The Importance of Concepts in Creativity and Improvement

A basic element in our thinking process, concepts play a crucial role in the creative changes that lead to improvement.

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CREATIVE THINKING PLAYS AN IMPORTANT role in any effort to improve. Since improvement comes from the application of knowledge, any approach to improvement must consider how knowledge is obtained and applied. A 1996 article in *Quality Progress*[1] introduced methods to facilitate creative thinking and to integrate these methods into improvement activities using the Model for Improvement[2] (see Figure 1). The use of the model encourages making improvements by obtaining new knowledge, then using this knowledge to develop, test, and implement changes. The model provides the framework for making both incremental change and more dramatic innovation. In the previous article, creative thinking methods that deal with "concepts" were mentioned but not discussed.

The purpose of this article is to explore the important role that concepts play in our creative thinking processes and in how we can use concepts to develop creative changes that lead to improvement. The notion of concepts will be presented, and then its application to developing creative ideas for improvement will be explored. Application of "change concepts" will be discussed and the role of concepts in TRIZ (the theory of the solution of inventive problems) will be introduced.

Creativity thinking and concepts

What is a concept? The answer to this question is paradoxical in the sense that it is simple and complex at the same time. It is simple to define in that a concept is a basic element of how we all think. It is complex to define in that the very definition of concept *contains* concepts. What are the concepts behind "basic element"? What are the many concepts involved in describing "how we think"?

Webster's College Dictionary from Random House (1995) defines a concept as a "general notion or idea." The same dictionary also defines a concept as a "directly conceived or intuited object of thought." Creativity expert Edward de Bono takes a more action-oriented approach to defining concepts when he writes, "Concepts are general

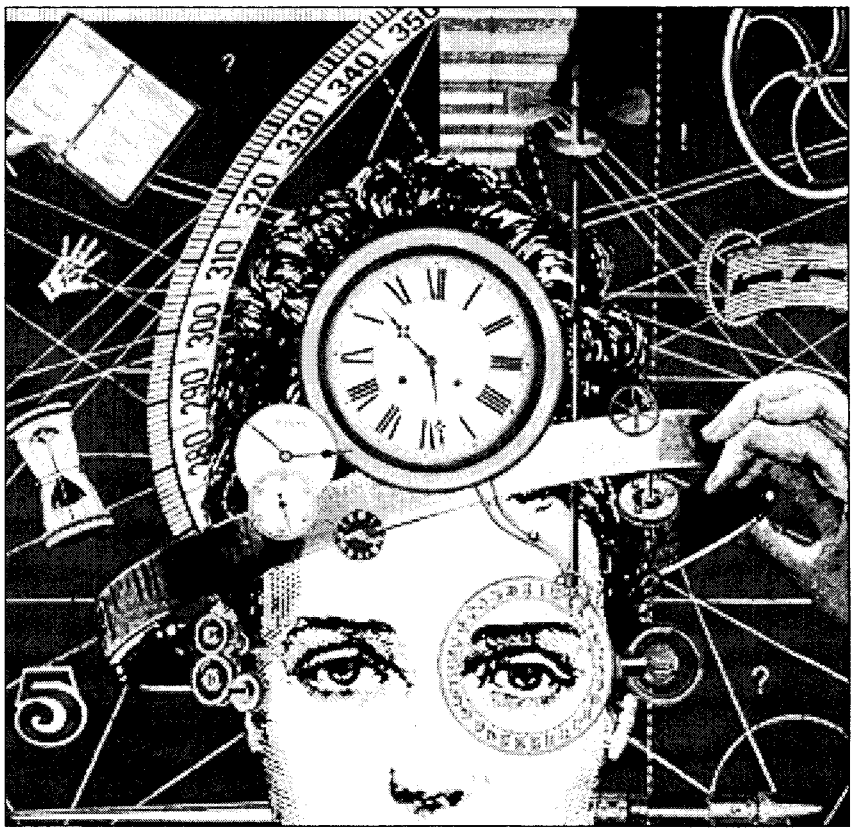

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Figure 1. The Model for Improvement

