years.
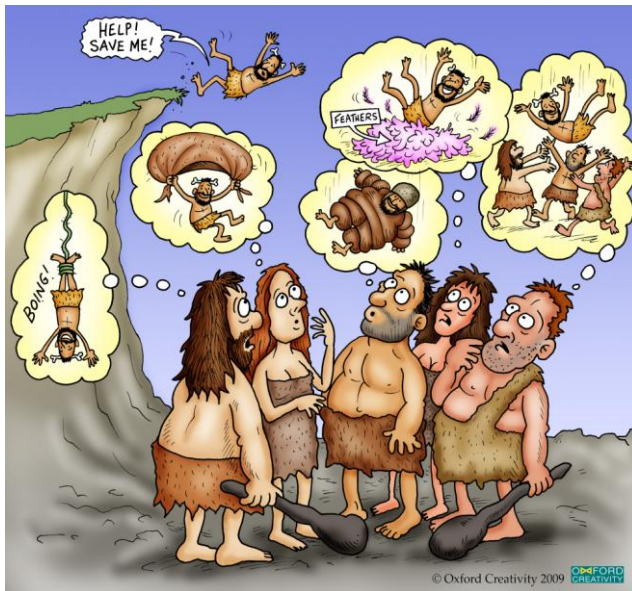
Brainstorming suits some but not others and has the hazard that quick thinking and over-confident management may sometimes get *their* inferior ideas accepted in a team brainstorm. The culture of an Oxford TRIZ session helped to break this with much humour and goodwill on all sides, especially at its first stage of gathering all ideas from all team members and then allowing everyone to both praise and criticize them. This was not for fairness but essential to TRIZ processes of quickly understanding everything we want, and then capturing everyone's first ideas of how best to achieve it (these ideas are the beginning of the TRIZ problem solving process).
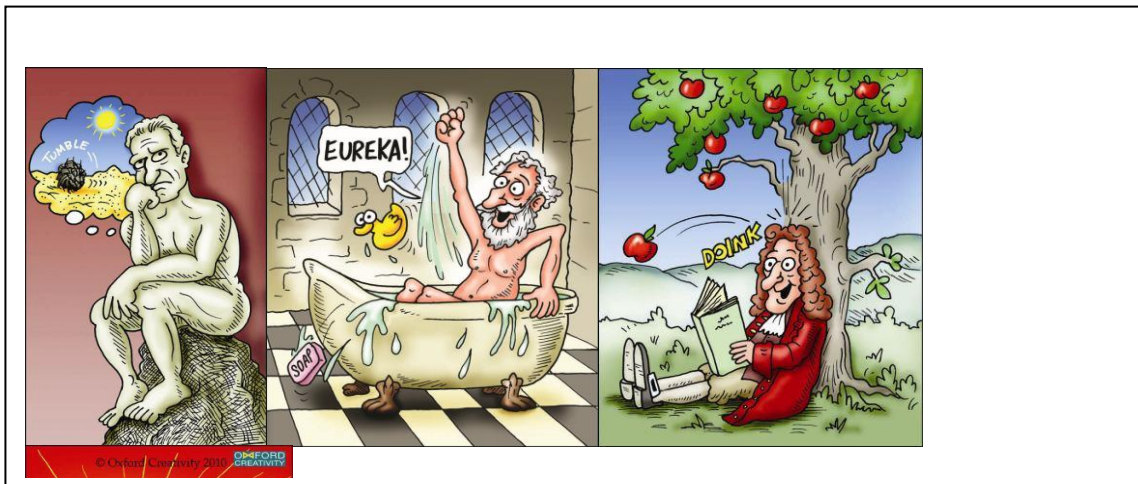
TRIZ (although consistent and simple) is different for everyone yet still establishes a Collaborative Culture, and a common language

TRIZ gets to everyone in different ways. One essential truth about TRIZ is that it is much more about prodding the brain rather than using other solutions. That's why when you put TRIZ in front of an original thinker they get TRIZ (see its power, its logic and its potential) very quickly and see lots more solutions to their problems immediately. Prod a good brain effectively and

you'll get what looks like miracles, prod any brain with TRIZ and something wonderful happens. This wonderful happening includes people who had described themselves as non-creative suddenly recognising their own innate creativity and this makes them feel confident about their abilities for innovation and problem solving – which develops their skills, and creates an upward spiral of great creativity, self-efficacy and solved problems.

