GERALD F. SMITH

Idea-Generation Techniques: A Formulary of Active Ingredients

ABSTRACT The profusion of creativity techniques that have been proposed and used is based on a much smaller set of active ingredients, devices that promote idea generation. This paper reports the results of a study that identified these active ingredients through an analysis of 172 idea-generation methods. Fifty idea-generation devices of three types — strategies, tactics, and enablers — were identified and organized in a formulary. Research results facilitate the evaluation of idea-generation methods and the selection of methods suited to particular idea-generation tasks.

INTRODUCTION

Creativity, a notoriously elusive concept, is concerned with the generation of ideas, alternatives, and possibilities (Mumford & Gustafson, 1988). The creative process can be viewed as encompassing front-end preparation and back-end evaluation, but idea generation per se is the process's indispensable core. Among psychologists and other students of creativity (de Bono, 1992; Finke, Ward, & Smith, 1992; Perkins, 1981), the most common view is that creativity is not a unitary process. People have many ways of generating ideas. The diversity of means for generating ideas is paralleled by a diversity of idea-generation techniques. There are literally hundreds, ranging from informal pieces of advice to tightly-structured procedures.

Idea-generation techniques are analogous to medications. Analgesics, a typical group of medications, are used to relieve pain. The group includes various products, prescriptive and non-prescriptive, branded and not, based on a small number of active ingredients (e.g., ibuprofen). Thus, the surface variety of pain-relieving products overlays a more fundamental set

of active ingredients. These drive decisions about which product to use in particular circumstances. Similarly, beneath the diversity of idea-generation techniques lies a substrate of active ingredients, devices used to promote creativity.

This paper reports the results of a study of active ingredients in idea-generation methods. The study identified means by which creativity techniques promote idea generation. These devices were organized into meaningful categories, comprising a formulary of active ingredients. The formulary offers benefits to creativity research. It can also help practitioners select appropriate methods for idea-generation tasks.

The paper begins by developing conceptual background pertaining to idea-generation techniques. It describes and illustrates the research method used to identify active ingredients in these techniques. The paper's largest section discusses the formulary, describing each of fifty identified devices. In concluding, the paper considers the implications of these findings and suggests future lines of development.

CONCEPTUAL BACKGROUND

Applied scientific research is based on the premise that understanding a phenomenon is a prerequisite for improving related practices. Research on creativity has been motivated by the assumption "that the creative process in human beings can be concretely described and, further, that sound description should be usable in teaching methodology to increase the creative output of both individuals and groups" (Gordon, 1961). Notwithstanding the value of research on the creative process, we are far from having a deep, comprehensive understanding of creativity. The remoteness of the process — its frequent reliance on unconscious mental activities — and its heterogeneity — the variety of means by which ideas are generated — create significant research challenges.

Idea-generation Techniques

The huge armamentarium of idea-generation techniques is a useful, if underused, resource for addressing these challenges. Each technique reflects beliefs about the creative process. Such beliefs can be derived from personal experience, popular assumptions, or scientific research. They can be valid or invalid, though the widespread use of creativity techniques suggests that many are effective, indicating that their underlying assumptions are sound. Descriptive creativity research has addressed issues spawned by prescriptive techniques. The incubation phenomenon noted by Wallas (1926) was incorporated into several methods before becoming the object of scientific study (Smith, 1995). An analysis of idea-generation techniques can

reveal practice-oriented beliefs about the creative process that researchers should assess.

Indeed, creativity techniques constitute a significant empirical phenomenon that merits study in its own right. Many books and articles propose techniques, extolling their virtues to potential users. A smaller set of papers, published in academic journals, assesses whether methods enhance idea-generation performance. Research findings are often inconclusive (Basadur, Graen, & Green, 1982). Few studies include careful analyses of methods or of the tasks to which they are applied. Idea-generation techniques are an important, but inadequately understood, part of the creativity puzzle.

A first step towards improved understanding is to decide what is to count as an idea-generation method or technique. A technique is a prescription. They range from highly structured procedures to informal pieces of advice. Additional requirements are that the prescription be plausibly effective and that it reach beyond common knowledge, what everyone already knows. A method asking users to "think long, hard, and about many things" should be viewed with skepticism, unless it provides means of promoting those behaviors. Generic enablers pertaining to any mental task — use a diverse group of well-rested people — should not be regarded as idea-generation techniques since they are not specifically intended for that purpose.