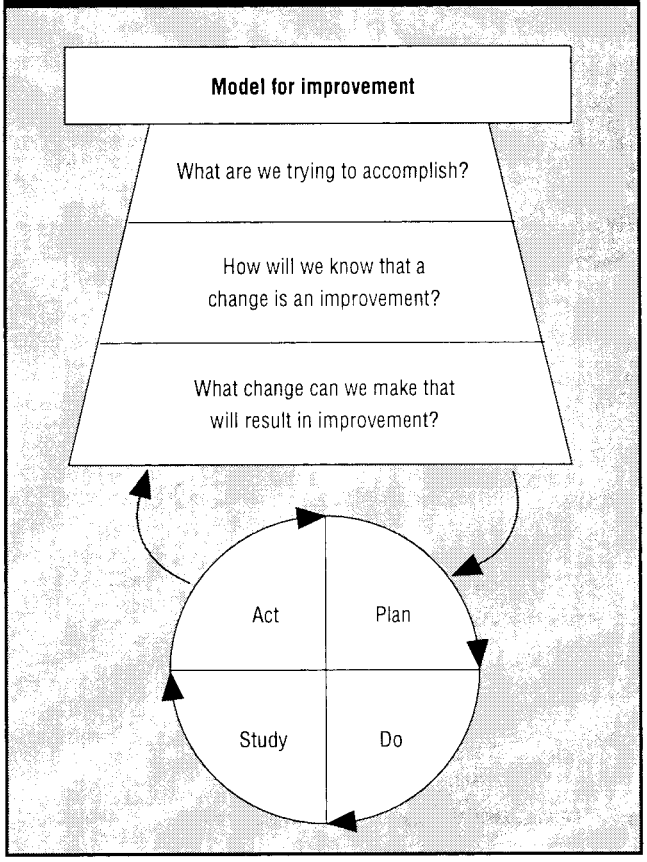


Figure 2. Role of Concepts in the Thinking Process

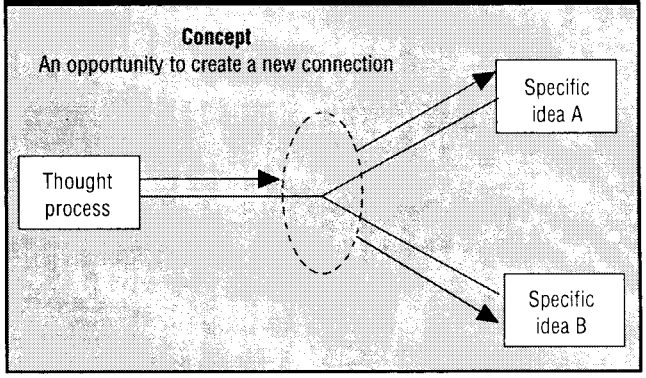
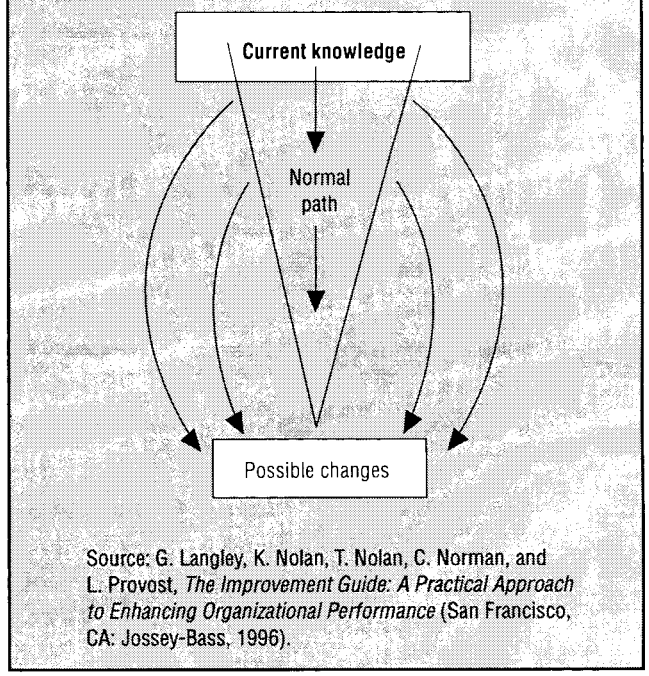


Figure 3. Provoking New Thought Patterns



Source: G. Langley, K. Nolan, T. Nolan, C. Norman, and L. Provost, *The Improvement Guide: A Practical Approach to Enhancing Organizational Performance* (San Francisco, CA: Jossey-Bass, 1996).

methods or general ways of doing things."[3]

The focus of this article is to understand the role of concepts in creativity and improvement. To explore this role, imagine that you have an orange before you. Look at this orange in your mind's eye. What are some thoughts that come to mind when you picture this orange? If you take a few minutes, you will be able to quickly develop a long list of things that the orange makes you think of: round, juice, color, vitamins, trees, Florida or California, navel, pulp, breakfast, and so on. This list could become very long if you were to spend even 10 minutes building it. A single imaginary orange creates an almost endless list of concepts that we connect to the image of the orange through our thinking.

