Artificial Intelligence for Engineering Design, Analysis and Manufacturing (2010), *24*, 153–159.

doi:10.1017/S0890060410000028

Creativity on demand: Historical approaches and future trends

GERARD J. PUCCIO,[1] JOHN F. CABRA,[2] J. MICHAEL FOX,[1] AND HELENE CAHEN[2]
[1]International Center for Studies in Creativity, Buffalo State College, Buffalo, New York, USA
[2]Strategic Insights, Raleigh, North Carolina, USA

(RECEIVED July 16, 2009; ACCEPTED July 16, 2009)

Abstract

This paper provides a brief introduction to the field of creativity studies. After more than 60 years of scientific study, there is much that has been learned about how to teach and facilitate creative thinking. We review some of the well-known methods for fostering creativity on demand, as well as the research that has explored the efficacy of these approaches.

Keywords: Creative Problem Solving; Creative-Process Model; Creativity; Creativity on Demand; Innovation

1. INTRODUCTION

Recent years have witnessed a burgeoning interest in the topic of creativity among individuals in universities, organizations, and schools. The increased level of interest by those in academe is perhaps best exemplified by the growth in refereed journals dedicated specifically to creativity research. A little more than 40 years ago the first academic journal in the field of creativity, *The Journal of Creative Behavior*, was launched. There was about a 20-year gap before the next creativity journal came along, and since then, a total of six journals have been regularly published. An examination of the table of contents for these journals would suggest that on an annual basis these six publications yield about 140 scholarly papers on the topic of creativity.

With the advent of the innovation economy those in industry have turned their attention to understanding how creativity in organizations might be used to their competitive advantage (Janszen, 2000). To that end, a number of recent books now position creativity as a core business skill (e.g., see Jay, 2000; Mauzy & Harriman, 2003; Gogatz & Mondejar, 2005; Bilton, 2007). It is widely touted (Rickards, 1996) and demonstrated through a small number of empirical studies that creativity—the production of original ideas that are made useful—is central to innovation (Blau & McKinley, 1979; Bharadwaj & Menon, 2000; Soo et al., 2002). Simply put, without creativity there is no innovation.

Although the recent interest among those in business has intensified, the view that creative thinking plays a crucial role in the workplace is not new. In a book published more than 50 years ago, *Applied Imagination: Principles and Procedures of Creative Problem-Solving*, Osborn (1953) outlined the strategies he developed within his advertising firm to facilitate creative thinking. This work is perhaps best known for the introduction of brainstorming, one of the most widely disseminated methods useful in the deliberate provocation of creative thought. Although Osborn's creative problem solving (CPS) process grew out of his experiencies in industry, his main concern was to develop strategies that would be useful in sustaining and developing creative-thinking skills among students. Educational reports published over the last 20 years have consistently identified creative thinking and problem solving as among the most crucial skills necessary for success in today's workplace, and thus have called on educational institutions to do more to promote these abilities (Carnevale et al., 1990; Secretary's Commission on Achieving Necessary Skills, 1991; Partnership for 21st Century Skills, 2008). More broadly, Puccio and Murdock (2001) have argued that creative thinking is an essential life skill. Given the important role creativity plays in modern day life, the remainder of this paper explores methods designed to foster creativity on demand, that is, creative process models and procedures that have democratized creativity. These approaches are designed to make creative thinking pedictable, teachable, repeatable, and accessible for all, not just for the gifted few.

Reprint requests to: Gerard J. Puccio, International Center for Studies in Creativity, Chase Hall 244, 1300 Elmwood Avenue, Buffalo State College, Buffalo, NY 14222. E-mail: pucciogj@buffalostate.edu

2. CPS

As noted earlier, CPS is one of the earliest published creative-process models. Since Osborn (1953) introduced CPS it has been one of the most widely adopted and thoroughly researched creative-process models (Isaksen & Treffinger, 2004; Puccio et al., 2005). As a creative-process model with a more than 50-year history, CPS has been subjected to ongoing development and continuous refinement (Isaksen & Treffinger, 2004; Puccio et al., 2005; Puccio & Cabra, 2009). The current version of CPS, which is used at Buffalo State's International Center for Studies in Creativity, is called the thinking skills model (Puccio et al., 2007). It features the following steps: exploring the vision, formulating challenges, exploring ideas, formulating solutions, exploring acceptance, and formulating a plan. These steps are organized into three main stages of operation known as clarification (exploring the vision and formulating challenges), transformation (exploring ideas and formulating solutions), and implementation (exploring acceptance and formulating plans). One meta-cognitive step, called assessing the situation, is used to help individuals and groups determine where to begin in CPS and then how to proceed through the steps and stages of this creative process.

