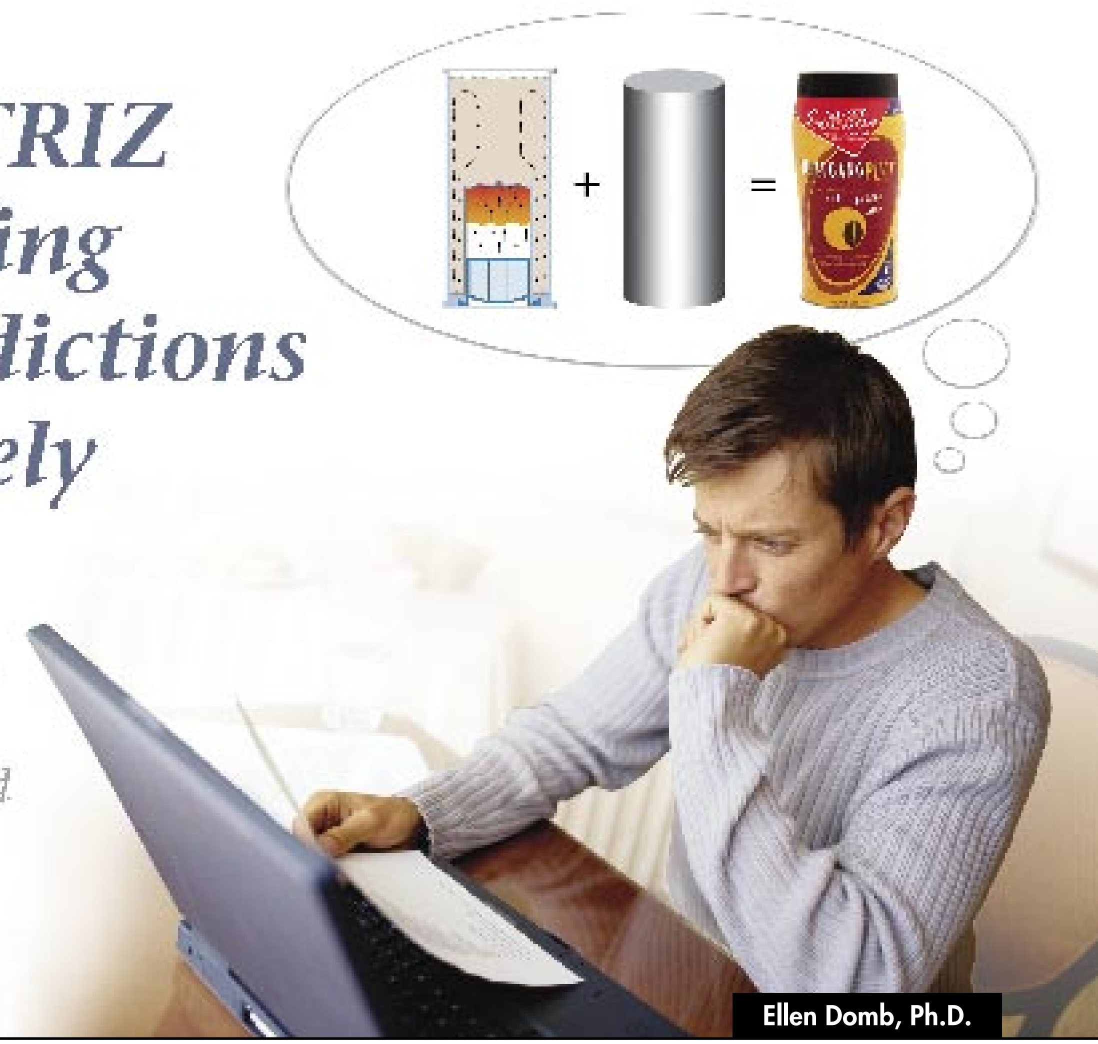
Think TRIZ for Solving Contradictions Creatively

This quality improvement method has not only solved but also documented those problems that defy root cause analysis.



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What's your secret for staying in business? Is it continuous quality improvement? Define-measure-analyze-improve-control (DMAIC) and design for Six Sigma (DFSS)? Plan-do-check-act (PDCA)? Plan-do-study-act (PDSA)? Quality circles? Process improvement? Total quality management? *Kaizen*? Or just plain old troubleshooting?

