The Innovation Process and Quality Tools

by Justin Levesque and H. Fred Walker

As quality professionals, we work to improve our organizations using specialized knowledge, tools and techniques. We call our work continuous improvement, which, historically, has primarily focused on reducing costs and waste while minimizing process variability to increase product or service quality. But are cost reductions and quality improvements the source of competitive advantage in a global marketplace?

The intent of this article is to make two points. First, cost control and product quality only sustain a level of competitive advantage, while product or service innovation is the actual source of competitive advantage in a global market.

Second, innovation consists of a series of steps, just like any other business or industrial process. Since innovation in and of itself is a process, specific quality improvement tools can be used for its improvement. Using quality improvement tools in the innovation process will get higher quality products to market faster and at a lower cost.

Why Should Firms Focus On Innovation?

Manufacturing and service industries are continuing the global trend of outsourcing, and this pressures new vendors and suppliers to innovate if they want to meet market demand. It is widely known that manufacturing work continues to move to Asia. With global commerce, a new company with a great product can buy off-the-shelf technology to become a first-rate manufacturer quickly. Many Asian firms have done this. These companies have become global competitors, with a niche application in the use of automated manufacturing technology, on par with any U.S. or European firm.

Education, when considered a service industry, might also be experiencing a similar global shift—
although this trend could be overstated. Recent articles in the popular press have stressed that China is catching up to the United States in graduating college students in engineering related disciplines. Duke University researchers have framed this debate in a study published in Issues in Science and Technology.¹

Figure 1 shows some of their preliminary findings. While the United States is the world leader in awarding engineering related bachelor’s degrees per capita, China is gaining at an increasing rate. A key question is whether this trend will continue. As service based call centers and other high-tech startups continue to flourish in India and China, their need for well-educated technical employees will increase.

These examples of globalization should concern quality professionals in the United States and Europe, as many of us are employed in the manufacturing, service and high-tech sectors. And, as quality professionals, if we continue to compete primarily by reducing product cost and making incremental process improvements, the outsourcing trend will likely continue and gain momentum. Firms that make developing new products and services a priority enjoy a competitive advantage over firms that focus mainly on cutting costs or improving product quality.

We illustrate this point in Figure 2 (p. 22), which outlines three innovation strategies. In the cost conscious firm, profit margins are low and rival competition is fierce; these firms are forced to cut costs to stay competitive, and there is a minimal focus on innovation.

A firm making product and service quality a high priority, the quality oriented firm, enjoys a competitive advantage—until rivals introduce a new product or service. Quality of the obsolete product or service then becomes a moot point.

The innovative firm is focused on developing new value added products and services. New products or services give the innovative firm a competitive advantage over its rivals. Quality and cost control programs then sustain this competitive advantage.

But how can we, as quality practitioners, contribute to the innovation process? One solution is to focus on conceptualizing and planning new products and services. This occurs in the earlier stages of the innovation process, before the cost and quality improvements typical during engineering and manufacturing.

Innovation: A Process That Can Be Mapped

The innovation process is an interrelated series of steps needed to bring new product and service ideas from conceptualization to market. The innovation process can be compared to a manufacturing process: Both require a series of steps to assemble a final product. Mapping quality tools to the earlier stages of the innovation process can

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1. Data provided by the Chinese Ministry of Education (MoE) Yearbook might include additional engineering and technology degrees outside traditional engineering fields; the China MoE Center for Education and Research Network (CERN) gives a more conservative estimate. Reprinted with permission.
seem like an abstract exercise. If the innovation process is compared to a manufacturing process, it is easier to see where quality tools and techniques can contribute to delivering new products and services.

Innovations in the traditional research and development (R&D) laboratory commonly take years to make it to market as commercially viable products or services. When quality tools are mapped to the innovation process there is potential to reduce innovation cycle time—saving the firm time and money while getting new products and services to market faster than competitors.

The innovation process has been mapped to many different company strategies. Regardless of how many strategies exist, it is important to choose one process to guide innovation. Without a specific strategy in place, systematically using quality tools in the innovation process would be difficult at best, and most likely ineffective. Figure 3 shows one of many strategies that can guide the innovation process. Andrew Graves, of the University of Bath, introduced this strategy.2

The innovation process in Figure 3 relies on multiple departments working simultaneously to develop new products or services. The six horizontal bars represent each department’s major functions. Each department becomes involved in the innovation process at staggered intervals; marketing analyses are typically done first, while manufacturing is last. Interdepartmental meeting points, or tollgate meetings, occur throughout the process and are depicted as vertical lines. At tollgate meetings, the progress of product or service development is reviewed. As the product or service development cycle matures, tollgate meetings become less frequent.

**New vs. Old**

As seen in Figure 3, we distinguish two quality toolsets: the old and the new. The quality community is well acquainted with the seven old tools: cause and effect diagrams, stratifications analyses, check-sheets, histograms, scatter diagrams, Pareto analyses and control charts. The old tools have proven their worth when mapping existing processes to learn about performance capability and characterization. When used alongside other traditional statistical quality control techniques, such as process setup and verification, acceptance sampling and designed experiments, the old tools are an even more powerful way to streamline production processes for improvement purposes.

However, the set of seven new tools has not widely caught on in the quality community because it is not...
as compatible with process improvement work—the tools are much more useful in conceptualization and ideation: a structured approach to thinking about solving problems. This conceptual work commonly occurs in the beginning phases of the innovation cycle. Because most quality practitioners typically work in the later phases of the innovation cycle, where efforts are centered on improving manufacturing processes for the sake of cutting cost and improving quality, it is easy to see why the seven new tools have not enjoyed such widespread popularity as the seven old tools.

