Creativity and Improvement: A Vital Link

Understanding this connection can lead to breakthroughs for your organization.

by
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IMPROVEMENT COMES FROM THE APPLICATION of knowledge. This might be knowledge of subject matter, such as engineering or chemistry, or knowledge of how to do some activity, such as driving a truck. Generally, the more appropriate the knowledge that is applied, the better the improvements will be. But any approach to improvement must consider how knowledge is obtained and applied.

People can make many improvements by using their natural creativity and the subject-matter knowledge they possess. W. Edwards Deming developed a concept known as profound knowledge—the interaction of systems knowledge, knowledge of variation, knowledge of psychology, and knowledge of learning—which can be combined with subject-matter knowledge to accelerate the rate of improvement.[1] Edward de Bono, a leading authority in the field of conceptual and creative thinking, has developed specific methods to increase knowledge by enhancing one's ability to think creatively.[2] These various sources of knowledge must be integrated if they are to be used to facilitate improvement in organizations (see the sidebar "Can Quality Improvement Stifle Creativity?").

After years of working with systematic improvement initiatives, many organizations now find themselves with many processes and products working exactly as designed. But improvement is still desirable and necessary. For such organizations, creative thinking should be viewed as an essential supplement to, though not a replacement for, critical thinking. This article introduces methods to facilitate creative thinking and shows how to integrate these methods into improvement activities.

Change and improvement

Improvement is impossible without some type of change. In an organization, products, services, and processes have to be designed or redesigned if they are to improve. The scope and magnitude of the change usually determines whether the change is considered an innovation or an incremental improvement.

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How does one actually use knowledge to make improvements? Previous *Quality Progress* articles have presented a Model for Improvement.[3,4] This model provides a way for individuals and groups to gain and apply knowledge for improvement. The model (see Figure 1) is based on three fundamental questions and the plan-do-study-act (PDSA) cycle. The three questions allow for flexibility between a rigid, step-by-step approach and natural creativity. The model encourages making improvements by obtaining knowledge and then using this knowledge to develop, test, and implement changes. It provides a framework for making both continuous, incremental change and more drastic innovations.

Sometimes when confronted with the question, "What changes can we make that will result in improvement?" the answer is obvious. More often, however, an appropriate change is not obvious or readily available. Where, then, can people find the knowledge to develop such changes? Methods based on both critical and creative thinking are available.

Improvement methods based on critical thinking

Knowledge can be obtained through the use of data combined with ideas or theories. The Model for Improvement, supported by some critical tools and methods, can be very successful in making improvements in a variety of environments. Figure 2 lists some of the many tools and methods that are commonly used in quality improvement activities. These tools are based on critical thinking, which means they depend on careful analysis, evaluation, and reasoning, including both deductive and inductive reasoning and both analytical and systems thinking. Some of the tools provide ways to summarize and communicate existing

Can Quality Improvement Stifle Creativity?

While the accompanying article explores the potential positive effects of creativity in continuous improvement efforts, another observation might also be made about their interrelationship: It is possible that the introduction of traditional process improvement methods in an organization might actually suppress the creative efforts already in place. Although no empirical data have been gathered to support this hypothesis, the phenomenon was observed by one of the authors of this article.

Prior to the introduction of quality improvement methods in the observed organization, many positive results accrued from using the creativity of individuals to generate new concepts and new ways of doing things. An open and innovative culture encouraged the free flow of ideas and the willingness to change and redesign. This culture can be attributed to the company's founder, who was a prolific inventor in his own right. He was known to hire people who shared his belief that creativity is a necessary foundation for organizational success. But, even with the positive results stemming from this creativity and innovation, severe industry conditions in the early 1980s led management to implement a formal quality improvement program.

As the quality philosophy and its methods were introduced into the organization, things seemed to change for the better. Teams were chartered to identify opportunities and carry out systematic, planned improvements using these newly found tools and methods. Significant positive results were achieved, and the entire company became immersed in the philosophy and methodology of quality. But something else was happening at the same time. There was a gradual abandonment of creativity and innovation as a central part of how the organization conducted its business.