This version is referred to as the thinking skills model, as both the thinking and affective skills developed through and employed by CPS are identified and described. Specific thinking and affective skills are associated with each step of the process. For instance, exploring the vision requires visionary thinking (cognitive skill) and dreaming (affective skill), while exploring acceptance relies on contextual thinking (cognitive skill) and sensitivity to environment (affective skill). Puccio et al. (2007) maintain that interplay between cognition and emotion is necessary to produce creative outcomes.

Although the structure of the CPS process has varied over the years, two features have remained constant. First, each step of the process begins with a divergent phase, the search for many, novel, and diverse options, which is followed by a convergent phase, the identification, and development of the most promising alternatives. This balance between divergent and convergent thinking is the hallmark of the CPS process. In this manner, individuals and groups are encouraged to first suspend their judgment to strive for many diverse and original options, and then to use affirmative judgment to select and develop the most promising options in each step of the process. This sequence of thought is crucial in avoiding premature closure. Second, the process includes efforts to clarify the problem, generate ideas, develop solutions and plan for action, which closely parallels descriptions of the stages included in individuals' natural creative process efforts. In this way, CPS is intended to provide individuals and groups with an explicit creativity model that parallels how the mind naturally thinks.

Two meta-analytic studies have confirmed the efficacy of CPS. Using the Torrance Tests of Creative Thinking (Torrance, 1974) as the common metric to compare creative process models, Rose and Lin (1984) found CPS to be among the most successful approaches. As these authors concluded, "The program with the most consistent impact on TTCT [Torrance Tests of Creative Thinking] scores is Osborn-Parnes CPS" (p. 16). In a more recent meta-analytic study, Scott et al. (2004) reported that creativity training based on cognitive models, such as CPS, were the most effective at enhancing attitude, problem solving, creative performance, and divergent thinking.

3. DE BONO TECHNIQUES

One of the most prolific authors in the field of creativity, and most ardent proponents for the trainability of creativity, is de Bono (1992). For more than four decades, de Bono has authored books designed to teach readers how to be more creative. Two of his most well-known concepts are lateral thinking (de Bono, 1977) and the six thinking hats (de Bono, 1999). Lateral thinking refers to a shift in thinking or perception—a complete break from previous thought (de Bono, 1977). In contrast, vertical thinking is an approach to a problem that is based on logical thinking. As de Bono described, vertical thinking is about digging the same hole deeper, whereas lateral thinking is focused on digging different holes. According to de Bono, the sudden breakthrough associated with lateral thinking cannot be produced through logical thinking; therefore, de Bono has devised strategies designed to help individuals generate radically new ideas. Such tools include random entry (i.e., generating ideas for a problem through the use of an object or a word that is unrelated to the challenge), provocation (i.e., the use of outlandish statements or wishes to generate new ideas), and concept fan (i.e., identifying the concept at the essence of an idea so that new ideas can be generated).

Where lateral thinking offers specific tools, the six hats method is designed as a framework for the creative process. Each hat represents a different kind of thinking a person is to adopt. For instance, the white hat relates to information and facts. When wearing the red hat, metaphorically speaking, the person is to focus his or her thinking on the emotional aspects of a situation. The green hat is associated with creative thinking. The black hat is concerned with critical analysis, whereas the yellow hat relates to constructive thinking, a speculative and positive form of analysis. Finally, the blue hat is most closely associated with meta-cognitive thinking as it focused on identifying which hat, that is, specific form of thinking, should be used and in what sequence. The hats are designed to foster "parallel thinking" during group problem solving efforts. The same hat, or way of thinking, is adopted by all group members, thus creating a shared focus and a more efficient process.

In her recent review of de Bono's methods, Dingli (2009) indicated that de Bono places great emphasis on the "practical and effective application of his methods" (p. 345), as such less effort has been directed to empirical examination of these methods. Birdi (2004) carried out an examination of the use of lateral thinking and six hats in an organizational creativity-training program. Postprogram analysis showed that de Bono's methods significantly improved participants' knowledge of creativity techniques and idea generation efforts back at work.