Active Ingredients

This definition of a technique — a plausibly effective prescription expressing more than common knowledge — implies that every idea-generation method includes one or more active ingredients. A technique can include steps serving administrative purposes and have features that make it user-friendly and provide market appeal. But to be plausibly effective, it must encompass at least one operation that promotes idea generation.

Idea-generation techniques should be studied via their active ingredients. These are the "operational mechanisms" (Prince, 1967) that prompt idea generation. Even when occurring within groups, creativity is essentially a mental phenomenon. A technique must prompt certain cognitive activities in users. It does so through active ingredients, devices producing desired mental changes. Active ingredients may be instructions users can mentally discharge (e.g., fantasize), stimuli they can respond to (e.g., visual displays), or conditions fostering idea generation (e.g., anonymity).

The technique-aided creative process encompasses four levels:

1. Techniques, idea-generation methods that have been proposed and applied.
2. Active ingredients, prescribed operations by which techniques affect user thinking.
3. Cognitive processes, mental states and activities involved in creative thinking, studied by psychologists.
4. Brain processes, neurological states and activities that underly creative cognition, studied by neuroscientists.

The brain process level, highly technical and poorly understood, is remote from practical idea-generation concern. The other three levels have immediate relevance to the enhancement of creativity. Interfaced between techniques and cognitive processes, the active ingredient level is especially significant. To understand how a technique works, its active ingredients and their connections to cognitive processes must be identified. To design a technique, active ingredients that exploit human mental capacities must be devised.

Classifying Idea-generation Techniques

In view of the large number of idea-generation techniques, it is important to characterize and classify them. Several attempts to this end have been made. VanGundy (1988) discussed 105 techniques for structured problem solving, classifying them by stages of the problem solving process. The 61 idea-generation methods were subdivided into group and individual techniques, a distinction, he admitted, that is not always crisp. VanGundy characterized these methods along several dimensions: whether idea generation is verbal or silent; whether ideas are produced by forced relationships or free association; and whether the technique employs stimuli that are related or unrelated to the problem.

Another classification framework was proposed by MacCrimmon and Wagner (1994). Viewing idea generation as a matter of making connections between ideas, these authors distinguished internal connections involving elements of a focal problem from external connections between the problem and outside factors. Further distinctions split internal connections involving problem form and function from connections involving elements of purpose. External connections can be local or distant, depending on how far a technique reaches in search of ideas.

Withholding judgment on these classification schemes, it is argued that the best way of characterizing idea-generation methods is in terms of active ingredients. There are, presum-

ably, a manageable number of these and they are, by definition, the source of a method's power. Indeed, research and practitioner attention should be focused on active ingredients, rather than on methods themselves. Recalling the analogy between idea-generation techniques and medications, just as scientists at the Food and Drug Administration ignore commercial products in favor of the active ingredients they contain, so idea-generation research should attend to the underlying devices that make techniques effective. Techniques should be characterized and classified in terms of the devices they employ.

METHOD

One-hundred-and-seventy-two idea-generation methods reported in the creativity literature were identified during two waves of search activity. The first wave identified 130 methods through a review of the author's personal library of books and papers, a search of all past issues of the *Journal of Creative Behavior*, and examination of creativity books in a university library. The second wave uncovered an additional 42 techniques by searching more carefully through practitioner-oriented books with idea-generation content. Several books (e.g., Higgins, 1994; VanGundy, 1988) were compilations of techniques published in various literatures.

All 172 methods satisfied the broad definition of "technique" — a plausibly effective prescription expressing more than common knowledge — proposed earlier. Techniques range from simple questions like the "What if . . ." method (Higgins, 1994) — Ask yourself, if something happened, what would the consequences be? — to elaborate methodologies like Synectics. Several were minor variations of each other, though differently named. Some were applicable to other parts of the problem solving process, but all could be used to generate ideas. Though there are more than 172 idea-generation methods, the techniques used for this study constitute a large and presumably representative subset of the population.

Identifying Active Ingredients

The task of identifying active ingredients in these methods is an instance of the conceptualization task in science: How does one derive scientific concepts from empirical data? The methodology used in this study is an adaptation of that proposed by Glaser and Strauss (1967; Strauss, 1987). Active ingredients were identified through an iterative, data-driven process. Data analysis was a "boot-strapping" effort that simultaneously identified idea-generation devices and assessed whether a given technique employed them.