No matter what you call it, the vast majority of successful organizations have some way of tracking down their problems and doing something about them. The quality profession has been in the center of both the tracking and the doing since its birth.

Quality improvement has grown from simple inspection to inspection with statistical process control to the array of analysis tools and teamwork methodologies now used to create and deliver services and products that do what our customers require. These tools work: In product and service development and delivery, we're able to identify problems and determine whether they're the result of special or common causes. We protect our customers by immediate corrective action, and we protect our business and customers by preventing future problems.

So why do we need new methods, tools and techniques for creativity? Because identifying a problem and its root causes doesn't always give us the ideas we need to find a solution. For at least the last 10 years, quality improvement leaders have been saying that the next step for quality is the merger of quality with creativity.[1,2]

"Standard" quality improvement systems such as DMAIC and PDCA have always incorporated brainstorming as a key method for finding creative solutions to problems. Brainstorming is designed to liberate a team's thinking from past patterns and uncover ideas that people might have unconsciously suppressed. When it works, it's fast, and the team reaches a high level of consensus fairly quickly because the idea is usually improved by the entire team and is seen as a collective product rather than one person's idea.

But brainstorming doesn't always work. If the solution lies outside the experience of the team, this tool won't reveal it. Some teams try to compensate by inviting outsiders to join them for brainstorming sessions. This works if the new members happen to have the information the team needs, but there's been no good method for determining that in advance. It's a classic "Catch-22": If you know what the solution is, then you know whom to invite, but then you don't need to invite them because you know the solution.

Know & Go

- Brainstorming doesn't always work to find solutions to quality improvement problems. If the solution lies outside the experience of the members of the team, brainstorming can't reveal it.
- TRIZ is a systematic method for finding innovative solutions to problems, based on two simple concepts that are completely compatible with modern quality methods.
- The first concept is that somebody, someplace has already solved a problem similar to yours—and there are structured ways to find those solutions.
- The second concept is that contradictions should be removed—don't just look for the best tradeoff, get rid of the root cause.
- Organizations of all sizes in all parts of the world are using TRIZ to develop and improve products, processes, systems and services in combination with Six Sigma, QFD, design of experiments and many other quality improvement methods.

TRIZ defined

TRIZ—a Russian acronym for "Theory of Inventive Problem Solving"—is a different kind of creativity system. It's based on the analysis of creative solutions to past problems. TRIZ applies to both continuous improvement and development of new products and services because continuous improvement requires solving current problems, and development requires finding a way to solve customers' problems.

Somebody, someplace, has already solved your problem or one similar to it.

Research on the TRIZ method was done in the former Soviet Union from 1946 to 1985 and has continued globally since then. *Quality Digest* featured an extensive introduction to the method in its February 2004 issue ("Enhance Six Sigma Creativity With TRIZ").

Two basic principles in TRIZ maintain that:

- Somebody, someplace, has already solved your problem or one similar to it. Creativity means finding that solution and adapting it to the current problem.
- Don't accept compromises. Eliminate them.

The quality improvement profession embraces these principles because quality thinking integrates benchmarking, which is strongly related to the first principle, and eliminating root causes rather than just improving symptoms, which is related to the second.

To illustrate the concept of "Somebody, someplace, has already solved your problem," consider the situation of dairy farmers in California. Producing milk requires handling large quantities of manure. In the past, the manure was dried in large ovens for deodorizing, shipping and recycling as fertilizer. But with the increasing cost of energy, drying ovens became uneconomical. The TRIZ method for looking at other technologies for potential solutions starts with restating the problem in general terms, emphasizing the functions being performed, rather than the technology itself. Thus, dairy farmers didn't search for better ways to dry manure; they looked for ways to separate a liquid from solids. A simple search with TRIZ techniques turned up a method, using a hydrophilic gas, in which the gas carries the water molecules away. This method has been used for more than 40 years for concentrating orange juice.[3]

Other examples of this principle include:

- The pharmaceutical industry found ways to manage foam in the production process by studying the beer industry.
- Medical information technology requires stringent privacy protection under Health Insurance Portability and Accountability Act (1996) regulations. Many solutions are being found in systems developed for the banking and securities industries.
- Paint companies have problems with the accumulation of sludge in processing equipment. The nuclear waste disposal industry has found many ways to prevent the buildup of sludge because removing it is extremely difficult and requires shutting down the facility for a long time.