4. SYNECTICS

Based primarily on the use of analogies, Gordon (1961) introduced a creative process model called Synectics. Gordon (1961) argued that creative people engage in a thinking process based on nonrational, free association models that occur in the preconscious levels of thought. Synectics was developed to make this process explicit and to overcome mental blocks to creative thinking through the use of metaphorical thinking. To that end, Synectics features a set of thinking tools that assists problem solvers in creating analogies, such as direct analogy (i.e., the individual thinks of ways similar to how problems in technology or biology, e.g., have been solved), personal analogy (i.e., the individual imagines him/herself as the problem), symbolic analogy (i.e., the problem solver uses images that symbolically represent the essence of the problem under consideration), and fantasy analogy (i.e., the individual identifies the perfect and most outrageous solution and then works backward to reach the ideal goal). Gordon (1974) and Gordon and Poze (1972) have also published workbooks containing exercises aimed at improving individuals' ability to engage in metaphorical thinking.

Gassmann and Zeschky (2008) wrote a recent article that carefully examined situations in which analogical thinking led to a successful new product innovation. These authors suggested that certain organizational conditions are necessary to promote effective use of analogies, for instance, efforts to create analogies must begin with a deep understanding of the problem and executive leadership must be open to external solutions. Recent descriptions of this creative process methodology and its use can be found in Prince (2002), Nolan (2003), and Rickards (2003).

5. THEORY OF INVENTIVE PROBLEM SOLVING (TRIZ)

TRIZ is based on objective and repeatable engineering principles and practices. Altshuller (2001) originally developed his theory of inventing more than 40 years ago in the former Soviet Union. He used his own experiences as an inventor and as an official working in the Soviet Navy patent department to identify patterns among inventions. As he observed (p. 5),

> Technical evolution has its own characteristics and laws . . . This means that certain *regularities* exist. If we can find these regularities, then we can use them to solve technical problems—by rules, with formulae, without wasting time on sorting out variants.

As a result of his analysis of thousands of patents, Altshuller (2001) was able to identify a set of repeatable patterns that led to the creation of 40 inventive problem solving principles (Mann, 2001; Moehrle, 2005). These principles are intended to enable individuals to resolve technical contradictions that are at the essence of the problem. The problem solver simply selects a principle that best fits the problem being addressed (Moehrle, 2005). An example of a TRIZ principle is dynamicity. Here the problem solver identifies a product's attributes, then selects one that is deemed immoveable, and thinks of ways to make it moveable. Other TRIZ principles include segmentation (i.e., dividing an object into independent parts), asymmetry (i.e., change shape of object from symmetrical to asymmetrical), universality (i.e., make a part perform multiple functions), and nested doll (i.e., place one object inside of another).

TRIZ has been widely adopted in organizations, and there are numerous papers that describe the use of this method. Recent examples of TRIZ applications to various business challenges are presented in Akay et al. (2008), Chang et al. (2008), and Su and Lin (2008). Examples of nontechnical applications of TRIZ can be found in Zhang et al. (2005) and Vincent et al. (2005). León-Rovira et al. (2008) also conducted an empirical study that tested the impact of TRIZ training on engineering students.

6. DESIGN THINKING

Design thinking represents a departure from those creative process approaches previously described, primarily as it is based on visual and empathetic thinking. Interest in design thinking has exploded in recent years, as evidenced by coverage in such popular media outlets as ABC's Nightline, *BusinessWeek*, and *Harvard Business Review*, as well as popular press books like *The Art of Innovation* (Kelley, 2001) and *The Opposable Mind* (Martin, 2007).

The word design has historically referred to an outcome, an object, or a building. Fifty years ago a small group of academics and designers began to jointly consider the commonality around the processes used in a range of fields, which led to the first conference in design methods in 1962 (Cross, 2007). This conference was shortly followed by the introduction of a number of design-oriented journals, particularly around engineering and industrial design. As a consequence of these efforts, design became more of an activity, a verb that many could apply to a process. During the past decade, as a result of a movement initially driven by the design consultancy IDEO, a new concept emerged: design thinking. In 2003, IDEO labeled itself a "design thinking" firm. Kelley, cofounder of IDEO, was quoted in Tischler (2009) as saying that this was "the most powerful moment that words or labeling ever made. . . . Now I am an expert at methodology rather than a guy who designs a new chair or car" (p. 5).