Each technique was analyzed to determine how it actually works or is intended to work. The guiding analytical question was: By what means might this method promote idea generation? The analysis took into account rationales proposed by a method's proponents. It considered findings from cognitive and social psychology, as well as folk psychological assumptions about human thinking and group processes. In each case, the analysis identified one or more operational mechanisms deemed responsible for a method's functioning.

The researcher made three passes through the initial set of 130 idea-generation techniques. Each time, I assessed how each technique functions, identifying pertinent active ingredients. These devices were subsequently evaluated: Some were deleted, others were consolidated, and new ingredients were created by splitting devices into parts. The revised set of active ingredients was used to direct the next analysis of techniques. The set was altered again as a result of that pass. Since no revisions were prompted by a third iteration, the designated set of active ingredients was deemed adequate for these data. It was organized into a formulary consisting of categories of ingredients, reflecting distinct idea-generation strategies. This formulary was used to analyze the 42 techniques that were subsequently identified. One additional idea-generation device was discovered through this analysis.

Some active ingredients are more likely to be effective than others, but each has been regarded, if only by a method's originator, as an aid to creativity. Active ingredients pursue different strategies; they also vary in scope and style. Though it was usually easy to say how a method was supposed to function, judgment calls had to be made. Some methods rely implicitly on certain prescriptive operations. With devices that often cooccur in techniques, it was necessary to decide if there is a single complex ingredient or several simple ones. Active ingredients shade into general means for enhancing mental performance — use intelligent people — and into logistical mechanisms — use slips of paper to record thoughts. Judgment was used to make distinctions in this regard.

Example Analysis

To illustrate what was done, consider the following analysis of a method described by Grossman and Wiseman (1993). The method has three steps:

1. Divide a sheet of paper into two columns. On the top of the left side, place or identify the object from which ideas need to be pulled. On the top of the right side, state the problem for which ideas are needed.

2. Ignoring the column on the right, list all the characteristics of the object on the left that you can think of. Try to list characteristics that are specific to or unique about that object.
3. For each descriptive item on the left, ask participants to find at least one idea pertaining to their problem. Write these in the right-side column, opposite the generating item. Write any ideas coming to mind in this way, rather than looking for direct solution relevance.

Analysis of this method reveals a number of active ingredients. The method's first step employs *remote stimuli*; an object unrelated to the problem is used to generate ideas. The method also uses *concrete stimuli* when the stimulus object is physically present for idea generation. *Decomposition* is the key device in Step 2, the stimulus being analyzed into parts and attributes. Step 3 is driven by *relationship search*, trying to connect left-side entries to the problem situation. It may employ a *force fit* device, depending on how strictly one is required to find a problem-side counterpart for each stimulus-side entry. *Association* is implicitly invoked by the suggestion to accept any ideas that come to mind, regardless of their solution relevance. Thus, this technique can employ as many as six active ingredients for idea generation, each potentially contributing to the method's effectiveness.

Validation of Results

Arguably, an effective procedure for identifying active ingredients in idea-generation techniques cannot be precisely defined. In lieu of prescribing such, the research focused on process outputs: candidate devices. To be accepted as an active ingredient for purposes of this study, a candidate had to satisfy several conditions. First, it had to be a plausibly effective idea-generation device, such that creativity techniques could be constructed around it. Ideally, each device could be supported by psychological research. Second, a device had to be clearly evidenced in at least one idea-generation method. Finally, independent assessors had to be able to reliably record the occurrence of active ingredients in idea-generation techniques.

In response to the final criterion, descriptions of the 50 idea-generation devices were incorporated in a coding manual that specified procedures for analyzing idea-generation methods. A set of 26 techniques, selected by systematic random sampling, was used to assess coding reliability. Two raters — the author and a research assistant — used the manual to inde-

pendently code the techniques. Each coder identified 42 devices, three more being identified by one of the two raters. Coders agreed on 35 of the 42 assignments, an agreement rate of 83.3%. If the extra/omitted codes are included in the base, the agreement rate is 77.8% (35/45). This level of coding reliability seems acceptable for current purposes. Disagreements, most resulting from judgment calls, were used to sharpen definitions of active ingredients.

In order to gauge the formulary's completeness, the 172 idea-generation techniques were reviewed to determine when each active ingredient was first observed. Thirty-two (64%) of the 50 devices appeared in the first 30 techniques that were analyzed; only four new ingredients (8%) were discovered in the last 82 methods; and none were found in the last 32. Though the identified set of active ingredients is certainly not exhaustive, there is reason to believe that it is substantially complete.