The idea of eliminating problems rather than accepting compromises goes against the grain of standard business and engineering teaching, which emphasizes tradeoffs, cost-benefit analyses and other methods of compromise. TRIZ recognizes two kinds of compromises (frequently called "contradictions"):

TRIZ doesn't depend on team members' knowledge or their personal creative capability to solve problems.

- *Technical contradictions*. These are the classic engineering and business tradeoffs in which the desired state can't be reached because something else in the system prevents it. In other words, when something gets better, something else gets worse. Examples include:
  - ❑ Product gets stronger (i.e., good), but the weight increases (i.e., bad).
  - ❑ Bandwidth increases (good) but requires more power (bad).
  - ❑ Service is customized to each customer (good), but the service delivery system becomes complicated (bad).
  - ❑ Automobile airbags deploy quickly to protect the passenger (good), but the faster they deploy, the more likely they are to injure or kill small or out-of-position people (bad).

- *Physical contradictions*. Also called "inherent" contradictions, these include situations in which one object or system has contradictory or opposing requirements. Everyday examples abound:
  - ❑ Surveillance aircraft should fly fast to their destinations but also slowly to collect data over the target.
  - ❑ Software should be easy to use but include many complex features and options.
  - ❑ Coffee should be hot for enjoyable drinking but cool enough to prevent burning consumers.
  - ❑ Training should be thorough but not take too much time.

TRIZ doesn't depend on team members' knowledge or their personal creative capability to solve these problems. The first group, the "technical" or "tradeoff" contradictions, are solved using the 40 principles of problem solving. Many people have expanded on the original TRIZ research to demonstrate that the 40 principles apply to a wide variety of disciplines. (See *The TRIZ Journal* [*www.triz-journal.com*] for examples of the 40 principles in chemical engineering, sales, microelectronics, education and quality management, among others.)

The second group, the "physical" or "inherent" contradictions, are eliminated using four basic principles to separate the requirements that appear to be contradictory in time; space; between the parts and the whole; and between the supersystem, system and subsystems.

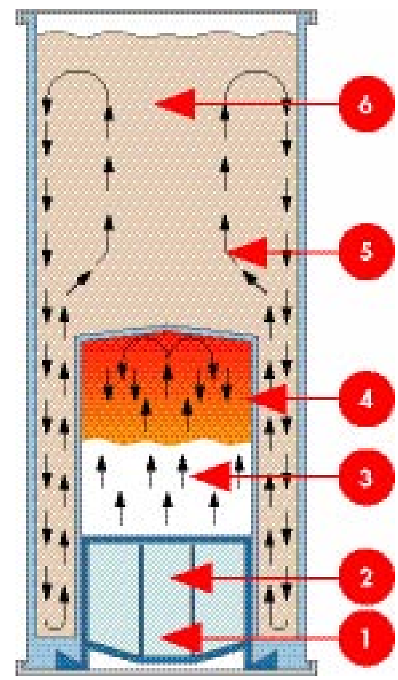
For example, the airbag problem can be solved at the subsystem level by changing the bag material so that it won't grab the skin of the face and twist the head of a small, out-of-position person. The problem can also be solved at the supersystem level, in several ways:

- If the car can't crash because it's part of a supersystem that knows the positions of all objects and controls their speeds (a technology that's fewer than eight years away, according to some predictions)
- If the structure of the car absorbs the force of the crash, and the airbag isn't needed
- If the social and/or legal system is such that small people never sit in the front passenger seat

TRIZ success stories

The Wolfgang Puck self-heating coffee can is a recent TRIZ success story. Michael S. Slocum, co-editor of *The TRIZ Journal*, was the vice president for science and engineering at Ontro (now OnTech), a food technology company based in San Diego. From 2001 through 2003, he used TRIZ, quality function deployment, and axiomatic design and robust engineering to solve more than 400 problems encountered in the development of the self-heating beverage container. This container was named one of 25 hot products to watch by *Fortune* magazine and then noted by the *New York Times*.[4,5]

