The Quality Management

FORUM

Winter 2005

Volume 31, Number 1

ASQ

AMERICAN SOCIETY FOR QUALITY™

Quality Management Division

www.asq-qmd.org

A Peer-Reviewed Publication of the Quality Management Division of the American Society for Quality

What does I-TRIZ offer the Quality Manager?

By Cal Halliburton

"We want high quality at low cost." Once upon a time, a statement like that would have been considered a meaningless contradiction. It was impossible. Today, the contradiction has been broken. In today's environment of rapid and often disruptive change, "high quality at low cost" is not only expected, but it must also be fast and profitable. The quality manager must be able to learn fast and adjust quickly. Agility is the name of the game, and the quality manager is looking for tools and methods that support agile adjustments to product quality, and that contribute directly to the bottom line.

While process quality and product quality are mutually dependent, they may be supported by different methods and tools. Deming, Juran, Ishikawa, Taguchi and many other leaders of the quality movement brought quality off the end of the production line and integrated quality responsibility and quality management throughout the company. Process improvements and reduction of variation produces product improvements and delighted customers. Design for Six Sigma, Design for Manufacturing and Assembly and other methods have moved the quality manager into the total development of products and services in the company. In the end, the product must delight or, at minimum, satisfy the customer and there are many ways that the customer must be satisfied. Quality managers have a variety of proven tools to help them accomplish this task, but the demand for speed and agility also demands interest in new tools and methods.

I-TRIZ Background

Although it appears to be a new kid on the block, I-TRIZ (the Ideation/TRIZ methodology) has a long and interesting history of development. Its foundations began in 1946, with Genrich Altshuller and his quest to develop a method for invention. Having found no existing methods and being skeptical of the current psychological methods of creativity, he looked to the accumulated results of invention as documented by patents. Over a period of forty years, Altshuller and his colleagues analyzed more than two million patents and made several important discoveries. They defined a truly inventive problem as having one or more internal contradictions. They discovered that there were identifiable patterns of solutions to inventive problems, and abstracted more than one hundred of those patterns. They discovered that technological systems evolve over time according to patterns that have predictive power. Most important, they developed several methods and tools for applying this knowledge, then tested the validity of their discoveries through extensive practical work solving tough technological problems. Altshuller and his colleagues established training and certification programs, and educated hundreds of students in the use of his methods. He and his colleagues engaged in continuous development of the science of invention until in 1986, his health declined and development of TRIZ passed entirely to his students and colleagues.

At the primary center of development, led by Boris Zlotin and Alla Zusman, TRIZ was restructured and modernized to include Altshuller's primary discoveries, the accumulated knowledge-base extracted from patents, and processes from several other problem-solving methodologies. The reformulation was initially completed in the early 1990s in the United States by the TRIZ masters and scientists who are a part of the Ideation Research Group. The objectives of the reformulation streamlined the method, shortened the training time and lead to the development of software. The revised methods dramatically speed learning and the generation of an exhaustive set of solution concepts. The result of their work, the Ideation/TRIZ Methodology, is a modern, computerized and expanded version of TRIZ accessible to anyone interested in solving problems and who is willing to learn.

The Ideation team of scientists continues the development of I-TRIZ as a method and tool for work with technological systems. The patterns of invention have been expanded to more than four hundred and several hundred lines of evolution have been identified. They have also evolved I-TRIZ into a general-purpose management tool with targeted applications that meet the needs of managers in all functions. To explore what I-TRIZ offers the quality manager, we'll relate it to the concepts of consumer satisfaction and quality developed by Kano in the late 1970s.

Kano Model

In the late 1970s, Dr. Noriaki Kano contributed to the concept of quality by introducing the notion that customer satisfaction and product function were salient variables in the description of quality. He proposed that quality was the result of their interaction. By placing those parameters at right angles on a graph, he then derived and described three types or dimensions of product quality: threshold quality, performance quality and excitement quality. The primary applications of the I-TRIZ system address each of the model's dimensions of quality.

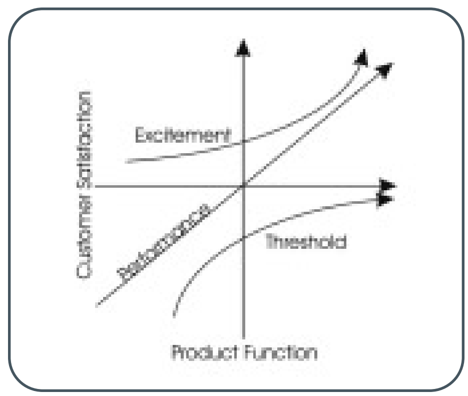

Figure 1 **— The Kano Model of Quality**

Threshold Quality Product Characteristics

The first level of product quality in the Kano model is the threshold characteristics. Threshold characteristics are necessary for a product to enter the market. Today's market

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requires that an automobile have an electric starter. Without the electric starter, you have no sales. Threshold characteristics are similar to attribute data. They are noted by the customer as being present or not present. Though there may be levels of quality and performance that can be measured, the product is expected to offer both high quality and reliability on all threshold characteristics. Because they are expected, the presence of threshold characteristics creates no customer satisfaction, but its absence usually results in great dissatisfaction and the loss of customers.

