As auditors, quality engineers, statisticians, inspectors and managers, most quality professionals appreciate an orderly approach to assessing situations, collecting data, solving problems and tracking corrective actions. Like other solid, left-brain thinkers, many of us cringe at the notion of engaging in right-brained creative thinking that often smacks of the touchy-feely programs the HR department would sponsor.

Indeed, many of the creative thinking programs in vogue call for people to think outside the box by using unorthodox activities to jolt thinking out of the comfortable routine ways of seeing a situation. But are we ready to follow Doug Hall’s example and pull out the water guns and hose each other down in a meeting to provide the jump-start our cognitive processes may need?¹

Tapping Into Creative Juices

The problem is most of us need to tap into the creative juices when we want to develop new approaches to improving work processes and new solutions for quality problems. Where can a systematic, orderly quality professional turn for creative ideas without going off the deep end of creative thinking exercises?

One answer is TRIZ, which, due to its Russian origins, rhymes with breeze. TRIZ is short for teoriya rezheniya izobretatel’nykh zadach (theory of inventive problem solving), developed by the Russian scientist Genrich Altshuller.²

TRIZ is a systematic approach to creative thinking, in tune with left-brain thinking. It is sometimes called creative thinking for engineers.

In 50 Words Or Less

• TRIZ, sometimes called creative thinking for engineers, is a handy tool for quality professionals.

• Its 40 creative principles are drawn from analysis of how complex problems have been solved.

• It provides a highly structured approach to generating possible solutions to a problem.

TRIZ: A Creative Breeze for Quality Professionals by John Dew
When Altshuller refers to problem solving, he does not seek the unknown cause of a problem but rather focuses on a method for developing ideas to improve a process, get something done, design a new approach or redesign an existing approach.

Quality improvement activities, such as quality project teams and Six Sigma projects, generally reach a point where fresh thinking to develop a new method or redesign a process is needed. That’s why TRIZ is such a handy tool for the quality professional (see sidebar “Where Does TRIZ Fit With Quality Methods?”)

Altshuller developed TRIZ by analyzing thousands of patent applications to identify the core principles behind new idea creation. To reduce the number of empty trials that are common to this approach, he analyzed the popular trial and error method often used in discovery.

Altshuller perceived the analysis of creative thinking is similar to the analysis of the game of chess—you become better by studying a great number of real examples.

Most quality practitioners are familiar with brainstorming, the method developed by A.F. Osborn in the 1940s to separate the stage of generating ideas from the stage of evaluating ideas.3 Altshuller found Osborn’s method was effective for generating solutions to organizational problems but not inventive problems.

Similarly, William J. Gordon introduced synectics in the 1960s, employing the use of analogies to develop creative ideas.4 People are encouraged to think about how a similar problem was previously solved, how you might see the situation if you were the object under consideration, how to describe the problem with just two words and how the problem would be resolved in a fairy tale.

Edward de Bono developed the concept of lateral thinking in the 1970s to describe nonsequential, open-ended approaches to generating ideas, which he thought were similar to the reverse gear in a car.5

The mind is most comfortable with patterns, de Bono found, and lateral thinking enables people to become more self-aware of the patterns they use and more facile in developing new ways of seeing situations.

Osborn, Gordon and de Bono’s methods all seek to jolt us out of what Altshuller called psychological inertia—the routine and comfortable way we see things.

What Altshuller wanted was a systematic approach based on objective rules of technical systems to help people overcome the paradigm paralysis that inhibits creative thinking.

Lateral thinking enables people to become more self-aware of the patterns they use and more facile in developing new ways of seeing situations.

Altshuller started with the recognition that different situations have different levels of complexity based on the number of variants involved. While some problems have only a few variants, some have dozens, hundreds, thousands or even hundreds of thousands.

Edison, for example, conducted 50,000 trials to invent the accumulator battery. What Altshuller sought was a methodology to minimize the number of failed trials.