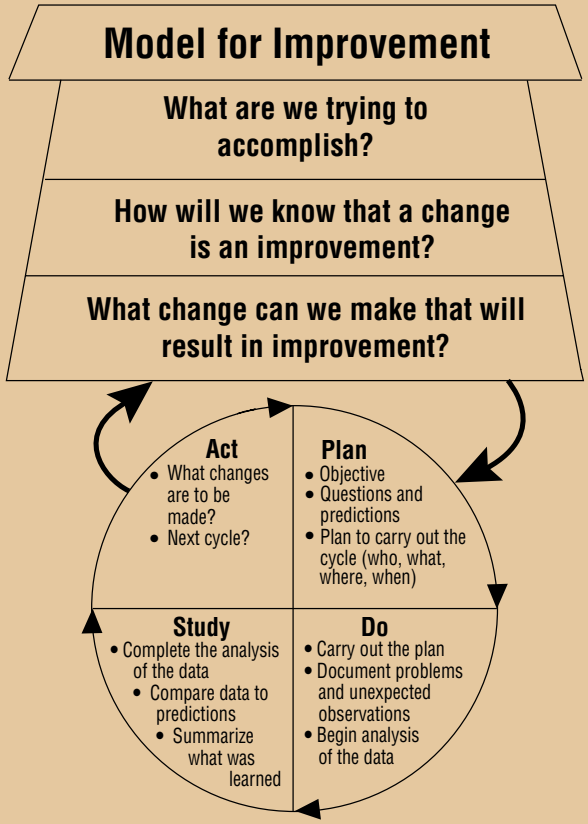
The early positive results that came from traditional data gathering and analysis techniques led many individuals to forsake their usual creative efforts. An unspoken belief began to permeate the company: The quality methods introduced in the training were the only legitimate way to make improvements.

Creative effort, because it was not specifically recognized and leveraged as a part of the quality improvement program, began to wane, and the kinds of results that had accompanied it in the past also began to disappear. At about this time, the first wave of positive results from the newly introduced process improvement framework crested and began to flatten out. It was then that the problem became apparent, and management realized that creativity had to play a more central and integrated role in the company's improvement efforts if these results were to be seen again.

The point is this: Continuous improvement efforts that do not actively integrate creativity stand to reap only limited benefits. Further, they might even suppress any previously existing creativity in the organization, thus losing out on the associated results.

knowledge; others focus on the collection, analysis, and display of new data. They are useful in understanding existing knowledge, gaining additional knowledge, and developing and testing changes. With their basis in analytical and deductive thinking,

Figure 1. The Model for Improvement



From G.J. Langley et al., *The Improvement Guide, A Practical Approach to Enhancing Organizational Performance* (San Francisco, CA: Jossey-Bass Publishers, 1996).

these tools help people:

- Understand how current processes or systems work
- Collect data and information to develop better ways to do things
- Identify where problems exist
- Decide which problems should be addressed first
- Focus on causes of problems and inconsistencies
- See information in data through graphical presentations
- Relate customer needs to process variables
- Learn about important relationships between variables
- Understand barriers to implementation

Many individuals and organizations have found these tools helpful in developing, testing, and implementing changes. Sometimes more complex analytical methods (time series analysis, modeling, etc.) are called for, but there are also methods based on creative thinking that can significantly expand one's ability both to improve incrementally and to innovate.

Creative thinking tools for improvement

The role of traditional methods for basic improvement are widely recognized and documented. The role of creativity as an integral part of improvement efforts, however, is not well recognized. As a result, few organizations are taking the initiative to

leverage creativity in their improvement efforts. Creativity can and should play a central role in improvement activities. But what are the tools of creative thinking, and how do they work?

First, it should be clarified that the concept of creativity that is being considered here is not artistic creativity. In the context of this article, creativity is the serious, deliberate, and systematic generation of new ideas, new concepts, and new perceptions of value. Creativity means escaping from existing perceptions and concepts to open up new ways of looking at and doing things. It has to do with reconceptualizing systems and ideas as well as creating new ones from scratch. This is important because at times one must go back and rearrange the components of an existing concept—a concept that was perfectly valid and valuable when it was originally formed. Reconceptualization is sometimes necessary simply because things have changed, new information is available, and the original concept is no longer effective in the present circumstances.