I-TRIZ Anticipatory Failure Determination™ (AFD™)

The threshold quality characteristics of the Kano model are "invisible" to the customer. However, when threshold characteristics fail to function properly, they can lead to enormous dissatisfaction and damage to the company. The company must be concerned with reliability and safety of all aspects of the product. Something as simple as a cup holder that is difficult to locate, is a distraction while driving, allows hot coffee to spill, or has edges or mechanisms that catch clothing or cut and injure can irritate customers to the point of lost customer loyalty and lawsuits. Major malfunctions can result in loss of life, billions of dollars of financial loss and immeasurable damage to a company's reputation.

How do engineers deal with the disastrous consequences of design failures in threshold quality? And, how can they ensure that their designs take into account and prevent such consequences?

There are several standard failure analysis and failure prediction tools available and all are susceptible to the same shortcomings. They rely on the same posture that the engineer has when originally designing a system. For failure analysis, the engineer asks, "What went wrong?" and for failure prediction the engineer asks, "What could go wrong?" The approach is to design a well functioning system. Because of the focus on the well designed system there is no effective method for locating and raising the negative aspects of the design.

Anticipatory Failure Determination (AFD) — for both Failure Analysis and Failure Prediction Applications — takes an inverted approach to the problem by asking, "How can failure be induced in the system?" This simple question has two important elements.

The question breaks the psychological mindset of producing a well functioning system. It converts the problem into one of subverting or destroying a functioning system. Causing failure is a significantly different approach than preventing failure, because to prevent failure an engineer or manager must truly understand how to cause it.

The question also brings to bear all of the creative power of the engineer's training and experience along with the inventive power of the I-TRIZ knowledge base, methods and tools, and focuses it on this new inventive problem of subversion. The AFD situation questionnaire, knowledge base and functional formulation tools, provide a near-exhaustive set of solution concepts to the problem of destroying the system. Finding all of the possible methods for subverting a system may seem like an infinite task consuming large amounts of time. AFD is efficient and effective because finite systems have a finite number of ways the system can go wrong and the AFD practitioner can complete an exhaustive search of "destructive" concepts with speed and accuracy. Even when the number of possible destructive solutions is large, the quality engineer must be able to quickly identify and anticipate all of them. AFD provides an exhaustive and rapid search of the so-called solution space and saves time necessary to implement preventive designs in well functioning systems.

One result of a thorough and rapid analysis is the foresight to prevent large warranty losses. A second result is the opportunity to convert a threshold characteristic into a performance or excitement characteristic. A car key once provided a threshold level of security. The addition of a "remote" key then provided an excitement characteristic for a period of time. The creation of the smart key or the smart car that knows its owner can add a new excitement characteristic to automobile security. Large and tall sport utility vehicles have encountered a problem of rolling over when turning or in high winds. Unbalanced tire pressure can contribute to the "roll over" failure. A smart tire or smart wheel that informs the driver of unbalanced tire pressure can help prevent roll over and create an excitement feature. By identifying unknown needs and demonstrating unexpected product enhancements for customer safety and security, a company can differentiate a product from its competition. Thus, AFD can help convert failure prevention into a source of performance or excitement characteristics.

Performance Characteristics

Performance characteristics are similar to variable data. The customer generally regards more of the characteristic as better. More of the performance characteristic produces higher customer satisfaction. Most customer needs fall within this category and customers are often willing to pay more for higher performance on these product characteristics. Both producers and customers are often faced with a trade-off between cost and a higher level of performance. High performance at low cost is a demanding goal.

I-TRIZ Inventive Problem Solving (IPS)

Performance quality is the ability of the product to reach desired levels of performance for each of its functions. Quite often the customer chooses the level of performance desired and trades cost for performance. The design engineer is faced with similar trade-offs. Within a product like an automobile, the conflicts among requirements and the usual trade-offs are many and complex. Requirement contradictions such as weight versus strength, weight versus fuel economy, weight versus acceleration, or weight versus stopping distance are typical. Eliminating such contradictions is the primary purpose for which Altshuller developed TRIZ and many of the original TRIZ tools can be of assistance in dealing with performance quality problems. However, the IPS application brings a streamlined, integrated and computerized system of inventive tools to the performance quality problem. The Ideation-TRIZ approach is to avoid trade-offs in favor of overcoming or breaking the contradiction. Contradictions are broken by finding new solutions within the scope of the product system and by finding new uses for existing system resources. The IPS method of problem definition, graphic problem formulation, integrated knowledge base and the semantic generator provides the design engineer and quality manager with tools that rapidly create and examine an exhaustive set of design possibilities.