Problems with low complexity may be solved with the knowledge available in one discipline, Altshuller found. Higher level problems often require bringing in new ideas from other disciplines.

For technical problems, Altshuller observed it helps to define the problem in terms of one part of a technical system that keeps you from improving
When we critically reflect on how we solve problems, researchers suggest we should ask four questions:

1. How do we identify and define a problem?
2. How do we mentally represent the problem?
3. How do we plan to proceed?
4. How do we evaluate our problem-solving performance?

Each question stimulates our metacognitive thinking—that is, our thinking about how we think.

Many of the familiar quality methods provide useful frameworks for identifying and defining a problem. Control charts, for example, identify and define a problem in terms of sources of variation. The cause and effect diagram developed by Kaoru Ishikawa provides a visual structure for identifying and defining the possible causes of a problem. Indeed, the primary impact of the quality sciences over the past 25 years may have been to help reframe the way problems are understood in terms of processes and variation.

Nevertheless, the whole issue of problem solving is muddled by the fact that the very word “problem” has multiple meanings, as Charles Kepner and Benjamin Tregoe have pointed out. This contributes to the multiple interpretations of what constitutes problem solving. Quality practitioners do well to adopt Kepner and Tregoe’s definition of a problem as a deviation in performance whose cause is unknown.

Much of the effort of problem solving within the quality sciences is devoted to identifying the location and cause of a deviation, using methods such as flow charting, data collection and display, control charting, quality function deployment, failure mode and effects analysis and experimental design.

The first three steps of the Six Sigma process, for example, all focus on locating and framing a problem. However, identifying and understanding the cause of a problem does not automatically provide a solution or a corrective action.

In examining how solutions are generated, researchers have identified at least six distinct cognitive processes practitioners might draw on to determine how to solve a problem:

- Divergent thinking.
- Creative thinking.
- Convergent thinking.
- Domain specific knowledge.
- Practical experience.
- Deductive reasoning.

One of the benefits of using a cross functional team approach to problem solving is it tends to broaden the cognitive methods that will be applied to solving a problem once it has been well defined.

Of these six cognitive processes, TRIZ falls within the area of creative thinking, which is why it is called inventive problem solving. TRIZ provides a highly structured approach to generating possible solutions, as opposed to brainstorming and synectics, which are both relatively unstructured.

All these approaches to creative thinking agree on certain core concepts, such as the tendency of the mind to see situations in familiar ways and the need to jolt the mind out of its familiar perspective to generate fresh ideas—getting out of the box.

As creativity researcher Edward de Bono has observed, “The brain is designed to set up perceptual patterns and stick to them. To be creative we have to do things which are not natural and which go against the way the brain is designed to work.”

James Adams, who served as dean of Stanford University’s College of Engineering, noted much of our thinking and behavior is programmed, and creative thinking requires us to deviate from our habitual thinking.

TRIZ is referred to as left-brain cre-
ative thinking because it uses an orderly approach to generating creative solutions, which appeals to well-ordered left-brain thinking. Because quality practitioners tend to be highly educated in math and engineering, which draw heavily on left-brain thinking, a left-brain approach to creative thinking may be a valuable resource to add to the quality practitioner’s kit of cognitive methods.

Going back to at least the early 1990s, de Bono advocated a synthesis of quality methods and creative thinking processes, noting that “when quality is poor there is a need for quality improvement but as quality improves there is a need to supplement quality with creative thinking.”

TRIZ provides quality practitioners with a structured approach to generating solutions to the problems they locate and frame using the quality sciences.

REFERENCES

another part of the system. Or, with physical problems, the problem may be described as a contradiction in which mutually opposing demands are placed on the same system or equipment.

Part of Altshuller’s development of TRIZ is based on his laws of the development of technical systems. Altshuller perceived that:
- Systems are only healthy when all the subsystems are healthy.