Figure 2. Some Tools and Methods of Improvement Based on Critical Thinking

Tools to visualize systems/processes
- Flow diagram
- Process model (input/outcome)
- Linkage of processes
- Systems map
- Simulation

Methods for collecting information
- Forms for collections of data
- Survey
- Benchmarking
- Planned experimentation

Tools for organizing information
- Cause-and-effect diagram
- Affinity diagram
- Matrix diagram
- Quality function deployment
- Force-field analysis

Tools for studying variation in data
- Pareto chart
- Run chart (line chart)
- Frequency plot
- Control charts
- Radar chart (spider diagram)
- Box plot

Tools for studying relationships
- Scatter diagram
- Two-way table
- Planned experimentation

Over the past 25 years, de Bono has combined his multiple backgrounds of medicine, psychology, and philosophy with worldwide consulting experience to develop a concept called "lateral thinking."[5,6,7] The term, coined in 1969, has become synonymous with a suite of creative thinking tools and methods used in organizational settings.

The logic behind de Bono's methods

Lateral thinking methods are serious, deliberate, and systematic; they do not rely on pure natural talent or acting crazy. Based on cognitive theory and the knowledge that the brain works as an active, self-organizing information system, these creative thinking tools are designed to help people deliberately produce thoughts that are outside their normal thinking patterns. This greatly increases the chances of producing new ideas, new concepts, and new perceptions from old situations.

According to de Bono, the brain's neural networks process information by forming patterns that are the basis of perception. As these patterns are reinforced over time, strong (mainstream) patterns or perceptions develop. Once the brain sets up these mainstream patterns—effectively, perceptual ruts—it is very difficult to produce thoughts outside those patterns when thinking about a particular subject.

To better understand this model, consider a virgin landscape and its interaction with the elements. Over time, as weather systems move randomly over the region, the elements—rain, for example—interact with the landscape, forming small streams, rivers, and, eventually, entire drainage basins. If one views this landscape as the human mind and the rain as incoming information or new experiences, it is easy to see how the two interact. One's previous experience affects how new information or experience is perceived. Mainstream patterns in the brain, like streams and rivers, act as perceptual ruts that tend to pull one back into the same old thoughts, opinions, and solutions again and again—much as rainwater runs off a hillside and into a stream. The final result is a system in which information (rain) interacts with the mind (landscape) and organizes itself into mainstream patterns (rivers and streams). Lateral thinking methods were designed with this model in mind.

Once an individual enters a mainstream thought pattern, he or she will remain there unless something is done to move him or her outside it. Other patterns that are lateral to the mainstream pattern (like streams that run parallel) are in fact invisible to the individual. But, if this person can somehow get outside that perceptual rut, he or she greatly increases the chances of linking up with another pattern and forming valuable new ideas, concepts, and perceptions.

Provoking new ideas

One of the more seemingly exotic methods to produce new ideas and concepts is known as provocation. As previously noted, without some means to get out of perceptual ruts, people just keep coming back to the same old ideas and are trapped in their existing perceptions. Provocations seek to jolt individuals out of these mainstream patterns so they can connect with other patterns to produce new ideas, concepts, and perceptions.

One way to deliberately generate these provocations is a method called escape. To produce an escape provocation, one first lists things that are taken for granted about the situation or process. Then, one escapes from what has been taken for granted by dropping it, canceling it, or doing away with it. Because the provocation itself (not the resulting idea) is meant to be bold, unusual, and illogical, it produces a highly unstable concept or situation that the mind must deal with. The mind then does what it does best: It tries to restabilize by connecting with other patterns in an effort to make some sense of the provocation. In this way, the natural tendency of the mind to form patterns can be used to develop new ideas and concepts.