Self-Heating Beverage Container Schematic



1. Consumer pushes the activation button
2. Water is released into calcium oxide
3. Combination of water and CaO begins the natural thermic reaction
4. The cone heats up
5. Heat is absorbed by the beverage
6. Within 6-7 minutes, the beverage is hot

A few of the contradictions addressed by the OnTech team included:

- Fast heating of the beverage is good, but fast heating of the water/CaO mix creates steam, which can rupture the capsule.
- Thin materials are needed between the water/CaO mixture and the beverage for rapid heating, but thin materials aren't strong enough to withstand the pressure created by the process.
- Multiple-layer materials are much stronger than single-layer materials, but they're expensive to manufacture.

Select Portion of the TRIZ Matrix

Improving feature		Worsening feature: Speed (9)	Shape (12)	Ease of manufacture (32)
9	Speed	+	35, 15, 18, 34	35, 13, 8, 1
15	Duration of action of moving object	3, 35, 5	14, 26, 28, 25	27, 1, 4
36	Device complexity	34, 10, 28	29, 13, 28, 15	27, 26, 1, 13

The numbers in the cell refer to the principles that have the highest probability of resolving the contradiction. The circled cell is discussed in the example below. The entire TRIZ matrix is available online at *www.triz-journal.com.*

- The customer wants to drink the beverage right away but will be disappointed if the beverage isn't hot.
- The top of the can should be metal to make it easy to use a conventional pop-top opener, but it shouldn't be metal to avoid burning the customer's lips.

Clearly, the OnTech team faced a mixture of technical contradictions and physical contradictions. The product's success is a tribute to OnTech's application of TRIZ to the solutions.

OnTech's package development has many examples of the interplay between solving a technical contradiction and a physical contradiction. For example, one difficult physical contradiction is that the outer wall must be thick so that it stays cool and users aren't burned when they pick up the coffee, but the outer wall must be thin so that the contents can be raised to a high temperature quickly during sterilization.

OnTech solved this problem by using six layers of material to separate the properties of the whole and the parts, but that solution created a technical contradiction: The complex six-layer structure was expensive to manufacture, and it was very difficult to get a good yield, especially in the double-seaming step where the edge of the wall meets the top and the bottom of the can. Using the TRIZ matrix (a portion of which can be found in the figure above), which expresses all technical contradictions in tradeoff terms, the tradeoff was:

- The complexity of the system improves (Parameter 36, "Device complexity")
- The ease of manufacture worsens (Parameter 32, "Ease of manufacturing")

The matrix tells us that the principles most frequently used to solve this problem are 26, 27, 1 and 13. Although the "best" answer may come from any of the 40 principles, the ones listed in the matrix are always a good place to start, because they are the ones that have been successful for other people.

In this case, the OnTech team used principle 1, "Segmentation." They divided the manufacturing process into smaller steps—instead of producing the complex system by precision blow molding, they used die stamping to cut the material to shape. The complexity of the product remained the same, but the cost of producing it went down enough to make manufacturing feasible.

Another recent TRIZ success is Jim Kowalick's application of TRIZ methods combined with techniques from the Taguchi method of robust engineering to improve direct mail advertising. He and his partners used TRIZ to create a system that triples customer response. They used techniques from the diet food industry to attract interest in a patio-building company. During the process, they resolved contradictions including:

- The customer wants thorough knowledge of the product, but doesn't want to spend time reading the information.
- The advertiser wants more response to the ads, but only from customers who are serious prospects.[6]

Conclusion

TRIZ has been incorporated into the general corporate culture for global companies in a wide variety of industries—Siemens, Samsung, LG, Unilever, Agilent, Hitachi, Dow Chemical, Johnson & Johnson and Delphi are among those that have talked about their TRIZ experiences at recent conferences. Small and medium-sized organizations with less familiar names are adopting TRIZ to support quality improvement in services, products and systems in fields as diverse as restoring the vitality of a downtown to creating software to improve sales of eyeglasses.

How do you recognize when quality requires creativity? When the solutions that your team creates don't get rid of the root cause. That's a strong indication that unrecognized contradictions are blocking you from finding a good solution, and that TRIZ will be the next tool you need.

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Comments