

W.R. (Bill) Klemm

---

## Abstract

Creativity is a leadership quality that should be an essential part of the job description. Leaders may not need to be creative themselves, but they need to understand key elements of the creative process (freedom/autonomy, working-memory limitations, ownership, acceptance, and creativity principles). Leaders should provide education, time, resources, and encouragement for their employees to generate many novel ideas. Leaders should make available and guide the use of specific techniques available for proper framing of tasks or problems and for stimulating the divergent and convergent thinking needed for arriving at optimal solutions for tasks and problems. The decision-making required of leaders should be delayed and focus on weeding out poor options frequently and quickly and in guiding the implementation of best ideas. Introduced here is the idea of systematically using a set of techniques known to guide idea creation and to treat ideas as a database that can be managed.

The history of vaccines provides a clear and concise case study of how creative ideas emerge and evolve into commercial development.

---

## Keywords

Initiative • Global development • Environmental degradation • Political stability • Capitalism • Transformation • Feminism • Management education • Student engagement • Transformational intent

---

W.R. (Bill) Klemm (✉)

Texas A&M University, College Station, TX 77843-4458, USA

e-mail: [wklemm@cvm.tamu.edu](mailto:wklemm@cvm.tamu.edu)

---

## Creativity as Part of the Job Description

In 2013, IBM conducted a global survey of over 1500 CEOs in 33 industries in 60 countries revealing that creativity is now considered the most important leadership quality for success in business. The reason is that corporate challenges are frequently changing, unpredictable, and increasingly complex (Nikrvan, 2015).

These challenges come from the rapid pace of technology development, market dynamics, and competitive pressures. Even if the product or service is an established brand and change may not seem advisable, creativity is frequently necessary for cost cutting, better production efficiency, better distribution, and marketing plans. Think of all the well-branded companies that no longer exist: Arthur Anderson accounting, DeLorean Motor Co., E. F. Hutton brokers, Enron energy, General Foods, Transworld Airlines, Eastern Airlines, Compaq computers, MCI WorldCom phone company, PaineWebber brokers, Pullman railroad cars, Woolworth's department stores, Pan American World Airways, Standard Oil (U.S. Business, NBCNEWS.com, n.d.). Even recently, we have seen demise of such stalwarts as Blockbuster, Nokia, Borders Books, and Motorola. These companies went under for different reasons, but all might have been saved had management been more creative.

The Compaq Computer Company provides a classical example of the importance of creativity. The company was founded when the founding leaders drew on a napkin a diagram of one of the most creative ideas of our time: a portable personal computer. But apparently the leaders became too comfortable with the brilliant idea of a suitcase-size computer. The creative juices withered on poorly nurtured vines and the company missed what now seems the obvious opportunity to invent laptops, tablets, and smart phones.

Even when creativity is needed, only lip service may be paid to it. I noticed this phenomenon in the Air Force Systems Command, where there was a continual challenge to come up with better weapons systems and R&D policies and practices (Klemm, 1990).

Many leaders actually have a bias against creative ideas, especially if they are not the ones who thought of them. In the Air Force we called this the N.I.H. syndrome (not invented here). This seems to be human nature. People like to hear tales of leaders whose fresh thinking transforms their organizations, but they don't like to work for creative leaders (Mueller, Goncalo, & Kamdar, 2011). The problem with creative leaders could be that they force employees out of their comfort zone. We all value order, peace, and quiet—especially the status quo.

---

## Understanding the Creative Process

Creativity and innovation are not mysterious forces over which leaders have no control. It is true, however, that leadership is often associated with orderly, controlling behavior, while creativity can be chaotic and unrestrained (Slocum, 2015) (Fig. 15.1).

**Fig. 15.1** Creativity is often thought of as some magical process wherein “stuff” is poured into the brain and wondrous creations comes out. Graphic from William Tallent. Permission granted (evidence available)



It probably doesn't matter much where an organization's creativity comes from, whether from the leaders or the workers. But if leaders themselves are not creative, they need to understand how to get the most useful creativity out of their workers (Reiter-Palmona & Illiesb, 2004). In any case, as Slocum says, creativity should be “a shared sense of responsibility.” We are moving into an era where creativity comes not from a few single free thinkers but rather a group process. The most important thing a leader can do is to communicate a compelling vision for where the organization needs to go and then support a culture that stimulates the creative ideas needed to get there. A leader has to know what motivates people to be creative in order to provide the right motivation. Below is a summary.