Imagine, for example, that a design engineer is seeking new ideas to improve personal computers (PCs). He or she would first list the things that people take for granted about PCs. These might include the assumptions that a PC requires a power

Figure 3. Creative Thinking Techniques

Tool/method	Description of tool/method	Basic uses of tool/method
Focus	The process of clearly defining the focus of the creative thinking, including defining whether the goal is to solve a problem, achieve an objective, carry out a task, or simply to generate ideas. Also includes generation of several different alternative definitions of the focus.	To define the focus and changing focuses of the thinking. To seek alternative definitions of the focus and choose subfocuses.
Challenge	A systematic examination of the way something is currently done or the current thinking surrounding it, including assumptions, boundaries, essential factors, avoidance factors, and so on. A three-step process of challenging the necessity, validity, and uniqueness is carried out with the intention of either eliminating the item being challenged entirely or producing superior alternatives.	To challenge traditional thinking, existing thinking, and the thinking taking place during a creative thinking session. Also to challenge the surroundings of the thinking. Useful in producing new perceptions of an established situation.
Concept fan	A systematic process of generating ideas/alternatives that operates at several different levels from broad to specific. Broad directions or approaches to the objective are defined. More specific concepts are identified and specific ideas are generated on how to carry out each concept. Moving between the various levels produces an organized "fan" of ideas (specific), concepts (broad), and approaches (very broad) to address the objective.	An elaborated method for defining different ways of doing things by going through concepts. The fan can also act as an organizing framework for all of the ideas generated for that objective, even those resulting from the use of other lateral thinking tools. Useful in achievement thinking.
Concept extraction	A deliberate attention to concepts. Seeking to extract and crystallize concepts using what is known as a "concept triangle" as a method for pulling back to identify and define the concept behind a specific idea or alternative.	Useful in all areas that are driven by concepts. When a proposed alternative or idea is unworkable, the concept behind it may be valuable if carried out in another way. The purpose is to then be able to produce more ideas within that same concept and identify or define other, different concepts for further exploration.
Escape provocation	A process that includes defining the usual way (taken for granted) of doing something and then producing a statement or thought that cancels, negates, drops, or removes that which is taken for granted. The result is a deliberate provocative statement or thought that is illogical and/or impossible.	Useful in all areas where challenge is useful. Useful for looking at existing thinking on a subject or process. Useful in producing totally new perceptions of a situation or process. May be useful in producing ideas for radical system change.
Stepping-stone provocation	Similar to escape provocation, but instead of canceling or dropping what is taken for granted, other methods are used to produce the provocative statement. Other methods include reversing the direction of the normal action, greatly distorting the normal relationship between the parties, or producing a bold fantasy desire (termed "wishful thinking") for the situation.	Generally used to try to get radical changes in the whole system approach. The most provocative of the techniques. The wishful thinking method also has a specific use in generating ideas from a greenfield (clean sheet of paper) situation. Generally works best when applied to the whole system.
Random input	Using a deliberately random word and forced association of that word to the subject in order to get the thinking outside of the traditional track of ideas. Other random stimuli (visual and aural) may also be used.	Used to provide fresh ideas on any occasion. Used to get going in greenfield situations or when ideas have run out. Used to seek additional and different ideas when there are already some ideas on the table.
Stratal	A number (usually about five) of parallel, yet unconnected, statements or observations about the focus. These statements are put together and looked at as a whole in order to sensitize the mind to produce new ideas.	Used at the beginning of thinking to allow ideas to emerge. Used later in the thinking to see what might emerge from the thinking that has already been done.
Filament technique	Several of the normal requirements of the creative focus are listed, then considered separately and independent of the focus. Extended from each of the requirements are ways of satisfying that requirement. Finally, these parallel filaments are scanned to pick out certain items along each strand. With this list of items, considered as a whole, new ideas are sought to satisfy the original focus.	Useful when there is a known set of requirements. Can be used in a passive way to let ideas emerge or in an active or forced way, similar to the random input technique.

source, it must have some sort of visual display, and it must have a keyboard for inputting data. From this last assumption, the engineer might form the escape provocation, "PCs have no keyboards."

If traditional judgment were applied to the provocation of PCs having no keyboards, it would simply result in rejection of the idea, regardless of how long judgment had been delayed, because it is not logical.

After this provocation has been constructed, the engineer must try to move forward to a new idea or concept. He or she must use an active mental process—known as movement—to get from the impossibility of this illogical provocation to an idea that is plausible, useful, and valuable. Unlike simply delaying or suspending judgment (as in traditional brainstorming), movement seeks to actively move the mind to something of value. If traditional judgment were applied to the provocation of PCs having no keyboards, it would simply result in rejection of the idea, regardless of how long judgment had been delayed, because it is not logical.