RESULTS

The results of this study are reported in Table 1, which lists fifty idea-generation devices, along with a brief description of each. The active ingredients have been organized into fifteen categories, identified in the table's left-hand column. Three types of active ingredients were differentiated: *Strategies*, the most numerous and significant type, are active means for generating ideas. Most refer to identifiable mental activities. *Tactics* are the least common type, comprising a single category of devices. They are stimulatory tools that support strategies. *Enablers* are passive means of promoting idea generation. Rather than directly inspiring creative output, enablers foster conditions within which ideas are more likely to appear.

In the device column, next to the device name, Table 1 reports the frequency with which each was observed in the 172 techniques analyzed during this study. These counts suggest the popularity of idea-generation mechanisms with designers of creativity methods. They do not indicate the overall importance of a device in creative thinking. Some devices, Past Experience for instance, are natural parts of our thinking and are often used implicitly, without being expressly invoked by a technique.

The right-hand column of Table 1 reports a representative technique for each device, and a source describing the technique. The remainder of this section discusses each active ingredient, grouped by category.

TABLE 1. A formulary of active ingredients in idea generation techniques.

Category	Device	Description	Technique
Analytical Strategies	Decomposition (32)	Reduce wholes into parts and attributes, ends into means, etc.	Morphological Analysis (Allen, 1962)
	Abstraction (10)	Conceive the problem in more general terms.	Functional Visualization (Taylor, 1969)
	Translation (1)	Conceptually convert one kind of thing into another.	Input-Output (Whiting, 1958)
Search Strategies	Association (11)	Mentally follow associative links among ideas in memory.	Focused-Object (Whiting, 1958)
	Past Experience (2)	Recall past experiences relevant to the current problem.	Transfer Analysis (Sands, 1979)
	Analogy (10)	Look for things similar to parts of the problem situation.	Bionics (Souder & Ziegler, 1977)
Imagination-Based Strategies	Fantasy (10)	Conceive of states in which reality constraints have been dropped.	Idealization (Keller & Ho, 1988)
	Mental Simulation (14)	Mentally enact images or dynamic scenarios.	Moment to Moment (de Bono, 1992)
	Identification (2)	Imaginatively become a non-human part of the problem.	Personal Analogies (Higgins, 1994)
Habit-Breaking Strategies	Challenge Assumptions (3)	Question beliefs associated with the problem.	Escape (de Bono, 1985)
	Negation (6)	Adopt counter-assumptions for problem-relevant beliefs.	Look for Opposites (Thompson, 1992)
	Change of Perspective (6)	Think about the problem from the viewpoints of different agents.	Napoleon (Higgins, 1994)
	Change of Attitude (4)	Adopt different attitudes towards the situation.	Fresh Eye (VanGundy, 1988)

TABLE 1. A formulary of active ingredients in idea generation techniques. *(Continued)*

Category	Device	Description	Technique
Relationship-Seeking Strategies	Relationship Search (21)	Look for relationships between two or more things.	Stimulus Analysis (VanGundy, 1988)
	Structure (7)	Organize information to reveal relationships.	Affinity Diagrams (Brassard, 1989)
Task-Focused Strategies	Goal Focus (3)	Decompose problem goals into sub-goals, seeking options for each.	Value-Focused Thinking (Keeney, 1994)
	Boundary Stretching (3)	Explore extreme values of variables in the situation.	Exaggeration (de Bono, 1992)
	Synonyms (1)	Generate and explore synonyms for words in the problem statement.	Two-Words Technique (VanGundy, 1987)
	Combination (16)	Combine elements, attributes, and other aspects of the problem.	Circumrelation (Laverty, 1974)
	Rearrangement (11)	Change the structure of a situation by rearranging its parts.	Relational Algorithms (Crovitz, 1970)
	Context Inclusion (1)	Think about the environment within which the problem exists.	Listing (Whiting, 1958)
Development Strategies	Enhancement (8)	Modify ideas to make them more feasible and effective.	Method 6-3-5 (Warfield et al, 1975)
	Compare and Contrast (3)	Compare ideas with the status quo to find points of advantage.	Camelot (Higgins, 1994)
	Integration (7)	Combine alternatives into problem solutions.	SIL Method (Warfield et al, 1975)
	Bootstrapping (10)	Analyze alternatives to generate new families of possibilities.	Idea Transformations (MacCrimmon & Wagner, 1994)
	Circumstances (2)	Think of circumstances in which an idea might be effective.	Under What Circumstances (de Bono, 1992)