---

## Freedom/Autonomy

Perhaps most people like to be told what is expected, what they are supposed to do. Not creative people. They want the freedom to make a unique impact on their organization. When they have what is arguably a better idea or plan, they want the chance to prove it.

Creative people are frustrated with leaders who have the N.I.H. syndrome. There are, unfortunately, leaders who think that only they can come up with good ideas.

Leaders who want a work culture of creativity need to apply pressure up front by letting their people know that creativity is expected and valued. Stating tasks and problems in ways that are open for “out of the box” thinking is usually a good idea (see later comments about framing ideas).

Personality has a great influence. The most creative people are those who are risk takers, intuitive, and who tolerate doubt and ambiguity.

Age discrimination is unwise. Older workers often have a historical perspective that promotes options that others might not consider. On the other hand, packing a work team with older workers can create a negative creative environment dominated by such thinking as “we never have done that” or “not invented here.”

Creativity teams should therefore be heterogeneous, including people with diverse educational and work experiences. It can be a good idea to have a few team members who have no expertise in the topic at hand.

## Ownership

What kind of incentive is there for a worker to generate good ideas, if management takes credit for them? People have pride in their “babies” and therefore want the recognition they deserve. The recognition may provide more deep satisfaction than a bonus.

This principle has actually been tested in corporate environments (Pelz & Andrews, 1976) who surveyed companies that provided opportunities for their scientists and engineers to have their names associated with the product, report, or process that they developed. Specific practices of such companies included:

- Giving employees as much autonomy as practical.
- Minimizing micromanaging.
- Letting professionals influence policy-making and set some of their own goals and priorities.
- Letting professionals present their own work in briefings and reports.

## Acceptance

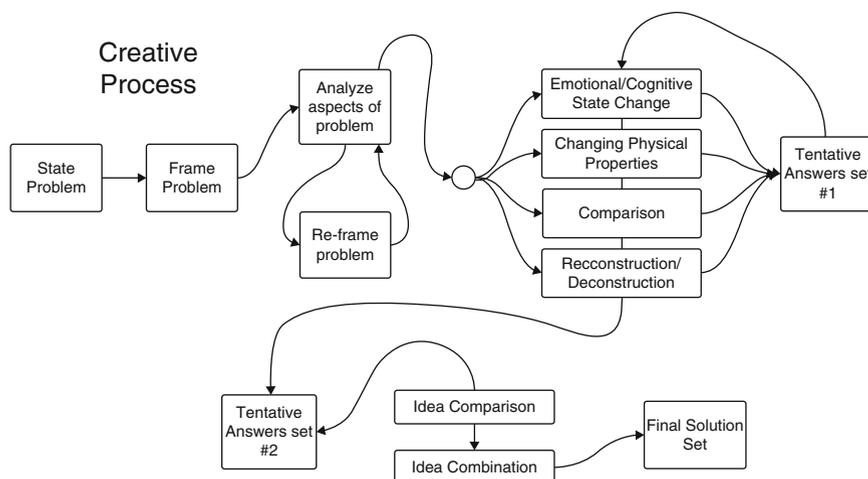
Creative people need to be valued, not regarded as crackpots, mavericks, or nuisances. They need encouragement from significant people in the organization. This often occurs in the form of a high-level “champion,” as documented in the classic book by Peters and Waterman (2004). Punishing unaccepted ideas will nullify the message that creativity is expected and valued. People tend to be naturally risk-averse. Punishment aggravates that problem.

---

## Promoting the Right Processes

Scholarly papers on creativity abound (Reiter-Palmona & Illiesb, 2004). The main steps in the creative process are: (1) understand and frame the task or problem, (2) gather information, (3) generate a wide array of ideas, (4) compare and combine ideas, (5) narrow the list of options to those that are most promising, and (6) pick the winning ideas (Fig. 15.2). There are formal tools that leaders can provide to facilitate this process (see section “Creativity Principles and Techniques”).