Brown (2008), the current CEO of IDEO, described design thinking as "a discipline that uses the designer's sensibility and methods to match people's needs with what is technologically feasible, and what a viable business strategy can convert into customer value and market opportunity" (p. 86). Martin, Dean of the Rotman School of Management, who was instrumental in including design thinking as a core skill for MBA students, defined design thinking as "the way designers think: the mental processes they use . . . as distinct from the end result . . . a project-based workflow around 'wicked' problems" (Dunne & Martin, 2006, p. 517).

Brown (2008) described the design thinking process used at IDEO as a "system of spaces rather than a pre-defined series of orderly steps" (pp. 88–89). IDEO's process comprises the following elements: the "inspiration" space, which is focused on understanding the nature of the challenge that requires user research, creating insights and stories; the "ideation" space, which is focused on generating, developing, and testing solutions including early prototypes; and (3) the "implementation" space, which is focused on fine-tuning and evaluating the elements required to successfully launch the new idea.

There are specific mindsets that are essential to effective engagement in design thinking. Some of these mindsets include undertaking a human centered approach, adopting visual thinking and prototyping, using stories and storytelling, and leveraging the power of multifunctional teams. We briefly describe each mindset in turn.

6.1. Human centered and empathetic

Design thinkers have a responsibility to fully understand the users, defined broadly as all those who may be affected by the change (Beckman & Barry, 2007). When Procter & Gamble's CEO Lafley implemented design thinking, he required that all the employees view the customer as "the boss" (Lafley & Charan, 2008, p. 34). This required observing and interviewing those affected by the changes "with your own eyes and ears" (Kelley, 2001, p. 28), as well as soliciting feedback throughout the design thinking process. Patnaik (2009) explains that empathy creates a win–win strategy for a company, because caring for its customers, employees, and community is likely to help develop solutions that will drive financial success. As Patnaik (2009) described, "Empathy helps you make sure that you're in the right place at the right time to discover your next big opportunity" (p. 164).

6.2. Visual thinking and prototyping

Visual thinking is highly valued by design thinkers as an alternative to verbal thinking (note that many of the creative processes previously described are based mainly on verbal thinking). Described by McKin (1972) as a "meta strategy," visualizing thoughts and sketching can help generate new understanding. Prototyping takes visual thinking to the next level of development. One mantra at IDEO is "build to learn" (Kelley, 2001). As Kelley explained, "Quick prototyping is about acting before you've got the answers, about taking chances, stumbling a little, but then making it right" (p. 107).

6.3. Story and storytelling

Stories alone, or together with prototypes, summarize the essence of a solution, provide a vision for a different future and create emotional connections that may change behaviors. As noted by Rodriguez and Jacoby (2007), "Focusing on storytelling ensures that the essence of the value proposition is communicated and understood in a way that allows people within an organization to learn and act" (p. 57).

6.4. Multifunctional teams

As problems become more complex and as individuals become more specialized, multifunctional teams are critical to success. In the *Ten Faces of Innovation*, Kelley (2005) described innovation as the "a team sport" (p. 262) that should include players with 10 distinct and complementary innovation roles (such as the Anthropologist, the Director or the Caregiver). Buxton (2007) highlighted teamwork as a key factor in the iPod success and explained that "Everyone is essential, but no person or group is sufficient on his or her own" (p. 53).

Among the many advances within the past 50 years, design thinking has evolved from the world of products to the world of services to changing organizations. As a consequence, design thinking has been embraced by consulting practices, teaching institutions such as the Stanford d.school, Rotman School of Management, and Chicago Institute of Design, along with major companies such as P&G and Microsoft.

7. FUTURE TRENDS IN DELIBERATE CREATIVITY METHODS

In the next 5 years technology will transform the field of creativity in unimaginable ways. Therefore, we close this article by describing three future trends that may serve to shape the deliberate application of creativity. The first trend is the integration of technology such as software programs that mimic the stages of the creative process. The second trend is the use of virtual environments. The third trend is the use of touch projection such as holographs and multitouch screens.