Based on the experience with the orange, it can be said that the human thinking process can be thought of as following a path of connected concepts. One thought leads to another based on some kind of connection. Often this connection is based on our past experience. One might, for example, follow this train of thought:

When I heard the computer was down again, I immediately began to worry about today's invoices. The last time the computer went down, we had to work late to finish the invoices.

The fact that we think in connected concepts has both positive and negative connotations. To see how it is beneficial, consider a person who does not seem to have any connections between the concepts that occur in his or her thinking. Concepts just seemingly pour randomly through his or her mind. People whose minds function in this seemingly random, unconnected way are not functional members of society. Many of them are in mental institutions. So the fact that almost all humans think in "connected" concepts is very beneficial to us as functioning, productive individuals. The connectivity is a key mechanism for allowing us to relate to the world around us.

In with the new

So what is the downside to our thinking in connected concepts? The problem is that we often ignore new and better connections. If we refer to a collection of concepts and their connections as thought patterns, then what we often miss because of the prior connectedness of the concepts is the chance to follow new thought patterns. It turns out that these connections tying certain concepts together play a big role in creativity. Concepts are like forks in the road or branching opportunities. We can pull back from a specific destination (idea) to a fork (concept) and look for another route (see Figure 2). The recognition of a concept underlying a specific idea and using it to follow a new direction are important parts of developing creative ideas.

Many experts in creativity say that all we have to do to be more creative is learn how to generate a disturbance or displacement in our normal thinking process, and an adventure in new ideas begins. This disturbance for opening up new territory in the mind is called a "provocation" by de Bono.[4] He stresses that having a provocation is only the beginning; how one uses the provocation is equally important. He calls the use of a provocation "movement" and contrasts movement with the other major activity of the mind, "judgment." Movement-type thinking carries a concept forward to produce new connections. Judgment evaluates the concept for its own usefulness.

As an example of using a provocation, suppose a botanical nursery wants to evenly disperse the amount of work it has throughout the year. At present, 90% of its business occurs between April and June. The rest of the year is very slow and workers must be laid off. In a session to generate creative ideas, the provocation "space shuttle" is used. This statement is not directly relevant to leveling the workload, but that is not its purpose. Rather, its purpose is to create mental movement. Where does the provocation lead? Some concepts that could emerge from the provocation when trying to connect it to the problem include:

- No seasons out in space
- Controlled lighting, atmosphere, water, and so on
- Confined space

Of course, many other concepts could emerge, but let's apply movement to these. Perhaps the nursery could become a resource for indoor gardening, supplying plants and equipment for year-round gardening. Possibly, the business could take advantage of "no seasons" by starting a mail-order business for plants. This would move the nursery closer to a no-seasons situation.

In this example the nursery owners used the provocation to move to new thought patterns, rather than judging the value of the statement "space shuttle." Judging the value of the statement would keep them in the same thought pattern. The provocation simply helped them explore concepts that were not part of their normal, everyday world. By displacing their thinking to a new place, the provocation and the skill of movement take advantage of the natural tendency of the mind, its self-organizing nature, to take a sight-seeing trip of concepts. The experience, again due to the nature of the mind, eventually ends up focusing on the aim of improvement and of using the new concepts to develop change. Figure 3 is a pictorial description of provoking a new thought pattern.