TABLE 1. A formulary of active ingredients in idea generation techniques. *(Continued)*

Category	Device	Description	Technique
Interpersonal Strategies	Group Interaction (28)	Verbalize thoughts in a group so one person's ideas prompt others.	Brainstorming (Osborn, 1963)
	Nominal Group (11)	Generate and share ideas silently within a group.	Brainwriting Pool (Warfield et al, 1975)
	Dialectic (1)	Conduct a debate between opposing sides on an issue.	Lion's Den (Higgins, 1994)
Special Resource Strategies	Checklists (19)	Use an established set of ideation prompts to generate alternatives.	Manipulative Verbs (Koberg & Bagnall, 1974)
	Outside Sources (6)	Solicit ideas from outsiders and established idea sources.	Tell Me Stranger (Koberg & Bagnall, 1974)
Stimulation Tactics	Personal Experience (2)	Involve the problem solver experientially in the situation.	Experience Kit (Higgins, 1994)
	Elaboration (1)	Enrich the problem situation to provide idea generation material.	Storywriting (VanGundy, 1988)
	Changing Environment (5)	Mentally or physically leave one's normal thinking environment.	Get Out of Town (Koberg & Bagnall, 1974)
	Display (11)	Make ideas visible in a graphic array.	Mindmapping (Buzan, 1983)
	Concrete Stimuli (13)	Use physical things or pictures in idea generation sessions.	Idea Triggers (Higgins, 1994)
	Related Stimuli (8)	Provide stimuli that are connected to the problem solving task.	Semantic Intuition (VanGundy, 1988)
	Remote Stimuli (23)	Provide stimuli that are unrelated to the problem solving task.	Nonlogical Stimuli (Rickards, 1974)

TABLE 1. A formulary of active ingredients in idea generation techniques. *(Continued)*

Category	Device	Description	Technique
Mental Readiness Enablers	Provocation (2)	Draw attention to the problem or task.	Provocation (de Bono, 1992)
	Block Removal (5)	Remove mental barriers that inhibit idea generation.	Creative Whack Pack (von Oech, 1992)
Motivational Enablers	Goal Setting (3)	Set quotas for ideas or establish time deadlines.	Lotus Blossom (Tatsuno, 1990)
	Competition (3)	Arrange idea generation contests between groups or individuals.	Force-Fit Game (Warfield et al, 1975)
	Personal Involvement	Foster personal feelings of affiliation with the organization.	Systematized Direct Induction (Bosticco, 1971)
Extra Effort Enablers	Mass Production (1)	Try to generate lots of ideas.	Crawford Slip Method (Clark, 1978)
	Force Fit (8)	Force unrelated ideas together to achieve breakthroughs.	Catalog (Taylor, 1961)
Anti-Rutting Enablers	Incubation (4)	Set the problem aside for awhile to escape mental ruts.	Idea Tracking (Armstrong, 1960)
	Non-Disclosure (2)	Do not state the problem at the outset of sessions.	Gordon-Little (Taylor, 1961)
	Suppressed Alternatives (1)	Keep obvious ideas out of mind.	Synectics (Prince, 1967)
Anti-Inhibition Enablers	Deferred Evaluation (9)	Withhold evaluation of ideas so as not to inhibit generation.	Trigger Method (VanGundy, 1988)
	Anonymity (3)	Insure that ideas can't be traced to their originators.	Collective Notebook (Haefele, 1962)

Analytical Strategies

More than any other category, analytical strategies demonstrate the value of convergent thinking for idea generation. These strategies provide a more fine-grained or fundamental appreciation of the problem, generating mental material that can be exploited by other devices. Analysis, thinking carefully about the problem, was viewed as an idea-generation strategy by Gestalt psychologists (Duncker, 1945; Wertheimer, 1982). More recently, Getzels and Csikszentmihalyi (1976) found that artists who did more critical analysis before and during their work were more successful in their careers. Finke's (1995) notion of "creative realism" suggests that established ideas can be analyzed as a way of transforming them into new possibilities.