Initially when promoting TRIZ in BAE Systems there was some resistance even from the original thinkers – those few who had heard of it were hesitant as they perceived it as a complex toolkit, hard to master and apply. This is a misapprehension, as each TRIZ tool is fairly simple and straightforward and learning the entire toolkit should offer no problems for engineers (or anyone). Although TRIZ is quite a large and rigorous toolkit many of the tools overlap, as TRIZ is designed to suit all types of problem solvers. Part of the genius of TRIZ is that it was developed to allow individuals to build their own, personal TRIZ toolkit which suits their problem solving style best. This is a bit like having a well-equipped gym with a large range of equipment – individuals choose and use only part of that equipment depending on what suits them and which fitness problem they are tackling. The TRIZ Toolkit is much the same – there are tools which have specific purposes and tools which work in many ways on different problems and an individual finds suit them well, and which they will use extensively.

TRIZ also helps us all to think more clearly – part of its power is that when we follow its processes it breaks our Psychological Inertia by helping us completely understand our problem – seeing both everything we want and ways to achieve it. This broader, clearer thinking breaks everyone out of their previous partial view of the problem and their infatuation with the first solutions which occurred to them. This builds consensus to properly understand the real problem, and find as many valid answers as possible.

Some False Starts or learning how to get it right

In our early days of problem solving with BAE Systems we encountered TRIZ enthusiasts who became TRIZ gatekeepers – these people love TRIZ but can hold back the widespread use of TRIZ within their own organisation. We always show TRIZ as simple and straightforward, easy to learn and understand so that when the TRIZ training is finished the TRIZ learning continues through real problem solving. We NEVER solve a company's problems but we ALWAYS get their people to solve it themselves with TRIZ. Gatekeepers like to emphasise how hard it is, how difficult to finally master, how it will take years before they could problem solve like them. They want to be seen as the TRIZ Gurus and often work hard before problem solving sessions and always present their solutions (arrived at through TRIZ) which awes the others and often are alright – but we find that it if you give the problem holder TRIZ skills that their solutions are generally better than any internal TRIZ consultant's more naive ideas.One of the things that worked at BAE was having a large community familiar with and confident in using TRIZ prevented a gatekeeper from "owning" TRIZ and making everyone do things his/her way (and making people feel they are the only people capable of using TRIZ).

We found such gate keepers can damage the innovation culture we strove to create and that although it took on that 'TRIZ is wonderful' if their message that 'TRIZ is hard' and 'TRIZ needs years to master' then this is difficult to overcome and can be harmful.

Different People like different tools

One great strength and problem of learning TRIZ is that we each like different tools and each have slightly different TRIZ toolkits. The TRIZ Tools are all different but some overlap and duplicate each other because they are designed to suit different styles of problem solving. Most of us will only need and will use about 80% of the tools, we will reject the ones which don't suit us but still have a complete TRIZ toolkit: which 20% we reject depends on each person. In BAE Systems we teach all the TRIZ tools we use for problem solving (we do not teach ARIZ and Su-Fields any longer – we did for a while but it did not prove useful). We find that teams respond well to each others' favoured tools and understanding all tools even the ones you don't favour is essential.

TRIZ offers a complete toolkit for everyone – no matter what their learning styles, preferences or experience. TRIZ achieves by this having such a wide ranging toolkit which contains tools to suit all situations and approaches. . The genius of the toolkit is that it has tools for all problem solving types, and allows each of us to build our own toolkit which suits us best. However it is important to learn and use all the tools so that when working in TRIZ Teams we can work together effectively, and not reject too many tools. There is a danger of becoming familiar with a small number of the TRIZ tools and only using them – and some TRIZ gatekeepers insist that everyone else in their company limits themselves to their particular choices – which is like playing only three players in football and keeping all your best talent on the reserve bench

Final Thoughts

We tried with our approaches of some humility and hard work to activate the TRIZ in individuals, teams, departments and whole companies, and the main part of that approach was to get TRIZ working for everyone – make it all available and there are many ways of doing this – this describes how it worked with BAE Systems – this is just one way – others have succeeded in other companies in other ways and the TRIZ message is probably that we should share our successes to encourage the others.

I am hoping that this will encourage both other TRIZ consultants (our road can be a hard one at times) and large companies to embed TRIZ into their innovation culture, their problem solving toolkits and their development programmes for engineers. This is supposed to show that it is not easy – there are many pitfalls – but it is worth persevering. I enjoy working within large organisations with important problems to tackle, and I feel a great pride in having established TRIZ in BAE Systems (and other companies such as Rolls-Royce). I hope this does not sound like a boast but a long expression of my gratitude to TRIZ and all it has done for me, and all it does to help engineers everywhere.