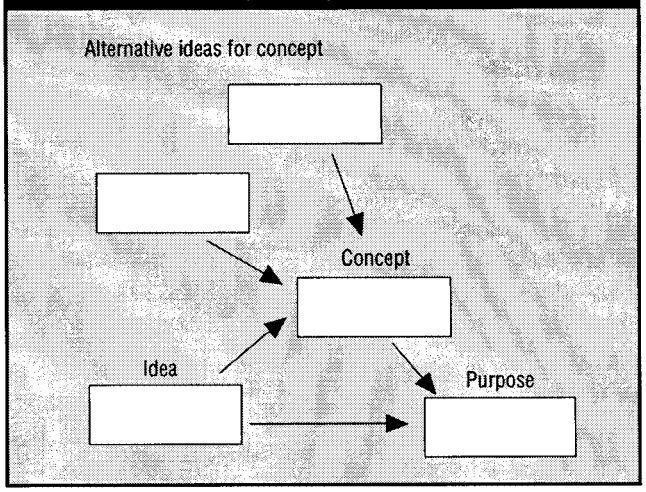
Concept tools for creativity

What are some tools to utilize the skills of provocation and movement? The concept triangle (see Figure 4) is a creative thinking method that helps generate new ideas that relate back to a particular purpose. The power of the method is that it helps us separate our current ideas from the concepts to which they are attached. This often allows us to come up with new ideas for the concept. Once an idea to carry out a particular function is produced, then the overall concept that gave us the idea is identified. Once the concept is identified, we may more easily identify other specific ideas that carry out the same concept.

Taken a step further, other concepts (different from the first) can then be generated, followed by specific ideas to carry each of them out. This extension of the concept triangle is called a "concept fan" by de Bono.[5] An example using both methods for creative thinking follows.

A technical support improvement team was formed "to develop creative ideas to improve the quality of service the customer receives from our technical support telephone lines." After discussing its purpose, the team moved from the general purpose to some concepts that might help with the purpose. One possible concept to support this aim is, "Provide consistent and appropriate responses to customer problems." From this concept comes ideas, such as with the concept triangle. Some ideas that could be generated by this concept are, "Hold training classes every Monday morning for the technicians," or "Provide each technician with a computerized database on known problems and their solutions." By using questions like "How does this help?" or "What are the general concepts behind this idea?" one can then move in the other directions to new concepts. For example, another concept behind the database idea is, "The technicians have the information they need at their fingertips." This concept can then lead to other ideas, such as a Monday morning training and sharing meeting for technicians, and so on. The concept fan promotes alternative ideas by providing a series of fixed points. A picture of the concept fan from the technical support improvement team is depicted in Figure 5.

Figure 4. The Concept Triangle

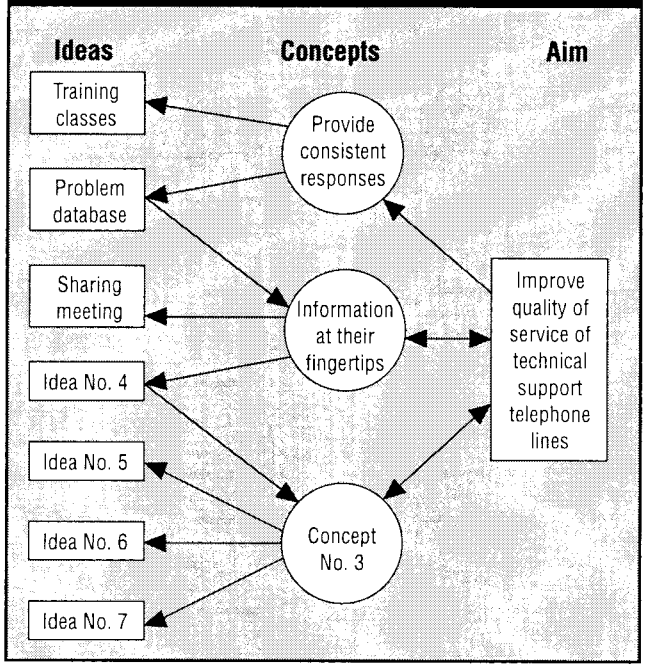


Use of concepts in benchmarking

Benchmarking is the study of other organizations for the purpose of identifying practices or generating ideas that could be adapted to result in improvement to the organization doing the study. Within an industry, changes spread relatively quickly. When one automotive company supplies antilock brakes, others will follow so as not to lose customers. Once a particular type of clothing is made popular by a retailer, other retailers also follow. Because of this rapid spread of new ideas, learning within an industry is almost a necessity to continue to meet customer expectations. The rapid spread of ideas also negates the usefulness of learning just from within an industry to discover creative ideas that will delight customers and increase market share.

To search for creative ideas that will excite customers, it is much more fruitful to study practices in other industries and adapt them. An organization seeking to find ways to make better decisions in a short time under pressure might study the processes used by race car teams, basketball coaches, and mili-

Figure 5. Structure for Concept Fan



tary field officers. Rental car companies, seeking to find ways to dispense the keys to cars automatically so that customers can rent a car anytime with no waiting, might study the technology used by banks in their automatic teller machines. A hospital, seeking to find ways to quickly prepare a room for a new patient after the previous occupant has been discharged, might study the processes used by a manufacturing organization known for its short setup times.