By overcoming or eliminating product contradictions, IPS gives the quality manager the opportunity to provide unexpected performance enhancements. This allows the company to differentiate its products from the current market and capture additional market share. An unexpected level of performance "high quality and low cost" pleases customers, senior managers and stockholders.

Excitement Characteristics

Excitement characteristics can provide a break from the mundane, energize a market or create a completely new market. Excitement characteristics resemble threshold characteristics, but they are credited by the customer if they are present. Customers rarely expect excitement characteristics because they have not thought of them. Since they are seldom verbalized by the customer, their absence seldom causes dissatisfaction.

I-TRIZ Directed Evolution™ (DE™)

One way to add excitement and create a "buzz" about a product is to add features or functions that customers don't know they need. When customers find a new characteristic that meets a previously unmet need, they are surprised and excited. Even small convenience features in cars, like cup holders and storage compartments can create enough product differentiation and added customer satisfaction to affect market share.

Altshuller's greatest discovery was that technological systems evolve over time according to identifiable patterns. Ideation scientists have refined Altshuller's original eight patterns into several hundred "lines of evolution." The patterns of evolution and the I-TRIZ extension of those patterns give them the power of predictive laws of technological behavior. The directed evolution application of I-TRIZ equips the company with searchlights and radar to see into the future of products and predict changes in their characteristics. This gives a company the strategic advantage of directing the next steps in product evolution in its current market or others, securing that advantage with strong patent protection, and slowing down or locking out its competitors.

Time and social attitudes

Time and changing expectations or changes in general consumer attitudes are not well accounted for in the Kano model. Remote key locks and air bags for automobiles were once excitement characteristics. Over time they have become basic expectations where their absence or failure will cause dissatisfaction. Some characteristics, like fuel economy and available horsepower, wander from performance quality to threshold quality and back to performance quality as they have done over the past 20 to 30 years. The application of Directed Evolution provides predictive indicators of these types of trends and allows the company to anticipate and prepare for necessary changes.

In addition to the integrated inventive systems found in the other applications, directed evolution incorporates a system of scenario planning. The scenario planning function allows the manager to prepare a range of scenarios from which senior management may select for the company's most opportune future.

I-TRIZ Control of Intellectual Property (CIP)

A growing emphasis on the quality and quantity of a company's intellectual property is a trend that will no doubt impact the duties of the quality manager. Patents and other intellectual property provide periods of product stability in a frantic world of new product development, and intellectual property is a growing influence in the evaluation of total business assets. Turning new or old intellectual property into performing products that are reliable and satisfy customer needs places additional demands on the quality manager. Elements of inventive problem solving and anticipatory failure determination may be used to deconstruct, assess and strengthen existing and proposed patents. Directed evolution may be used to plot the strategic direction of a company's technology. I-TRIZ provides the tools to

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I-TRIZ Applications

A battery of methods and tools to support the work of the quality engineer and the quality manager.

Anticipatory Failure Determination™ (AFD™)

Failure Analysis is a systematic procedure for identifying the root causes of a failure or other undesired phenomenon in a system, and for making corrections in a timely manner.

Failure Prediction is a systematic procedure for predicting and then preventing dangerous or harmful events that might be associated with a system.

Inventive Problem Solving (IPS)

IPS is a systematic procedure for resolving tough technological problems, enhancing system parameters, improving quality, reducing cost, etc., for current generations of products and technologies.

Directed Evolution™ (DE™)

DE is a systematic procedure for strategically evolving future generations of technological systems.

Control of Intellectual Property (CIP)

CIP is a systematic procedure for increasing IP value and providing protection from infringement and circumvention.

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deal with the demand for quality in intellectual property.

I-TRIZ provides tools for rapid learning, rapid response and bottom-line results in a fast-changing environment. They help protect and extend the quality of a company's current technologies and help evolve and protect new technologies for the future. They are necessary tools for the agile quality engineer and quality manger in the agile company. They are tools for high quality at low cost, quickly and at a profit.

NOTES

1. TRIZ, pronounced *trees*, is a Russian acronym that translates as Theory of Inventive Problem Solving.
2. Many thanks to Boris Zlotin, Alla Zusman, and the many scientists and staff of Ideation International for their mentoring and teaching.
3. Special thanks to Zion Bar El for his willingness to spend time with and encourage a novice.

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