7.1. Integration of technology

Increasingly open-sourced computer programs are finding their way into creative process methods. For example, Tufts University developed the Visually Understanding Environment that permits multiusers to simultaneously structure, present, and share digital information. That is, each member attending a business meeting can submit and view each others' ideas via their own respective laptops. A facilitator can then be assigned to manage and maneuver this information using Smartboard technology. Programs also exist for mind mapping and for visually tagging themes within a data set making vast amounts of information easier to manage and interpret (Puccio & Cabra, 2009). In a similar vein, software programs can now create digitized prototypes, models, and simulations that can be manipulated to undergo endless iterations, what *Strategy + Business* is coining iterative capital (Schrage, 2006). A software program called the Data Visualizer, in concert with another program called Catai, can perform thousands of iterative checks in seconds to examine the interface possibilities among component widgets (Schrage, 2006). The implication here suggests that reliance on nondigital technology

so often used in creativity meetings, such as flipcharts, whiteboards, and post-its will no longer be practical, in fact awkward and archaic, because they will be limited to physical space, too slow, and inflexible in capturing and managing idea flow.

7.2. Multivirtual environments

Multiuser virtual environment interfaces such as Second Life (a three-dimensional virtual community) provide opportunities for avatars to facilitate creativity with the help of other avatars (Hof, 2006; Kirkpatrick, 2007). Uribe and Cabra (in press) reported a successful CPS facilitation experience involving a Fortune 100 company carried out in Second Life. They illustrated how virtual worlds have the potential to transform the space where creativity occurs into a domain that promotes remote–synchronous creativity interactions.

Users of Second Life will one day be able to put on virtual reality eyewear linked with full body force feedback systems to stimulate the five senses (Walczak, 2002). Because the exchange of information will grow exponentially and in speed, the implication for a facilitator is likely to change to one of hyperediting in which he or she filters information by using quantitative and qualitative techniques to assess risk and reward (Schrage, 2006) and to one of group processor who intervenes based on feedback generated by software programs that interprets speech inflection and detects emotions (Gurstelle, 2005).

7.3. Multitouch screens and projections of holographs

Kurzweil (2005), a respected futurist, argued that instead of experiencing a hundred years of progress in the 21st century, it will seem more like 20,000 years of progress should today's rate of progress remain constant. In recent years, movies and televisions shows have served as precursors to real-life technological developments. For instance, take the 2002 science fiction film the *Minority Report* by Steven Spielberg (2002). Tom Cruise plays a member of a specialized police department that arrests criminals based on foreknowledge. In one scene, Tom Cruise stands in front of a transparent glass screen, and uses hand movements to bring up information. Then with a virtual interface he interacts with objects in three dimensions. Four years later, Microsoft developed TouchLight technology to mimic similar capabilities as seen in this movie. TouchLight may permit team members to one day manipulate data and concepts simultaneously allowing for optimization of new product development procedures. Pay attention to movies as they do provide glimpses of the future.

In the movie *IronMan* by Jon Favreau (2008), Robert Downey Jr. utilizes holographic interface technology to prototype armor for his superhero character. Although this technology has not been developed yet, Cisco Systems has developed Telepresence (a live, face-to-face communication experience over the network). In concert with another company called Musion, they coherently integrated three-dimensional holographic display technology to create the first real-time virtual presentation. This system may one day allow team members in various locations around the world to remotely run iterative, seemingly real, and real-time creative and design thinking process meetings.

8. CONCLUSIONS

Creativity is a complex and multifaceted phenomenon. Given space restrictions this review of the field of creativity was limited to a brief excursion into some of the methods useful in encouraging creativity in a deliberate manner. There are many variables that impact the generation and realization of creative thought. We did not, for example, explore characteristics of the individual nor environment that facilitate or inhibit creative output. Creativity is at the essence of what it means to be human; we all have the capacity to apply our imagination in a manner that brings new ideas into existence. The methods presented here, and others, can do much to render what is too often considered a mysterious and random process, more predictable and deliberate. Given the fact that creative thinking and problem solving are essential life skills, it would be wise for schools to teach creative processes and principles and for organizations to adopt such methods. All of society would be the beneficiary of improved creative thinking skills.

REFERENCES

Akay, D., Demiray, A., & Kurt, M. (2008). Collaborative tool for solving human factors problems in the manufacturing environment: the theory of inventive problem solving technique (TRIZ) method. *International Journal of Production Research*, *46*, 2913–2925.

Altshuller, G. (2001). *And Suddenly the Inventor Appeared: TRIZ, the Theory of Inventive Problem Solving* (Shulyak, L., Trans.). Worcester, MA: Technical Innovation Center.