**FIGURE 1** The TRIZ Process

1. State the contradiction: _____________________________
   (what is not working)

2. Expand your understanding:
   - Materials being used __________________________
   - Equipment being used _________________________
   - Environmental conditions_______________________
   - Work methods being used ______________________
   - People involved ______________________________

3. Define the ideal state: ______________________________
   (what you’d like to have happen)

4. Generate multiple ideas using the 40 principles (presented here in the order used originally by Genrich Altshuller):
   - Segmentation
   - High speed
   - Mechanical replacement
   - Pneumatics and hydraulics
   - Membranes
   - Porous materials
   - Homogeneity
   - Color changes
   - Change physical state
   - Phase transitions
   - Change physical state
   - Discarding and regenerating
   - Spheroiality
   - Discarding and regenerating
   - Dynamics
   - Phase transitions
   - Partial or excessive actions
   - New dimension
   - Heat expansion
   - Mechanical vibration
   - Enrich
   - Inert
   - Periodic action
   - Continuous useful action
   - Composite materials
   - Short life
   - Optical copies
   - Intermediary object
   - Self-service
   - Feedback
   - Turning harm to good
   - High speed
   - Removal
   - Intermediary object
   - Feedback
   - Turning harm to good
   - High speed
Quality practitioners will typically encounter a wide range of opportunities for innovative thought. These can include:

- Developing corrective actions to audit findings.
- Addressing changing regulatory requirements.
- Modifying or redesigning processes to reduce cycle time, scrap rates or process variation.
- Contributing ideas for new product development.

Following are some examples of applications from manufacturing and service settings.

**Changing Regulatory Requirements**

Changes in Occupational Safety and Health Administration requirements made it unacceptable to clean power transformer filters with high pressure air hoses at a large chemical processing facility. TRIZ methods encouraged people to think about where the problem existed, which was when high pressure air loosened debris that could endanger workers. The local quality principle in TRIZ stimulates thinking about changing temperature and pressure conditions to develop new ideas.

In this case, a team of hourly employees designed a container filters would fit into that used a partial vacuum to pull air through the filters for cleaning. This invention enabled the facility to maintain lower operating temperatures in its power transformers for a cost savings that ranged up to $400,000 per year, based on power load.

**Process Redesign**

The number of scholarship applications at a major research university has continued to increase every year, creating a bottleneck in responses. The traditional process of reviewing every candidate against every potential scholarship was resulting in a four-month delay in making scholarship awards, putting the institution at a competitive disadvantage for the best students.

The other way around principle in TRIZ was applied to completely reverse the process. A student now
might sound because patterns begin to emerge. Some principles are closely related, being mirror images of one another. Here is a description of some of the 40 principles:

- **Segmentation** is the principle of breaking an object into independent parts, such as subdividing a large room into smaller rooms. With segmentation, you seek creative ideas associated with splitting things apart, such as making it easier to disassemble. If an object or process is already somewhat fragmented, look at how it might be fragmented further.

- **Removal** is the principle of separating one part of the process or equipment and putting it in another location. Remove a noisy engine and put it in a special area to minimize the noise.

- **Local quality** is the principle of having different parts of an item carry out different functions, like the hammer that has a nail puller included. Look for ways to accentuate different functions in a process to obtain new results.

- **Asymmetry** jolts your thinking by telling you to change the shape of an object from symmetrical to asymmetrical. If it is already asymmetrical, increase the degree of asymmetry.

- **Merging** encourages you to bring objects closer together and to assemble similar objects, such as networking multiple microprocessors. With merging, you think about how you could bring objects together, such as developing medical instruments that can perform multiple tests at the same time.

receives a scholarship award within two weeks of completing his or her application, giving the school a noticeable advantage in attracting top high school graduates.

Once awards are made, the scholarship office now determines how to meet the award obligations by drawing upon the hundreds of scholarship resources.