The concept triangle introduced earlier (see Figure 4) is a good method to relate particular ideas in one industry to solutions from another industry. After an idea to carry out a particular function is produced, then the overall concept that gave us the idea is identified. Once the concept is identified, we can look for solutions in other industries.

Figure 6 illustrates the use of the concept triangle in solving a parking problem at a university. The idea of making more parking spaces available was proposed as a solution to the problem. The team working on this problem then extracted the concept of "limited slots with variable demand" from this idea. Next, the team thought about how other industries have solved problems related to this concept. Two examples were identified: scheduling patients in a doctor's office and managing customers in a restaurant. A leading health management organization and a restaurant in town noted for its service were selected to study their approaches to dealing with "limited slots with variable demand."

Change concepts

While all changes do not lead to improvement, all improvement requires change. The ability to develop, test, and implement changes is essential for any individual, group, or organization that wants to improve. A change concept is a general notion or approach to change that has been found to be useful in developing specific ideas for changes that lead to improvement.[6]

What kind of creative changes result in improvement? Usually a unique, specific change is required to obtain improvement for a specific set of circumstances. Thus there are many, many kinds of changes. But these specific changes are developed from a limited number of change concepts. Creatively combining these change concepts with specific subject-matter knowledge is a productive approach to developing changes that lead to improvement. Many of these change concepts can be used to develop specific changes that do not require trade-offs between costs and quality.

Figure 7 contains a listing of 71 change concepts, grouped into nine categories. This collection of concepts comes from hundreds of sources collected by the authors and their associates over the last 20 years. Most of the change concepts contained in the list are based on W. Edwards Deming's system of profound knowledge—appreciation of a system, understanding variation, the theory of knowledge, and psychology. Many of the concepts come directly from experiences with clients that we have helped with improvement efforts. Some come from newspaper and magazine articles. Others were derived from experiences relayed to us by friends and colleagues. Many of the change concepts have been presented individually in books on quality, marketing, industrial engineering, and psychology.

The book *The Improvement Guide: A Practical Approach to Enhancing Organizational Performance*[7] contains an appendix that further discusses change concepts, including a discussion about the use of change concepts to develop creative ideas. The bulk of the appendix further describes each change concept and gives some specific ideas and examples of applying change concepts in different situations.

Change concepts and creative ideas

Using change concepts will provoke new ways of thinking about the problem or opportunity at hand. The following two examples are presented to illustrate their use:

Example 1: Warehousing. Steve was the manager for the warehousing department at a large chemical plant. He had been hearing complaints about the inability to keep track of inventory in the warehouse and to ship the right materials in a timely fashion. There had also been complaints about packaging and labeling. When Steve asked some of his employees about these problems, they all said there simply was not enough room in the warehouse.

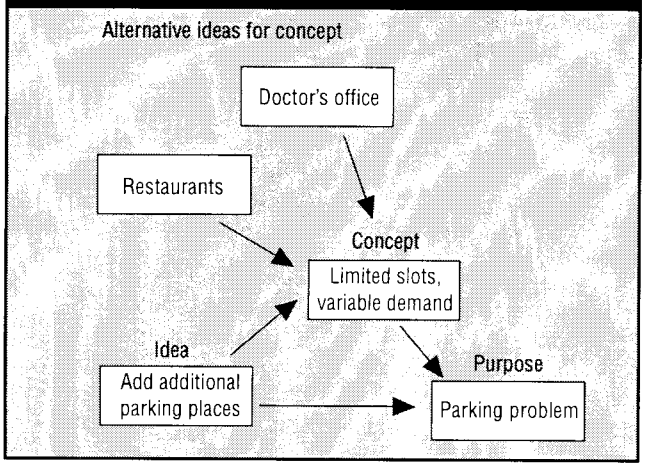
Having recently attended a seminar on ways to develop creative new ideas using change concepts, Steve decided to see if there were some improvements he and his employees could devise without having to make capital investments in more storage space. Steve used these steps:

1. Review a list of change concepts, looking for several that might help in the improvement effort.
2. Use each change concept as a provocation in a brainstorming session with a group of workers involved in the process.
3. Develop a list of possible changes based on the creative thinking that is generated.

Steve was excited about sharing these concepts with his group. He hoped group members would help generate some specific, creative ideas for change.