Beckman, S.L., & Barry, M. (2007). Innovation as a learning process: embedding design thinking. *California Review Management*, *50(1)*, 25–56.

Bharadwaj, S., & Menon, A. (2000). Making innovation happen in organizations: individual mechanisms, organizational creativity mechanisms or both? *Journal of Product Innovation Management*, *17*, 424–434

Bilton, C. (2007). *Management and Creativity: From Creative Industries to Creative Management*. Malden, MA: Blackwell.

Birdi, K.S. (2004). No idea? Evaluating the effectiveness of creativity training. *Journal of European Industrial Training*, *29*, 102–111.

Blau, J.R., & McKinley, W. (1979). Ideas, complexity, and innovation. *Administrative Science Quarterly*, *24*, 200–219.

Brown, T. (2008). Design thinking. *Harvard Business Review*, *86(6)*, 84–92.

Buxton, B. (2007). *Sketching User Experiences. Getting the Design Right and the Right Design*. San Francisco, CA: Morgan Kaufmann.

Carnevale, A.P., Garner, L.J., & Meltzer, A.S. (1990). *Workplace Basics: The Essential Skills Employees Want*. San Francisco, CA: Josey–Bass.

Chang, W.T., Tseng, C.H., & Wu, L.L. (2008). Conceptual innovation of a prosthetic hand using TRIZ. *Journal of the Chinese Society of Mechanical Engineers*, *29*, 111–120.

Cross, N. (2007). *Designerly Ways of Knowing*. Basel: Birkhaüser Verlag AG.

de Bono, E. (1977). *Lateral Thinking*. Harmondsworth: Penguin Books.

de Bono, E. (1992). *Serious Creativity: Using the Power of Lateral Thinking to Create New Ideas*. New York: Harper Collins.

de Bono, E. (1999). *Six Thinking Hats*, rev. Boston: Little, Brown and Company.

Dingli, S. (2009). Thinking outside the box: Edward de Bono's lateral thinking. In *The Routledge Companion to Creativity* (Rickards, T., Runco, M.A., & Moger, S., Eds.), pp. 338–350. London: Routledge.

Dunne, D., & Martin, R. (2006). Design thinking and how it will change management education: an interview and discussion. *Academy of Management Learning and Education*, *5(4)*, 512–523.