*Frame the Problem.* The first and fundamental step in the creative process is to state the task or problem in a way that does not create a logjam to novel ideas. A question can easily limit creative thinking if it restricts the space of potential answers. It therefore is important to pose questions in open-ended ways and ways



**Fig. 15.2** Summary of how principles of creative thinking and a grouping of specific associated tools can be integrated to enhance creativity and problem solving. From Talent, LaFayette, and Klemm et al. 2015

that do not make too many assumptions about an acceptable answer. As Reiter-Palmona and Illiesb (2004) put it, “The leader’s role is to facilitate the construction and selection of the problem definition that is most appropriate given the organizational goals and needs.”

*Gather Information.* As creative thinkers gather information they habitually ask themselves, “How might this information apply to the problem I need to address?” A proper role for leaders is to manage the process so that employee findings and ideas are connected and shared widely. Unfortunately, some leaders hoard knowledge because it is a source of their individual power (at the expense of organizational power).

Special care is needed to avoid search and encoding activities that foreclose securing the information to support new ideas (Reiter-Palmona & Illies, 2004). What counts as relevant should be flexible and allow collection of a wide range of information. Commonly, creative ideas come from knowledge domains outside the one of the immediate task or problem.

*Generate a Wide Range of Ideas.* Generation of new ideas begins with the imperative of deliberately trying to think of multiple options. The practical task becomes one of reducing the size of the problem and alternative solution space to workable dimensions. That may well be why one has to be immersed in the problem for long periods, with subconscious “incubation” operating to help sort through various alternatives and combinations thereof.

Specific creativity tools can be a necessary part of such divergent thinking (see below). Leaders should make these tools available to employees and encourage their use. Some patience is needed, inasmuch as the first ideas generated are not as likely to be novel as ones that emerge later in the process (Reiter-Palmona & Illies,

2004). In Einstein's case, once he got the basic idea for general relativity right, which took about a decade, he worked out the equations for it in the last five weeks.

Imagery is more likely than language to stimulate new thought. Some famous scientists claim that their best thinking occurs in the form of visual images, even at the level of fantasy. Words and language, according to Einstein, had no role in his creative thought and math was used mainly to express and test the ideas quantitatively. In one of Einstein's fantasies he visualized himself riding on a beam of light, holding a mirror in front of him. Since the light and the mirror were traveling at the same speed in the same direction, and since the mirror was a little ahead of the light's front, the light could never catch up to the mirror to reflect an image. Thus Einstein could not see himself.

A famous Nobel Prize scientist, Linus Pauling, said "To have a good idea, you have to have lots of ideas." Knowledge can empower thinking because it provides a source for seeing other potential alternative approaches to a task or problem.

The reader may perhaps recall the famous quote from Louis Pasteur, "Chance (discovery) comes only to the prepared mind." Einstein, for example, would not have discovered relativity if he had not known basic physics in general and Maxwell's ideas and equations in particular. As my friend, Ann Kellet has said, "To think outside the box, you have to know what is inside the box."

Though organizations need employees with expertise, all organizations can benefit from having at least a few generalist "Renaissance" people because of the diverse perspectives of their knowledge. Leadership training in the military creates diverse experience by frequently rotating the types of command assignments.

*Think Beyond the Obvious Relationships.* Our natural tendency to classify things can block creativity. For example, something in Newton's sensory or cognitive world caused him to see the similarity between an apple and the moon in a new way; of course they both were round, solid bodies, one red, one yellow, one edible, the other not. But Newton saw another relationship: both could fall in response to some force (gravity). Our usual insistence on describing, naming, and classifying can get in the way of fresh thinking.

*Compare and Combine Ideas.* The next stages involve realizing permutations of alternatives that are significant. These alternatives can be processed logically (by associating, sorting, and aligning into new or unusual categories and contexts) or more powerfully by the use of images, abstractions, models, metaphors, and analogies.

This convergent thinking stage of creativity involves a progressive narrowing of options and a readiness to break down and reformulate the categories and relationships of thoughts and facts and reconsider earlier decisions in the later stages.