At the next group meeting, Steve explained what he was going to do and asked members to think positively and suspend judgment about the concept while changes were being suggested. He started with the change concept "Eliminate things that are not used." Mike pointed out that the plant had a large

Figure 6. Application of Concept Triangle to Learning From Other Industries



amount of product from experimental runs and some rejected material in the back four warehouse rooms. Others nodded in agreement and offered ideas about wasted space in the various warehouse rooms.

Steve was starting to feel good about this approach. He tried another concept: "Match inventories to predicted demand." Karen said she and other forklift operators had talked about certain grades of product that seemed to sit in the warehouse for months before they were shipped. If they could use past data to predict when the various grades would be needed, they could save a considerable amount of space. She wondered why workers hadn't been given this concept before.

Next, Steve tried "Minimize handoffs." John jumped up and shouted, "After the packers finish, we put the product in room 14. After the lab is finished, we move it to the south warehouse. And after sales designates it for shipping, we move it to the north wing. Can't we just put it in one place?" Everyone laughed because John was usually not this animated. But they all agreed with his idea.

Steve was very happy about how the meeting was progressing. The group had begun to develop a number of innovative ideas for changes, and he still had more change concepts left. The possibilities for improvement now seemed nearly endless.

Steve was employing one common approach for using the change concepts. He reviewed the list for concepts that seemed relevant to his purpose. Then he used them to provoke specific ideas for change; for example, "Move old experimental product out of the warehouse."

Steve's approach is not the only way that the change concepts can be used. A specific idea for a change can be generated first; for example, moving packaged material to one designated place to eliminate multiple moves. Identifying the general notion that's being applied to generate this idea should lead to the change concept: "Minimize handoffs." New ideas can then be generated from that change concept. One person, for example, might be assigned to complete all paperwork for inventoried product. Or, even better, paperwork might be eliminated altogether by having a computer track the flow of finished product. Additionally, other change concepts in appropriate general groupings—such as improve work flow or optimize inventory—might be explored to generate other ideas for changes.

Example 2: Hip surgery. A second example of applying change concepts is from health care. A group of nurses, a physical therapist, and a doctor were trying to shorten the length of time it takes for a patient to recover from total hip replacement.

One of the nurses decided to use some creative thinking methods to help the team develop an improvement. The nurse used a three-step process. First, he looked through a list of change concepts. He picked the change concept "Change the order of process steps" from the list because the team had been focusing on a flowchart that showed the order of activities for patients having total hip replacements. Second, the nurse explained to the group members that they were going to use the change concept as a provocation for thinking about the process of hip replacement in a new way.

Although this approach initially did not make much sense to most of the group members, they spent some time discussing the concept. From the discussion, it became apparent that there might be some value to shifting the timing of the rehabilitation activities to before the surgery. According to the doctor, this might prepare the patients' muscles and other tissues for the surgery. Several nurses and the physical therapist said it would probably be better to teach patients the rehabilitation movements and exercises before the surgery. So, as the third step, the team developed a plan to test the idea.

There were several results of the tests: Patient outcomes were improved; patients experienced fewer complications, less pain, and faster healing; the length of hospital stays dropped from an average of nine days to six days; and the number of patients who had to be readmitted to the hospital also dropped slightly.

Finding a better way

These two examples summarize several key factors in using change concepts to develop creative ideas for improvement. Useful concepts for change do not necessarily have to be highly technical. They often do not seem logical when they are first presented because they involve a new thought pattern. They require an interest and willingness in finding a new and better way.

A change concept is not specific enough to use directly. Concepts such as "Change the order of process steps" and "Minimize handoffs" must be applied to a specific situation and then turned into an idea. The two ways to use these suggested change concepts are similar because they are based on the skill of going back and forth between the general (change concepts) and the specific (ideas), as illustrated in the concept fan. The examples demonstrate the use of this skill; it is an important one to practice. Here are some other ways of using the change concepts listed in Figure 7:

- Select a change concept at random and see what ideas are provoked. Because rational judgment is not used in selecting the concept, this approach often leads to very innovative ideas.
- Select one of the groupings of change concepts that you think is applicable to your problem or improvement opportunity. Select a change concept from this group at random and see what ideas are provoked.
- Study the different change concepts and document some ideas for their use in your organization. Rely on this knowledge when faced with a new situation.
- Copy specific ideas in documented examples based on a change concept if the ideas apply directly to your situation.