ASQ has recognized the value of the seven new quality tools by including them in the higher level bodies of knowledge for several certifications, namely manager of quality/organizational excellence. Knowledge of the new tools as a requirement for such a high level ASQ certification illustrates the value they bring to strategic planning and the innovation process.

**Seven New Quality Tools**

Table 1 shows the seven new quality tools. Due to space limitations, we cannot go into great detail about the inner workings of each tool, but we can provide an overview. We encourage readers to consult ASQ’s website for more detailed information. Also, *Creating Quality* by William Kolarik and *The Quality Toolbox* by Nancy Tague offer excellent overviews of the seven new tools.

1. **Affinity diagram.** This is one of the basic tools used to stimulate creativity and bring structure to the brainstorming process. The affinity diagram is especially useful in any interdepartmental project—it helps put team members at ease with one another because the tool is designed to welcome a diverse range of ideas. Because the innovation process relies heavily on people from different departments working together, the affinity diagram would be powerful in the early stages of the innovation process.

2. **Relations diagram.** This tool discovers causes and effects of problems. It identifies the cause of problems that can occur in high-level strategic planning by systematically linking the many factors that contribute to a problem, providing a big-picture view of what’s at stake.

3. **Tree diagram.** This logic based tool, which can also be called a systematic diagram, is more focused than the affinity or relations diagrams. It starts with a broad category, theme or problem and attempts to break the issue down into granular levels of detail using a branch system. The logic behind the tree diagram is that as a broad issue is broken down into finer levels, a solution pathway emerges. The tree diagram is effective after developing affinity and relations diagrams because the ideas from these broader tools can be applied to the tree diagram to help find a clear solution.

4. **Process decision program chart (PDPC).** When faced with multiple options to solve a problem, the PDPC is useful in assessing all the alternative solutions to find the one that fits best. A PDPC can also be used in a what-if analysis. If a solution or process is already agreed on, the tool can identify what might go wrong if the solution were to be employed. Because a tree diagram might give multiple solutions to the issue at hand, the PDPC is the logical tool to use after the tree diagram to determine which solution has the most promise.

5. **Arrow diagram.** This tool addresses resource problems and bottlenecks during the innovation process. Similar in scope to a Gantt chart, the arrow diagram allows the mapping and scheduling of multiple tasks. The tool is valuable when resources must be allocated across an interdepartmental project. When significant penalties occur if a project falls behind schedule, resource allocation becomes an important focus.

6. **Matrix diagram.** This shows relationships between groups of information. It draws out

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**Table 1: The Seven New Quality Tools**

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<thead>
<tr>
<th>Degree of complexity</th>
<th>New tool</th>
<th>Useful area</th>
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<tbody>
<tr>
<td>Low: 1</td>
<td>Affinity diagram</td>
<td>Brainstorming, consensus</td>
</tr>
<tr>
<td></td>
<td>Relations diagram</td>
<td>Cause and effect</td>
</tr>
<tr>
<td></td>
<td>Tree diagram</td>
<td>Logic based problem solving</td>
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<tr>
<td></td>
<td>Process decision program chart</td>
<td>Identifying best solution</td>
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<tr>
<td></td>
<td>Arrow diagram</td>
<td>Resource planning</td>
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<tr>
<td></td>
<td>Matrix diagram</td>
<td>Determining interrelated factors</td>
</tr>
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|                      | High: 7                               | Matrix data analysis                       | Quantitative analysis
interrelated factors, illustrating how changing one factor might affect others. The strength of the relationship can be characterized as varying degrees of positive and negative. Many different shapes for the matrix diagram are possible.

7. Matrix data analysis. This is a mathematical technique that quantifies the interrelated factors created in the matrix diagram. Weights are given to the interrelated factors when hard data are unavailable; software programs using statistical correlation methods are used to quantify the relationship between factors when data are available. Due to the mathematical rigor involved, matrix data analysis is the most complex of the new tools.

Considerations for Quality Professionals

Firms can structure the innovation process in such a way that quality improvement methods with the new tools are not aligned with the model we have illustrated. For the new quality tools to be of use, we recommend readers evaluate the current state of the innovation process in their firms with other department stakeholders. Other stakeholders can include marketing managers, R&D scientists and managers, technology transfer officers, product engineers and manufacturing managers.

When the existing state of the innovation process is known, a phased-in approach of the new quality tools can then be completed over time. A good place for introduction of the new tools might be at the interdepartmental meetings that occur during the innovation process.

R&D personnel and other departments involved in the innovation process might be hesitant to embrace quality tools, which is an issue of organizational culture and communication. But as quality professionals, we all know quality impacts the ultimate profitability of our firms. Most of us can probably think of a time when we have had difficulty explaining to senior management that quality is an investment, not a cost. Communicating this concept of quality to R&D managers, as well as to other innovation stakeholders, will be no different. We must embrace the concept of quality not just in engineering and manufacturing, but also throughout all stages of the innovation process.

As quality practitioners, we historically have competed primarily by reducing costs, decreasing waste and increasing product or service quality. The innovation process is an area in which quality practitioners can apply the seven new quality tools to get new higher quality products and services to market faster and at a lower cost to help our firms stay competitive in a global marketplace.

REFERENCES


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