These operations must occur in working memory, which unfortunately has very limited capacity. That is probably the reason why insight and creativity are so hard to come by. People think stepwise with what is in their working memory. The practical point is that as tentative ideas surface, they should be condensed into as few words or drawing elements as possible, because they need to be held in working memory while searching for associations with other options (which also should be chunked).

*Narrow the List.* When working to reduce a list of potential ideas, best results for finding novel associations and spin-off of other ideas will occur if the original list is shuffled several times. Serial order of items affects how well they are held in working memory, which favors the most recent items in a serial list. Also, items first in a list also get preferential working memory treatment. Shuffling the list gives the options in the middle of a list a better chance to receive their due notice.

*Pick the Winners.* Critical and logical analysis should be delayed until this final stage to force a refinement of the emerging ideas. Analysis may force the realization that the wrong problem is being worked or that it needs to be reformulated. The final choice only requires that each idea is tested against the selection criteria (cost, efficiency, competitive advantage, or whatever is appropriate). Selection may even be data driven.

---

## Creativity Principles and Techniques

Leaders need to know how to get their colleagues' creative juices flowing by using specific methods and tools that have been designed just for that purpose. My colleagues (Will Tallent and Carol LaFayette) and I have surveyed about 100 known methods and tools that reportedly stimulate creative thinking, as summarized at <http://www.mycoted.com>. Our aim was to identify the set of underlying principles embodied by those methods and tools. We identified four major categories of principles as follows:

### 1. Emotional/Cognitive State Change

- *Emotional Perspectives:* frame the problem through different emotional or mental states.
- *Competition:* use a game-like environment to liven up a group or individual.
- *Shock Factor:* use something shocking or “off the rails” to get the mind off the task at hand and loosen up a mind that is too focused.
- *Visual Representations:* use visual representations of ideas, words, or problems.

### 2. Changing Physical Properties

- *Expansion:* use a more generalized view, looking at the bigger picture, or changing the size and scale of a problem or solution.
- *Synonym:* change a word or phrase into something similar in order to get a different perspective.
- *Opposite:* change an entire sentence or any element of it into its opposite meaning.
- *Visual Abstraction:* use either purely abstract visuals to spark ideas or abstract an already formed idea.
- *Abstract Associations:* imagine how to relate two things that are either somewhat or completely unrelated.

### 3. Comparison

- *Comparison of Possible Solutions:* find quantitative differences and/or similarities in solution sets or aspects of a problem.

#### 4. Reconstruction/Deconstruction

- *Deconstruction*: pull apart elements of a problem or idea.
- *Combination*: combine ideas, similar or not, into one cohesive plan or idea.

We recommend that whenever leaders are confronted with a problem or need for invention, they should guide workers through a set of tools that embody the principles in each of the four categories. Most of the creativity literature emphasizes framing the problem and then seeking novel ideas by divergent thinking to generate a wide range of alternative solutions. Many divergent thinking techniques use random stimuli to force novel connections. Convergent thinking approaches creativity in the different, but complementary, way of being more specifically goal-directed to the task or problem at hand. Here the idea is to view a problem from multiple perspectives. In each category, we ranked the methods we liked best and identify them here. However, we emphasize that a comparison of the effectiveness of the various methods has not been experimentally tested, and research in this area seems sorely needed. Nonetheless, here are the approaches we think show promise, by category (Table 15.1).

**Table 15.1** Recommended tools for creativity

Technique	How it works
<b>Framing the Problem</b> (state the problem in different ways to gain new perspective)	
Exaggeration	Change the magnitude or nature of the problem (make it bigger/smaller; use caricature; change power or status).
Osborn's checklist	As in Exaggeration. Also, substitute, reverse, combine, or rearrange components of the task.
Boundary examination	Underline key words and examine each for hidden assumptions. Redefine with different words.
Reversal	Reverse statement of the task or problem.
<b>Divergent Thinking</b> (use non-typical thinking to generate ideas)	
Escape thinking	Change the assumptions. Compare multiple alternatives.
Brutethink	Bring random word into problem and think of its associations. Force connections with the problem.
Heuristic Ideation	Choose two novelty goods related to area of interest and describe the attributes of each good.
Circle of technique	Draw a clock with 12 numbers and list attributes of the problem on each number. Roll dice to select two attributes in turn and identify how they can associate with each other and with the problem.
<b>Convergent Thinking</b> (view the problem at hand from different perspectives)	
KJ method	Write all facts and information on separate post-its cards, shuffle, and group cards that seem to belong in the same group. Name the group. Create larger groups from the initial grouping. Use arrows to show relationships (cause/effect, interdependent, conflicting, similar, etc.). Verbally explain the structure of the cards.
Cherry split	State tentative challenge or problem in two words. Then state each word with two separate attributes. Split each of these into two more attributes. Think of ways to change each attribute with the aim of refining to a better solution.