Favreau, J. (Producer), Arad, A., & Feige, K. (Directors). (2008). *Ironman* [motion picture]. Hollywood, CA: Paramount Pictures.
Gassmann, O., & Zeschky, M. (2008). Opening up the solution space: the role of analogical thinking for breakthrough product innovation. *Creativity and Innovation Management*, *17(2)*, 97–106.
Gordon, W.J.J. (1961). *Synectics*. New York: Harper & Row.
Gordon, W.J.J. (1974). *Making It Strange*. Books 1–4. New York: Harper & Row.
Gordon, W.J.J., & Poze, T. (1972). *Strange and Familiar*. Cambridge, MA: SES Associates.
Gogatz, A., & Mondejar, R. (2005). *Business Creativity: Breaking the Invisible Barriers*. New York: Palgrave Macmillan.
Gurstelle, W. (2005). Call now—robots are standing by. *Wired 13.06*, 44.
Hof, R. (2006). My virtual life. *BusinessWeek May*, *1*, 72–82.
Isaksen, S.G., & Treffinger, D.J. (2004). Celebrating 50 years of reflective practice: versions of creative problem solving. *Journal of Creative Behavior*, *38*, 75–101.
Janzen, F. (2000). *The Age of Innovation*. London: Prentice Hall.
Jay, R. (2000). *The Ultimate Book of Business Creativity: 50 Great Thinking Tools to Transform Your Business*. Oxford: Capstone Publishing.
Kelley, T. (with Littman, J.) (2001). *The Art of Innovation*. New York: Currency Books.
Kelley, T. (with Littman, J.) (2005). *The Ten Faces of Innovation. Ideo's Strategies for Beating the Devil's Advocate & Driving Creativity Throughout the Organization*. New York: Doubleday.
Kirkpatrick, D. (2007). It's not a game. *Fortune February*, *5*, 56–62.
Kurzweil, R. (2005). *The Singularity Is Near: When Humans Transcend Biology*. New York: Penguin Group.
Lafley, A.G., & Charan, R. (2008). *The Game-Changer. How You Can Drive Revenue and Profit Growth with Innovation*. New York: Crown Publishing Group.
León-Rovira, N., Heredia-Escorza, Y., & Lozano-Del Río, L. (2008). Systematic creativity, challenge-based instruction and active learning: a study of its impact on freshman engineering students. *International Journal of Engineering Education*, *24*, 1051–1061.
Mann, D. (2001). An introduction to TRIZ: the theory of inventive problem solving. *Creativity and Innovation Management*, *10(2)*, 123–125.
Martin, R. (2007). *The Opposable Mind: How Successful Leaders Win Through Integrative Thinking*. Boston: Harvard Business School Press.
Mauzy, J., & Harriman, R. (2003). *Creativity Inc.: Building an Innovative Organization*. Boston: Harvard Business School Press.
McKin, R.H. (1972). *Experiences in Visual Thinking*. Monterey, CA: Cole Publishing Company.
Moehrle, M.G. (2005). What is TRIZ? *Creativity and Innovation Management*, *14(1)* 3–13.
Molen, G.R., Curtis, B., Parkes, W.F., de Bont, J. (Producers), & Spielberg, S. (Director). (2002). *Minority Report* [motion picture]. Central City, CA: 20th Century Fox.
Nolan, V. (2003). Whatever happened to Synectics? *Creativity and Innovation Management*, *12*, 24–27
Osborn, A.F. (1953). *Applied Imagination: Principles and Procedures of Creative Problem-Solving*. New York: Scribner's Sons.
Partnership for 21st Century Skills. (2008). *21st Century Skills, Education & Competitiveness: A Resource and Policy Guide*. Tuscon, AZ: Partnership for 21st Century Skills.
Patnaik, D. (2009). *Wired to Care*. Upper Saddle River, NJ: FT Press.
Prince, G.M. (2002). *Your Life Is a Series of Meetings . . . Get Good at Life*. Weston, MA: 1st Books Library.
Puccio, G.J., & Cabra, J.F. (2009). Creative problem solving: past, present, and future. In *The Routledge Companion to Creativity* (Rickards, T., Runco, H.A., & Moger, S., Eds.), pp. 327–337. London: Routledge.
Puccio, G.J., & Murdock, M.C. (2001). Creative thinking: an essential life skill. In *Developing Minds: A Source Book for Teaching Thinking* (Costa, A., Ed.), pp. 67–71. Alexandria, VA: ASCD.
Puccio, G.J., Murdock, M.C., & Mance, M. (2005). Current developments in Creative Problem Solving for organizations. *The Korean Journal of Thinking & Problem Solving*, *15*, 43–76.
Puccio, G.J., Murdock, M.C., & Mance, M. (2007). *Creative Leadership: Skills That Drive Change*. Thousand Oaks, CA: Sage.
Rickards, T. (1996). The management of innovation: recasting the role of creativity. *European Journal of Work and Organizational Psychology*, *5*, 13–27.
Rickards, T. (2003). Synectics: reflections of a little-s practitioner. *Creativity and Innovation Management*, *12*, 28–31.
Rodriguez, D., & Jacoby, R. (2007). Embracing risk to grow, learn and innovate. *Rotman Magazine Spring*, 55–58.
Rose, L.H., & Lin, H.-T. (1984). A meta-analysis of long-term creativity training programs. *Journal of Creative Behavior*, *18(1)*, 11–22.
Schrage, M. (2006). Here comes hyperinnovation. *Strategy + Business First Quarter*. Accessed February, 15 2007, at http://www.strategy-business.com/press/10900?pg=0
Scott, G., Leritz, L.E., & Mumford, M. (2004). The effectiveness of creativity training: a quantitative review. *Creativity Research Journal*, *16(4)*, 361–388.
Secretary's Commission on Achieving Necessary Skills. (1991). *What Work Requires of Schools: A SCANS Report for America 2000*. Washington, DC: US Department of Labor.
Soo, C., Devinney, T., Midgley, D., & Deering, A. (2002). Knowledge management: philosophy, processes, and pitfalls. *California Management Review*, *44*, 129–150.
Su, C.T., & Lin, C.S. (2008). A case study on the application of fuzzy QFD in TRIZ for service quality improvement. *Quality & Quantity*, *42*, 563–578.
Tischler, L. (2009, January 14). Ideo's David Kelley on "Design Thinking." Fast Company.com. Accessed June 5, 2009, at http://www.fastcompany.com/magazine/132/a-designer-takes-on-his-biggest-challenge-ever.html
Torrance, E.P. (1974). *Torrance Tests of Creative Thinking: Norms and Technical Manual*. Bensenville, IL: Scholastic Testing Services.
Uribe, D.L., & Cabra, J.F. (in press). A virtual facility to encourage creative behavior among members of a fortune 100 company. *Creativity and Innovation Management*.
Vincent, J.F.V., Bogatyreva, O., Pahl, A.-K, Bogatyrev, N., & Bowyer, A. (2005). Putting biology into TRIZ: a database of biological effects. *Creativity and Innovation Management*, *14(1)*, 66–72.
Walczak, D. (2002, September). Encompassing education. In *Department of Commerce Technology Administration's Visions 2020: transforming education and training through advanced technologies*. Accessed February 15, 2007, at http://www.technology.gov/reports/techpolicy/2020visions.pdf
Zhang, J., Chair, K.-H., & Tan, K.-C. (2005). Applying TRIZ to service conceptual design: an exploratory study. *Creativity and Innovation Management*, *14(1)*, 34–42.