A basic movement technique, known as moment-to-moment, allows the mind to move forward by imagining or visualizing what might happen if the provocation were indeed reality. In this case, the moment-to-moment technique might lead the engineer to visualize a person typing away on a blank desktop or the tray table of a passenger plane. It would be obvious to the engineer that there had to be some way to translate these finger movements into data entry without using a keyboard. It might then occur to him or her that a similar translation of finger movement has been accomplished in other fields using virtual-reality-type gloves. This in turn might lead to the idea of using these same gloves (connected to the computer) to sense finger position and fingertip impact on any surface, thus generating input to the PC without the need for a keyboard—assuming of course that the user is a touch typist.

Random entry

Another lateral thinking tool is random entry. In this method, rather than dropping an assumption to create an unstable provocation, a random word is used to provide a totally new starting point outside the mainstream pattern. A truly random word, one that is completely unconnected to the subject, is obtained and juxtaposed with the subject. The mind is then allowed to move forward to try to relate the two in some way. Making this connection takes advantage of the mind's natural tendency to form patterns. To move forward to a new idea, one extracts a principle or a broad direction from this combination, or makes a simple association. For example, a hotel chain is looking for new ways to obtain a higher customer response rate when gathering feedback on the quality of accommodations and service. Using the random word "radar" (which was obtained by flipping through a dictionary), the following ideas resulted:

- Radar suggests the principle of reflection (of radio waves), which brings to mind the reflection in a mirror. Mirrors are almost always a point of focus in a room, particularly the bathroom. If one were to place a customer feedback form on the bathroom mirror in some way, it would be more noticeable and more likely to be filled out than a typical survey placed on a table top.
- Radar also leads to the association of a dish, like a radar dish. Dish leads to the idea of a dish of food or a meal. This leads to the idea of giving guests a discount on a meal in the hotel restaurant or a free beverage in the hotel bar for participating in the customer feedback program. This might have the added benefit of boosting restaurant and bar sales at the same time.

When using this method, care must be taken not to select the word in any way—it must be truly random. People have a strong tendency to select a word when they have some idea or concept, consciously or subconsciously, with which they believe they can make a link. If this is the case, the idea should simply be voiced. To ensure that the word is not selected, try flipping through a dictionary and pointing to a word at random. Because nouns seem to work best for this method, if the randomly chosen word is not a noun, simply find the noun that is closest on the page to the chosen word. Other random stimuli, such as sights or sounds, can also be used to get people to a new starting point outside the mainstream pattern.

Other methods for creative thinking

Numerous systematic methods have been developed by de Bono and others working in the field to enhance people's ability to generate, recognize, and develop creative ideas. Some seem rather exotic, such as the provocation method described earlier, while others deal with more familiar components of the creative process. Figure 3 lists some of de Bono's creative thinking techniques, which are explained in detail in his book *Serious Creativity*.[8]

Case study: Quality improvement in metal cutting

The following case study illustrates the integration of traditional improvement methods and creativity methods to improve quality in a metal cutting process. A team of two operators, a process engineer, and a maintenance superintendent were chartered to make improvements to the process. They used the three questions from the model in Figure 1 to guide their efforts.

What are we trying to accomplish? The plant manager assigned the following tasks to the team:

1. Improve the metal cutting process by dramatically reducing variation in the critical dimension of an engine component.
2. Develop the capability to not only meet the tight specifications of a potential new customer, but give the plant a competitive advantage based on low variation.

How will we know that a change is an improvement? The team set the following indicators:

1. The specification for the potential customer is ±10 units from nominal.
2. Based on the current control charts of the critical dimension, the process is stable with a capability of ±30 units.
3. New customers are attracted by parts that have extraordinarily low variation.

What changes can we make that will result in improvement? Four PDSA cycles were run, using both creative and critical thinking methods, to answer this question.