(continued)

**Table 15.1** (continued)

Technique	How it works
Analogies	Identify what you want ideas for. Find a core verb phrase that captures the nature of what you are looking for. Find analogies for each verb phrase of what each action is like in some way. Pick an analogy that is interesting and comes from another domain. Describe the analog including how it works, what it does, what it affects. Use description to suggest refined ideas relevant to your problem.
Morphological forced connections	A matrix method for using problem or idea attributes to identify uniquely useful combinations. List attributes of situations, task, or problem in top row of matrix. Below each attribute create rows to place as many alternates as you can think of. When completed, make random runs through the alternates to pick a different one from each column and assembling the combinations into entirely new forms of the original.

## The Organizational Environment for Creativity

Leaders, even unimaginative ones, can learn how to recognize and value creative people and provide a welcoming environment for new ideas that does not intimidate or punish people for maverick thinking.

One road-block for managers to cultivate a creativity culture is the assumption that only a few workers are creative and that there is not much you can do to turn “sows ears into silk purses.” Certainly it is true that naturally creative people are rare and may be hard to entice onto the payroll, but a proper creativity environment can bring out the best in an ordinary workforce. Just what is needed?

People who have looked carefully at the creative process have learned that everyone of ordinary intelligence has latent creative abilities that can be enhanced by training and by a favorable environment. But many of us have not developed our creative capacity. Our brains seem frozen in cognitive catalepsy, boxed in by rigid thinking. Yet most people have innate creative abilities that can become manifest when creativity is nurtured. D. N. Perkins, author of *The Mind's Best Work*, reports experiments showing that creativity arises naturally and comprehensibly from certain everyday abilities of perception, understanding, logic, memory, and thinking style.

One job of a leader is to stimulate workers to be more creative. Beth Comstock, the CMO at General Electric, gives some practical advice on how to think innovatively (Comstock, n.d.). Her specific advice for workers and leaders includes:

1. Nurture the newborn idea. Be patient with questionable ideas. They will often grow or transform into better ideas. Sit on it, let it incubate (Fig. 15.3).
2. Commit to a promising idea. Successful ideas are nurtured by passion. If you believe in the promise of an idea, noodle it to fit a meaningful problem. Do your homework. Smooth the rough patches. Ask others to help make the idea better.



**Fig. 15.3** Good ideas have to be nurtured as they grow to yield their fruit. Image courtesy of Sura Nualpradid at FreeDigitalPhotos.net

3. Tell others, even when you feel embarrassed about how weird the idea might be. This clarifies your own thinking and at least a few of your listeners may get intrigued and help you improve the idea.
4. If you believe in your idea, don't give up. Don't be intimidated by negative feedback. Use such feedback to improve the idea. If necessary, put the idea in storage until improvements come to mind, or new technology or resources become available, or others are more accepting.

---

## Leadership in Decision-making

Organizational leaders need to be engaged in making a final decision on which ideas to pursue. This process is beyond the scope of this chapter, but I suggest use of some formal decision-making tools such as Value Engineering ([www.mycoted.com](http://www.mycoted.com)).

## The Value of Fast, Frequent Error

You may not have ever watched a rat learn a maze, but it can be instructive. A rat (that knows the maze has a food reward at the end) will move rapidly through the maze, making rapid mental notes on wrong choices. The faster the rat can make those errors, the faster they will find the right path.

This applies to human testing of new ideas. Many such ideas are not practical, and the faster you find that out, the faster you can find the ideas with big payoff

(Babineaux & Krumboltz, 2013). This winnowing can be accomplished by “proof-of-concept” tests that are small-scale trial runs. Such tests identify problems early on, leading quickly to finding glitches, dropping poor ideas, and identifying limitations of good ideas that need to be patched early when it is probably less expensive to do so.