Gerald J. Puccio is Department Chair and Professor at the International Center for Studies in Creativity, Buffalo State. He holds a PhD in organizational psychology from the University of Manchester, England. Gerard has worked with major corporations, universities, and numerous school districts, including Fisher–Price, Sun Life Insurance, Blue Cross and Blue Shield, Kraft Foods, Synovate (Market Research Firm), New Jersey Institute of Technology, Rochester Institute of Technology, and the Fashion Institute of Technology. Dr. Puccio has delivered creativity workshops and presentations around the world and has written more than 40 articles, chapters, and books. His most recent book, coauthored with Mary Murdock and Marie Mance, is titled *Creative Leadership: Skills That Drive Change*. In recognition of his outstanding work as a scholar, Gerard received the State University of New York Chancellor's Recognition Award for Research Excellence and the President's Medal for Scholarship and Creativity.

John F. Cabra is an Assistant Professor at the International Center for Studies in Creativity, Buffalo State. He holds a PhD in organizational psychology from the University of Manchester, England, and an MS in creativity from Buffalo State, State University of New York. John was formerly the operations manager for American Airlines in Buffalo, NY. He also held internal consulting positions for American Airlines in

the fields of training and development, employee relations, and organizational development. Before joining American, John was a bilingual training and organizational development specialist for Fisher–Price in Mexico. As an external consultant, John designed and presented programs on leadership and creativity for organizations such as Motts in Mexico, United Airlines, Chilean Travel and Tourism Association, Boehringer Maanheim, Quaker Oats, University of Rochester, Hyatt Aruba, Transitions Optical, and El Dorado Bogotá International Airport Authority. Dr. Cabra has presented his work in 22 countries and has published several articles in Latin American business journals. John's research interests are organizational creativity and perceptions of creativity across cultures.

J. Michael Fox is a Lecturer and the Undergraduate Program Coordinator at the International Center for Studies in Creativity, Buffalo State. He holds a Bachelor's degree in landscape architecture from the University of Minnesota and an MS in creative studies from Buffalo State College. John designs and delivers workshops on creativity and innovation for the public and private sectors as well as for inventors, designers, and educators. He has worked with a variety of companies and organizations including the American Society of Landscape Architects, IBM, Fisher–Price, Proctor & Gamble, and colleges and universities across the country. His textbook, *Exploring the Nature of Creativity*, examines the multifaceted nature of creativity and how to nurture. Mike's diverse background includes experience as a corporate executive, landscape architect, prairie restoration consultant, author, and airline pilot.

Helene Cahen is an experienced innovation consultant, facilitator, and trainer for Strategic Insights. She received an MS in creativity and change leadership from Buffalo State College in 2008. Helene has held executive and management positions in advertising, marketing research, human resources, finance, and sales. As an independent consultant for the past 9 years, Ms. Cahen has received multiple accolades for her valuable assistance to small businesses and nonprofits. She has more than 20 years of insight and practical knowledge in the areas of facilitation, market research, communications, and new product development. Her international experience ranges from managing multimillion dollar marketing research budgets for The Clorox Company to directing agency advertising campaigns for packaged goods companies such as Unilever, Nestle, and Kraft Foods.