Cycle 1: Escape provocation helps develop a modification to the process

The team had no idea how it could possibly meet the goals

that management had established. After all, the plant's continuous improvement efforts had already eliminated most of the problems in the process. So, to develop a new direction, the team decided to use an escape provocation. It started by listing the key assumptions in the process. One of these assumptions was, "The part is secured in a jig while it is processed." Thus, the escape provocation formed was, "There is no jig to hold the part." Using the moment-to-moment movement technique, the team visualized what might happen if this were true: The part would begin to spin when the cutting tool made contact with it. As the part rotated in their mind's eye, it occurred to the team members that, because of its geometry, if the part were rotated 90 degrees and then clamped after the first operation, it would be far more stable. No one had ever tried this, but the process engineer remembered that something similar was done in another process. The team developed a test for this idea, which indicated the potential for substantial reductions in variation. It then modified the process equipment to try out the new method. At times the process worked much better, but the team could not maintain a stable process for more than a few hours.

Cycle 2: Control charts identify key source of variation

The team listed sources of variation that might be causing the instability and developed a cause-and-effect diagram to summarize what it knew. One source in particular was identified for study: the variation in raw material lots. Because the change in clamping position had reduced common-cause variation, the team was able to observe this source of variation for the first time. To better understand this variation, the team worked with its metal supplier and found that heat-to-heat differences was the cause. The supplier developed better process control procedures, including ongoing monitoring of the heat-to-heat variation. After about a month, the team updated the metal-cutting process control charts and found that capability had improved to ±12 units. The team then modified all of the equipment and changed the standard operating procedure to reflect the new clamping method. After another month, the process capability was ±9 units. The process was now capable of meeting potential customers' specifications.

Cycle 3: Random entry identifies an alternative

Based on its initial success, the team wanted to try another creativity method to make further improvements. It chose the random entry method. The word "lamp" was obtained at random from a book and used as a starting point. The team tried to relate this word to the metal-cutting process. By moving to one of the aspects of a lamp, light, it began to focus on the idea of using laser technology for the process. None of the team members had any knowledge of laser cutting, so they scheduled a visit to the local university where the technology was being tested.

The team established a project in cooperation with university personnel to develop the use of laser cutting in the process. Preliminary tests indicated that variation could theoretically be reduced to ±3 units. After further testing, the team developed a proposal to replace the plant's existing equipment with laser-based equipment. The operators were excited about the change but, once the equipment was in place, the process control charts were unstable and final inspection audits indicated that the process was not attaining the expected capability.

Impediments to the Integration of Creativity

The use of creativity methods can range from solving problems and restoring systems to where they were before to making innovative changes that have dramatic impact throughout the entire system. So, then, why haven't more organizations exploited the obvious potential of creative thinking tools and methods in their improvement efforts? The most likely reason for this is the critical thinking style (inherited primarily from Greek philosophers) that leads people to concentrate on improvement solely through identification and removal of faults and problems. They focus on what already exists and look for what is wrong so that, once found, it can be put back right. This approach is certainly valid and appropriate in many situations, but it is incomplete when used exclusively. In real-world situations, faults or problems are not always easily identifiable or might be beyond the control of the organization to change. In these cases, a new way forward must be designed, which requires creativity in addition to critical thinking. Unfortunately, even when the value of creative thinking is recognized and the pitfalls of using critical thinking exclusively are known, other misperceptions can create barriers to integration:

Creativity cannot be learned. Many believe that creativity is a talent that people are born with: You either have it or you don't. When this belief prevails in an organization, little or no effort is made to integrate creativity into process improvement companywide. It is seen as an impossible feat—there just aren't enough naturally creative individuals in the organization. Edward de Bono and others, however, have demonstrated that valuable creative thinking skills can be taught.

Creative thinking only requires that people become less inhibited. Another barrier holding back the integration of creativity is the idea that all you have to do to be creative is remove your inhibitions. This idea, the primary basis for brainstorming, is a weak approach to creativity. Certainly, being inhibited will not allow people to be creative, but removing inhibitions will not automatically make them creative. People must have specific creative thinking skills; if they don't, being uninhibited will help very little.

Creative thinking doesn't fit with traditional improvement. Many people hold the mistaken belief that creativity is mystical or a little crazy. Leaders hesitate to use this "misfit" approach because of the seemingly obvious clash between creativity and traditional improvement methods. This idea, however, is incorrect, and knowing why creative thinking methods work can make all the difference for leaders. Once they understand the patterning behavior of the human mind, techniques that once seemed a little crazy—like using an escape provocation or random entry to generate ideas—become perfectly logical and acceptable.