## Transitioning to Implementation

In technical fields, this process is called “technology transition.” But whether a great creative idea involves technology or not, the final process of transitioning has to be accomplished. Implementation is a whole different ball game with different rules and required skills of managers and workers. In military research and development, for example, there are formal distinctions made between basic research and applied research (putting “rubber on the runway” as they say in the Air Force) (see examples in Table 15.2).

In some research and development environments, a “team” mentality prevails in which the original idea becomes a team project which they implement. This has the advantage that the team is invested in the idea and motivated to make it succeed. But all too often, the original team lacks the skills to achieve successful transition. At the very least, management needs to provide such teams with a “champion” and supporting resources that do not exist within the team (Peters & Waterman, 2004).

As an example of a complete R&D process, we could consider how the US military has been doing it for many decades. I was fortunate enough to participate in this process in a small way and share here a summary of the categorization scheme that the military uses in weapon-systems research and development. I paraphrase the steps in Table 15.2. This process outline seems to have application to civilian R&D.

**Table 15.2** Military R&D processes<sup>a</sup>

Category	Processes
6.1	Seek basic knowledge and understanding without applications in mind
6.2	Seek a knowledge and understanding that might lead to a solution to a known problem
6.3	Prepare for proof-of-concept field experiments and tests
6.4	Test in a realistic operating environment to assess cost and performance
6.5	Evaluate needed engineering and manufacturing capabilities
6.6	Develop management support systems
6.7	Begin manufacturing and acquisition. Test and evaluate

<sup>a</sup>[http://www.rand.org/content/dam/rand/pubs/monograph\\_reports/MR1194/MR1194.appb.pdf](http://www.rand.org/content/dam/rand/pubs/monograph_reports/MR1194/MR1194.appb.pdf)

### Case Study 15.1: A Condensed History of Vaccines

Vaccines either contain antibodies to combat a bacterial or viral infection (passive immunity) or stimulate a patient's immune system to develop the antibodies (active immunity). Historically, these vaccines are produced by harvesting the antibodies from an animal or tissue culture or harvesting the infectious agent after it has been weakened in some fashion.

The idea of vaccines was first formalized by Edward Jenner who lived in a time when smallpox was rampant throughout the world (Reidel, 2005). Infected people often died, but Jenner focused on the ones that survived. Why did they survive? He reasoned that the infection might have stimulated a body defense mechanism. He also knew from public reports that people who survived smallpox were resistant to a repeat infection, and such people were often used to provide medical care for smallpox patients. Jenner correctly reasoned that some benefit might accrue from deliberately infecting people with a weaker version of the virus that was not potent enough to kill them. It was a "what doesn't kill me makes me stronger" idea.

Jenner's professional life was probably relevant to his creative insight. He was trained as a physician, but one of his main mentors was a biological scientist. Jenner had diverse interests, even studying geology and conducting multiple biological experiments that included human blood, hedgehog hibernation, bird migration, cuckoo rearing of chicks. He even built and launched a hydrogen balloon. He played the violin and wrote poetry.

The smallpox breakthrough came when Jenner learned that dairy maids who had contracted cowpox from milking infected cows seemed unaffected by smallpox epidemics. Voila! Could it be that cowpox is a weakened form of smallpox that could be used as a vaccine? Yes. In 1796, he injected matter from a dairymaid's skin lesion into an 8-year-old boy. The boy became sick with a mild fever but recovered after 9 days. Two months later, Jenner injected matter from a fresh smallpox lesion into the boy. No sickness occurred. Jenner submitted a research report to the Royal Society, which they rejected. He repeated the experiments with other patients with the same good results and self-published a booklet explaining his research and its implications. Scholars of the era rejected Jenner's data and ideas in that publication. Fortunately, some of Jenner's physician contemporaries knew about his work and bought in to the idea and generated compelling data. By 1800, smallpox vaccination became widespread in Europe. Consider the discussion questions in Table 15.3.