Many of the change concepts in Figure 7 may be familiar,

Figure 7. Listing of Change Concepts

A. Eliminate waste	
1. Eliminate things that are not used	7. Reduce classifications
2. Eliminate multiple entry	8. Remove intermediaries
3. Reduce or eliminate overkill	9. Match the amount to the need
4. Reduce controls on the system	10. Use sampling
5. Recycle or reuse	11. Change targets or set points
6. Use substitution	
B. Improve work flow	
12. Synchronize	18. Smooth work flow
13. Schedule into multiple processes	19. Do tasks in parallel
14. Minimize handoffs	20. Consider people as in the same system
15. Move steps in the process close together	21. Use multiple processing units
16. Find and remove bottlenecks	22. Adjust to peak demand
17. Use automation	23. Change the order of process steps
C. Optimize inventory	
24. Match inventory to predicted demand	26. Reduce choices of features
25. Use pull systems	27. Reduce multiple brands of same item
D. Change the work environment	
28. Give people access to information	34. Invest more resources in improvement
29. Use proper measurements	35. Focus on core processes and purpose
30. Take care of basics	36. Share risks
31. Reduce demotivating aspects of pay system	37. Emphasize natural and logical consequences
32. Conduct training	38. Develop alliance/cooperative relationships
33. Implement cross-training	
E. Producer/customer interface	
39. Listen to customers	43. Reach agreement on expectations
40. Coach customers to use product/service	44. Outsource for "free"
41. Focus on the outcome to a customer	45. Optimize level of inspection
42. Use a coordinator	46. Work with suppliers
F. Focus on time	
47. Reduce setup or start-up time	50. Extend specialist's time
48. Set up timing to use discounts	51. Reduce wait time
49. Optimize maintenance	
G. Focus on variation	
52. Standardize (create a formal process)	56. Develop contingency plans
53. Stop tampering	57. Sort product into grades
54. Develop operational definitions	58. Desensitize
55. Improve predictions	59. Exploit variation
H. Mistake proof	
60. Use reminders	62. Use constraints
61. Use differentiation	63. Use affordances
I. Focus on the product or service	
64. Mass customize	68. Influence or take advantage of fashion trends
65. Offer product/service any time	69. Reduce the number of component parts
66. Offer product/service any place	70. Disguise defects or problems
67. Emphasize intangibles	71. Differentiate product using quality dimensions

but the 71 change concepts listed are not meant to be original nor complete. There might also be other concepts that you would add. The important thing is that concepts for change are documented for easy reference, and other concepts can now be added to the list. The rate of improvement will accelerate as people use the change concepts and develop and document new ones. Some of the new concepts may prove more useful in a particular field, such as health care or education.

One way to discover change concepts is to study the improvements that have been made in your organization and ask:

1. What was the specific change that was made?
2. What was the idea used for the change?
3. Where or from whom did the idea originate?
4. Which of the change concepts could generate that idea?
5. Can the idea be generalized for other situations?
6. Would a new concept be useful to describe this idea for change?

TRIZ methodology

TRIZ is a Russian acronym meaning "the theory of the solution of inventive problems."[8] The TRIZ methodology is an example of the use of concepts for finding creative solutions to problems. The methodology helps develop solutions based on the principles and knowledge that are a part of its database. In 1946, Genrikh Altshuller, a Russian inventor and creative thinker, began developing a body of principles and knowledge that lays out a process for solving difficult problems. Altshuller, who was employed at the patent department of the Russian navy, analyzed thousands of patents and inventive solutions from different fields of engineering. He discovered that often the same problem had been solved in different technical fields using a core set of fundamental inventive principles.

The TRIZ approach was further extended and used by engineers and inventors in the former Soviet Union and recently was introduced in other parts of the world. The methodology was introduced in the United States during the last seven years and has caught the interest of a number of major companies, which now offer workshops on the TRIZ methodology.[9,10] Software recently has been developed to facilitate the use of the method.

Altshuller and his associates observed that there are only 27 inventive principles (in other words, concepts) behind all existing patents (see Figure 8), and that these principles address standard technical conflicts in design or problem solving. (Note that different versions of the principles have been presented in various documents.) The use of TRIZ helps solve technical con-

flicts through the use of design concepts, which are by-products of standard inventive principles. TRIZ is designed to help every engineer who uses the approach become more inventive. TRIZ can take the engineer out of the box of limited thinking and put him or her into a world of creative or inventive thinking.