Cycle 4: Flow diagrams standardize the process

The team reviewed the control charts that the operators kept on the process. It was clear that operators on different shifts had developed their own ways of operating the new equipment, so the team mapped out a flow diagram to describe the new

process in detail. In shift meetings, team members reviewed the diagram with all of the plant operators and invited suggestions for improvement. After some minor adjustments, the process flow diagram was adopted as the new standard operating procedure. A large copy of the diagram was posted on the wall in the production area. One week later, the process control charts were updated: The process was at last stable with a capability of ±3 units.

Integration and application

When answering the first question in the model in Figure 1—What are we trying to accomplish—organizations can benefit from both critical and creative thinking. Two important considerations for leaders of an organization are:

1. Where in the organization should improvement efforts be invested?
2. How do we communicate the intention to improve?

Determining where to focus improvement efforts is an excellent place to use creative thinking. While there are many opportunities for improvement in any organization, selection of these opportunities is often unintentionally skewed toward the most obvious problems. In most organizations, there is seldom any effort to deliberately look for opportunities that are not obvious but that might hold great improvement potential. One of the principles of de Bono's work in creativity is that one should deliberately seek creative alternatives—even when there is no obvious need to do so. Similarly, one of the tenets of the Deming philosophy is the idea that improvement should be sought even for problem-free processes and products.[9] Most quality improvement practitioners intellectually understand and accept this, but there is still a tendency to focus on the identification and removal of problems in order to achieve improvement.

When communicating change, people often become the focus: How do we get everyone to embrace the changes we are implementing? Both creative and critical thinking methods offer help in mitigating resistance to change and getting buy-in. For example, the various provocation methods can be used to help frame the change in a positive way. Innovative methods to communicate and reinforce the change can be developed by investing time in creative thinking.

Tap into the value of creative thinking

The value of creative thinking methods in quality improvement has generally gone unrecognized because of misperceptions about the nature of creativity and how it can fit with traditional improvement methods (see the sidebar "Impediments to the Integration of Creativity"). But using creativity in improvement efforts is a serious business, and serious and deliberate creative thinking methods do exist that are useful in both problem-solving activities and in making innovations in products, services, and processes.

Like any skill, creative thinking can be learned. The deliberate integration of creativity into improvement activities requires training individuals and teams, just as the use of traditional improvement methods requires training. Once learned, the methods of creative thinking can be applied in all phases of improvement.

Deming recognized and acknowledged the need for fundamental change and innovation; de Bono and others have developed creative thinking methods to help people achieve this need. Applying these methods to improvement offers a rich opportunity for any organization or individual serious about continuous improvement.

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References

1. W. Edwards Deming, *The New Economics* (Cambridge, MA: Massachusetts Institute of Technology, Center for Advanced Engineering Study, 1993).
2. Edward de Bono, *Serious Creativity* (New York, NY: Harper Business, 1992).
3. G.J. Langley, K.M. Nolan, and T.W. Nolan, "The Foundation of Improvement," *Quality Progress*, June 1994, p. 81.
4. R.D. Moen and T.W. Nolan, "Process Improvement," *Quality Progress*, September 1987, pp. 62-68.
5. Edward de Bono, *Six Thinking Hats* (New York, NY: Basic Books, 1989).
6. Edward de Bono, *I Am Right You Are Wrong* (New York, NY: Penguin Books, 1990).
7. de Bono, *Serious Creativity*.
8. Ibid.
9. W. Edwards Deming, *Out of the Crisis* (Cambridge, MA: Massachusetts Institute of Technology, Center for Advanced Engineering Study, 1986), pp. 25-26, 49-52.

Bibliography

de Bono, Edward, *Teaching Thinking* (New York, NY: Penguin Books, 1989).

The Improvement Handbook—Model and Methods (Austin, TX: Associates in Process Improvement, 1995).

Nadler, Gerald, and Shozo Hibino, *Breakthrough Thinking* (Rocklin, CA: Prima Publishing and Communications, 1990).

Perkins, D.N., *The Mind's Best Work* (Cambridge, MA: Harvard University Press, 1981).

"Planning for Improvement," in *Quality as a Business Strategy* (Austin, TX: Associates in Process Improvement, 1993).

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