#### Epilogue

A whole pharmaceutical industry developed over the next 200 years that used technologies to scale up vaccine production and to develop vaccines for a wide range of diseases. Invariably, these technologies involved cultivating infectious organisms in live animals, eggs, or tissue culture.

(continued)

(continued)

**Table 15.3** Smallpox analysis questions

1. What is the relationship of creativity to the dictum: "Find a need and fill it?"
2. What in Jenner's life background might have helped make him a creative person?
3. Did those experiences make him more creative or just reflect that he was creative?
4. What roles in his creative vaccination ideas do you think were played by such factors as:
  - Observation (seeing what others looked at but did not see)
  - Prior knowledge
  - Persistence
  - Serendipity/luck
  - Risk acceptance, courage
  - Communication with others
  - Leadership

But a wild new idea has emerged in the last few years, derived from the whole new industry of genetic engineering. Why not figure out a way for plants to make vaccines? Plants are cheap to grow, they grow fast in large quantity, and they make proteins (antibodies are proteins). Traditional vaccine production methods can take six months or more. Plants can theoretically do it in a matter of weeks, which can be crucial for a sudden epidemic like Ebola or a new flu strain for which there is no existing vaccine. We know that genes direct which proteins are made inside cells, whether they be from animal or plant origin. In animals or humans that make antibodies in response to a specific infection, there must be a gene that directs the cells to make that antibody protein. How do we get those genes into plants?

Remember the Greek Trojan-Horse story? Why couldn't you use a living organism to insert those genes into a plant so that the plant can make the antibody protein cheaply, rapidly, and in large quantities? The rigid cell walls of plant cells also could allow the vaccine to be taken orally and protected from destruction by stomach acids. The theory is sound. It is just a matter of developing the technology. But the technology needed had its own demands for creative thinking. Which plants? How do you get them infected? In 2000, a U.S. Patent US 6034298 was awarded on this idea to Prodigene, Inc. that had developed a practical approach.

Proof-of-concept was developed in tobacco plants in North Carolina (Reuters News, 2014). My own university received a \$40 million federal grant to help turn this novel idea into a new industry (World Heritage Encyclopedia, 2014). Tobacco plants are being used by Caliber Biotherapeutics

(continued)

(continued)

for the rapid production of flu antibodies. A viral antigen that triggers an immune response is identified. The gene that makes this protein is transferred to bacteria, which in turn are used to “infect” the tobacco plant so that it starts “manufacturing” the antibody.

An extension of this idea is to find a way to get the genes into the reproductive organs of the plants so that seeds of each generation of the plant have the ability to make the vaccine. This may prove to be tricky, but a proof of concept has been successful. Consider the discussion questions in Table 15.4.

**Table 15.4** Plant vaccines analysis questions

1. What is the relationship of creativity to the dictum: “Find a need and fill it?”
2. What roles in the creativity do you think were played by such factors as:
  - Observation (seeing what others looked at but did not see)
  - The negative and positive effects of prior knowledge
  - Metaphors
  - Persistence
  - Serendipity/luck
  - Risk acceptance, courage
  - Communication with others
  - Leadership
3. How does this example illustrate the differences between basic and applied research?
4. If plant production works better, how would you go about creating a way to rescue traditional companies?
5. What is the limitation of plant production of vaccines? Hint: can they make an active vaccine with an attenuated live infectious agent? Why or why not?

### Discussion Questions

1. Is it important for leaders to be creative if they value creativity and nurture it in their employees? Why or why not?
2. Do you agree with Slocum’s assertion that creativity should be a shared responsibility in an organization? Why or why not?
3. If you were conducting a hiring interview, what questions would you ask to find out if the job applicant was creative?
4. If you were a leader of a work team or organization, what would you do to create a systematic process for generating task-relevant ideas and deciding which ones to implement?
5. Describe a task or project that you have been involved in where creative ideas proved to be essential. How did that creativity arise? Describe also a task or project that failed because of insufficiently creative ideas. What interfered with the production of creative ideas?