TRIZ incorporates three thought patterns: evolution, contradiction, and ideality. The analysis of patents identified the typical *evolution* of technical systems. *Contradiction* deals with mutually exclusive demands. (A manufacturing material, for example, might need to be both stronger *and* lighter; TRIZ demands creative solutions that emphasize that combination, with no trade-offs.) The *ideal* technical system, according to the TRIZ ideology, is a system that does not actually exist, yet all of its functions are fulfilled.

Figure 8. TRIZ: 27 Inventive Principles (Methods, Effects, and Tricks)

1. Do it
2. Change the state of the physical property
3. Do it in advance
4. Do a little less
5. Matreshka (nested dolls)
6. Separate conflicts in time or space
7. Replace special terms with simple words
8. Incorporation into one system
9. Fragmentation, consolidation
10. Dynamization
11. Add magnetic powder; apply a magnetic field
12. S-field modeling
13. Self-service
14. Heat expansion inversely
15. Macrostructure to microstructure
16. Effect of the Corona discharge
17. Curie point of ferromagnetic materials
18. Combination of various effects
19. Geometric effect of the Moebius Ribbon
20. Geometric effect of the Rotating Hyperboloid
21. Ideal final result (IFR)
22. Introduction of a second substance
23. Utilization of soap bubbles and foam
24. Operator STC (Size, Time, Cost)
25. Model with Miniature Dwarfs (MMD)
26. Make a copy and work with it
27. Build a model of the problem

Source: H. Altov, *The Art of Inventing: And Suddenly the Inventor Appeared,* translated and adapted by Lee Shulyak (Worcester, MA: Technical Innovation Center, 1994).

TRIZ represents a well-developed approach to using concepts to obtain creative solutions to problems and creative designs for new products. The list of inventive principles contains concepts that are more technical and science based than the change concepts previously described. (Additional information on TRIZ can be found in the references.)

Future use of concepts

Specific tools have been provided by de Bono and others that make it easy for us to use concepts in our improvement or problem-solving efforts. These tools, such as the concept triangle and the concept fan, can be used any time a more creative approach is desired. G.J. Langley et al[11] have developed a list of change concepts that are applicable to all types of design and redesign activities. The inventive principles of TRIZ use concepts to aid in invention and creative problem solving. But what are the future possibilities for the use of concepts?

The Institute for Healthcare Improvement (IHI) has incorporated the use of change concepts into its large-scale collaborative improvement efforts.[12] These projects, known as the Breakthrough Series, focus on improvements in specific medical areas such as cardiac surgery, delays and waiting times, asthma care, and cesarean section rates, among others. The Breakthrough Series approach is based on the premise that prevailing practices in the area of focus deviate from the best available knowledge about the subject.

To begin these collaboratives, groups of experts on the topic are convened. Each expert group develops a set of change concepts specific to the topic of interest. These topic-specific change concepts are then taught to collaborative members and become the focus for developing specific ideas for improvement in the collaborative members' organizations. Members use the Model for Improvement to test and implement specific changes developed from the change concepts. Examples of change concepts used in the Breakthrough Series on delays and waiting[13] are shown in Figure 9.

Figure 9. Change Concepts for the IHI Breakthrough Series on Delays and Waiting Times

Change concepts for system design

1. Do tasks in parallel
2. Remove or rearrange a step
3. Use multiple processes
4. Give timely feedback
5. Use pull systems
6. Synchronize to a common point in time

Change concepts for system design

7. Triage
8. Combine services
9. Extinguish demand for ineffective care
10. Relocate care
11. Promote self-care
12. Smooth the flow of work

Change concepts for matching capacity to demand

13. Improve predictions
14. Identify and manage the constraint
15. Work down the backlog
16. Balanced centralized and decentralized capacity
17. Use contingency plans

Thinking about change

Creativity is not its own reward. It is the use of creativity to develop new ideas that leads to improvement that is meaningful. A basic element of thinking—concepts—plays a crucial role in this use of creativity. As discussed, three creative thinking methods that focus on concepts include the concept triangle, the concept fan, and change concepts.

Change concepts come in many forms and are evolutionary. TRIZ incorporates the use of concepts into a methodology for enhancing engineering creativity. IHI has made the use of change concepts a critical component of its Breakthrough Series. The successes documented in both of these approaches illustrate the benefits of incorporating the use of concepts into innovation and improvement activities. As organizations become more aware of the need for creative ideas in their improvement efforts, concepts will play an important role in critical and creative thinking about change.

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