**Cycle Time Reduction**

Disconnecting electric motors and moving them to a shop area to repair or replace motor brake drums was an expensive and time consuming process at a power facility. Using the principle of equipotentiality from TRIZ, maintenance staff determined they could conduct on-site repairs using a portable induction heater, brake drum puller and portable floor crane.

This shortened the maintenance cycle time, reduced maintenance man-hours, avoided potential problems associated with hoisting and moving large electric motors, and improved the operational availability of high speed motors, saving $90,000 per year.

**Community Problem Solving**

A small rural community identified the lack of a community college or other access to higher education as a primary barrier to economic development.

Attracting a private college or obtaining state funds to build a new community college was beyond the community’s financial and political resources. And, most homes in this economically depressed region did not have computers or internet access.

A quality practitioner, trained in TRIZ, helped the mayor and school board use the concept of universality to develop an entirely new approach to higher education by constructing a university center that provided high speed internet access that allows community members to earn their degrees online from major universities across the country. Instead of having campuses for each institution, the community built one “campus” to serve all universities.
Using 40 principles is not as challenging as it might sound because patterns begin to emerge.

- **Nesting** is the principle of placing one object inside another and placing that object, in turn, inside another, such as with measuring cups and Russian dolls.
- **Spheroidality** kicks you into switching from the direct or linear to the indirect. Could you benefit by going from flat or cubical to spherical? Where could you use rollers, ball bearings or spirals to achieve new results? Could you go from a linear motion to a rotary motion?
- **High speed** makes you look for creative solutions by speeding things up. You can perform a problematic task better, in some cases, by doing it quickly. You can cut things so fast you avoid the buildup of heat.
- **Equipotentiality** causes you to change working conditions so you do not have to raise, lower or move an object. Instead of moving students from classroom to classroom, you can schedule block classes and keep them in the same room.
- **Other way around** is a creative principle that everyone has used in moving furniture. If there are difficulties in moving in a straight line, move back, up or down. Turn an object on its side to move it. Or, remove an object or part of an object from the site.
- **Optical copies** encourages you to substitute a real object with a photograph. This principle is used in designing low cost, mock-up control rooms for power plants so operators can simulate work evolutions.
- **Short life** gets you thinking about using an inexpensive substitute with a short life for a more expensive and durable alternative. You could buy a very expensive camera for underwater photography, but if you only go snorkeling once a year, how about using an inexpensive one-use camera?

While it may take a day to learn the 40 principles, once they are recognized, individuals or teams will quickly plow through them to develop a robust set of inventive ideas for solving a problem. The TRIZ method is a valuable addition to any quality practitioner’s tool box and can help in process redesign, developing corrective actions and finding new ways to reduce errors (see sidebar “Opportunities for Applying TRIZ,” p. 48).

Over time, Altshuller went on to identify logical ways to group the creative principles based on the technical contradictions being studied. If, for example, the contradiction involves length and shape of an object, Altshuller recommended focusing on the other way around, spheroidality, dynamics and nesting principles.

**Challenges and Opportunities**

The challenges for expanding the use of TRIZ have been discussed by leaders of the Altshuller Institute, drawn from organizations such as Ford Motor Co., Boeing, Westinghouse and Air Products.

Using TRIZ requires some training and a good deal of practice. Companies should be looking at ways to include TRIZ training in their internal corporate training programs.

The TRIZ method has already been embraced in the engineering curriculum at some universities. Eugene Rivin has reported on the use of TRIZ in the design curriculum at Wayne State University in Detroit. Julian Blosiu with the Jet Propulsion Laboratory has observed TRIZ training is a common denominator in many corporate training programs for engineers at companies such as Motorola, Ford Motor Co. and Proctor and Gamble.

If this quick introduction sparks your interest in TRIZ, you can find Altshuller’s books in most engineering libraries or locate more information at www.triz-journal.com. There is also an Altshuller Institute (www.aitriz.org), which has an annual meeting, TRIZCON, which focuses on the application of TRIZ methods.
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