### Summary

- Creativity is part of the job description for leaders.
- Leaders need to surround themselves with creative people, especially if the leaders are not particularly creative.
- Leaders can get too comfortable with the current status quo.
- Creativity and intelligence are two different things, often not found in equal degree in the same person.
- Creativity and innovation are not mysterious forces over which leaders have no control.
- Creativity requires freedom/autonomy, a balance between pressure and freedom, framing ideas to accommodate human working memory limitations, a sense of ownership over one's ideas, acceptance by significant others, and the right processes that stimulate creativity.
- Creative strategies include framing the task or problem, gathering information, generating multiple and diverse ideas, use of imagery, and use of specific creativity-stimulating techniques.
- Creativity principles include emotional or state change, changing physical properties, comparison, and deconstruction or reconstruction of the emerging tentative ideas.
- To create a work environment for creativity requires supportive leadership and creativity tools that collectively encompass the full range of creativity principles.
- In early stages of creativity leaders should be hands-off, but in final stages they should structure the process to identify weak ideas quickly.
- Implementation transitioning needs highly structured and sequenced processes.

---

### References

- Babineaux, R., & Krumboltz, J. (2013). *Fail fast, fail often: How losing can help you win*. New York: Tarcher/Penguin.
- U.S. Business, NBCNEWS.com. *15 most memorable companies that vanished*. Retrieved May 30, 2015, [http://www.nbcnews.com/id/41027460/ns/business-us\\_business/t/most-memorable-companies-vanished/#.VWstps9VhBc](http://www.nbcnews.com/id/41027460/ns/business-us_business/t/most-memorable-companies-vanished/#.VWstps9VhBc).
- Comstock, B. *Behind the scenes: here's how I sell an idea*. Retrieved September 16, 2014, from <https://www.linkedin.com/pulse/article/20140915225646-19748378-here-s-how-i-sell-an-idea?trk=eml-mktg-inf-m-doit-0916-p2>.
- Klemm, W. R. (1990). Leadership: creativity and innovation. In R. I. Lester & A. G. Morton (Eds.), *Concepts for air force leadership* (pp. 426–439). Montgomery, AL: Maxwell Air Force Base Alabama, Air University.
- Mueller, J. S., Goncalo, J. A., & Kamdar, D. (2011). Recognizing creative leadership: Can creative idea expression negatively relate to perceptions of leadership potential? *Journal of Experimental Social Psychology*, 47(2), 494–498.

- Nikrvan, L. (2015, May 30). Why creativity is the most important leadership quality. *SABA*. Retrieved June 6, 2015, from <http://www.clomedia.com/articles/why-creativity-is-the-most-important-leadership-quality>.
- Pelz, D. C., & Andrews, F. M. (1976). *Scientists in organizations: Productive climates for research and development*. Ann Arbor, MI: University of Michigan.
- Perkins, D. N. (1981). *The mind's best work*. Cambridge, MA: Harvard University Press.
- Peters, T. J., & Waterman, R. H., Jr. (2004). *In search of excellence*. New York: Harper Collins.
- Reidel, S. (2005). Edward Jenner and the history of smallpox and vaccination. *Proceedings of the Baylor University Medical Center*, 18(1), 21–25.
- Reiter-Palmona, R., & Illies, J. J. (2004). Leadership and creativity: Understanding leadership from a creative problem-solving perspective. *The Leadership Quarterly*, 15, 55–77.
- Reuters News Service (2014, October 1). *Plant-based vaccines challenge big pharm for \$3 billion flu*. Retrieved June 6, 2015, from [http://www.lifescrypt.com/health/news/reuters/2014/10/01/plant-based\\_vaccines\\_challenge\\_big\\_pharma\\_for\\_3\\_billion\\_flu\\_market.aspx](http://www.lifescrypt.com/health/news/reuters/2014/10/01/plant-based_vaccines_challenge_big_pharma_for_3_billion_flu_market.aspx).
- Slocum, D. (2015, January 27). The rise of creativity as a key quality in modern leadership. *Forbes*. Retrieved May 30, 2015, from <http://www.forbes.com/sites/berlinschoolofcreativeleadership/2015/01/27/the-rise-of-creativity-is-a-key-quality-in-modern-leadership/>.
- World Heritage Encyclopedia. (2014). *Plant expressed vaccine*. Retrieved June 6, 2015, from <http://www.worldheritage.org/article/WHEBN0028280299/Plant%20expressed%20vaccine>.