The most frequently used of all strategies, at least in this study's sample of techniques, is *Decomposition*. Decompositional methods are reductive; they convert an undifferentiated stimulus into one rich in detail, offering cues for idea generation. Decompositions can be from wholes into parts and attributes, and from ends into means, among others. Morphological Analysis decomposes a problem into parameters and components, searching for combinations that have promising solution implications. *Abstraction* is an analytical device that asks one to think about the problem in more general terms. Situation-specific details are sloughed off to focus on underlying principles, hoping to connect the mind to other situations and solutions of relevance. Van Gundy (1988) cited a case in which group members were asked to think of ways to stack things, their ideas being considered as ways of parking cars. Functional Visualization, a design method, asks one to think about the functions of an artifact and how they might, in principle, be fulfilled. Less widely employed, *Translation* conceptually converts one class of things into another. Many design methods translate functions into structures and forms. The Input-Output technique was used to devise a fire alarm: Starting with a fire as input, the method identified a chain of resultant factors leading to an output alarm (Whiting, 1958).

Search Strategies

All idea-generation methods rely on retrieval of information from memory. Search strategies are especially dependent on this process, calling for directed retrieval efforts. Differentiations within this category reflect differences in how information is stored in memory. *Association* is a search strategy following associative links among items in a network-structured memory. The strategy assumes that links can reflect solution-relevant relationships. Studies have found moderate positive correlations between measures of associational

abilities and indices of creative achievement (Mumford & Gustafson, 1988). The Focused-Object method uses stimuli that are related to and remote from the problem as starting points for free association.

Past Experience is, arguably, the most widely-used idea-generation strategy: Faced with a problem, we generate solutions by recalling relevant past experiences. But experience has both positive and negative effects on idea generation, the latter when inadequate prior solutions prevent new ideas from being conceived (Stein, 1989). Owing perhaps to its everyday familiarity, this device is not used by many techniques. New products have been developed through Transfer Analysis, a method that derives ideas from an inventory of successful innovations. Techniques using *Analogy* rely on similarity-based searches of memory. Bionics asks users to think about how the problem is solved in nature. Analogy plays an important role in creative thought (Holyoak & Thagard, 1995), although Perkins (1983), citing experimental and archival data, argued that remote analogies rarely drive creative discoveries.

Imagination-Based Strategies

Imagination, our ability to conceive of possibilities, is virtually synonymous with creativity. The strategies in this category require significant acts of imagination: One must imagine unrealistic states, conceive detailed mental images, or run extended scenarios. People's abilities to do so have been demonstrated by psychological research, which has also demonstrated the creative value of these activities (Finke, Ward, & Smith, 1992).

Using the *Fantasy* strategy, a person conceives of states in which reality constraints have been dropped. Doing so promotes the restructuring of mental representations (Dominowski, 1995). Idealization, a version of this strategy, asks one to drop all constraints and envision a perfect solution. The *Mental Simulation* strategy uses imagination to enact dynamic scenarios. Compared to Fantasy, it is less focused on constraints and more concerned with predicting how alternatives would work if implemented. With the Moment to Moment technique, one visualizes, in detail, what would happen if an idea was put into action. The most radical imagination-based strategy, *Identification* requires people to imaginatively become a non-human part of the problem. This device, first employed in Synectics, relies on empathy to generate insights. By imagining that they were human hairs, people at Gillette were aided in the development of a new shampoo (Higgins, 1994).

Habit-Breaking Strategies

These strategies are based on the premise that the mind must break out of normal response patterns to think creatively. Past experience and the current problem solving context engender a mental set or fixedness. Researchers have found that context-induced set must be overcome for creative insights to occur (Schooler & Melcher, 1995). Habit-breaking strategies prod us out of mental ruts. *Challenge Assumptions* questions beliefs associated with a task. The strategy can be difficult to operationalize, since implicit assumptions rarely leap into consciousness when called. With the Escape method, one identifies, and consciously tries to escape from, the main track of thought. A more radical strategy, *Negation* adopts counter-assumptions: Assume the opposite of what you currently believe. Negation provides more direction for idea generation and can result in dramatic breakthroughs if a counter-assumption has useful implications.

A relative of the Identification strategy discussed earlier, *Change of Perspective* asks one to think about the problem from the viewpoints of different agents who may or may not be part of the situation. Empathic identification helps one recognize interests of other stakeholders, promoting idea generation. Or, as with the Napoleon technique, adopting a viewpoint associated with a famous person or different vocation can help one escape habitual modes of thought. *Change of Attitude* assumes that feelings influence thought, a view having some empirical support (e.g., Isen & Nowicki, 1980). People are instructed to adopt different attitudes towards the situation. The Fresh Eye method asks one to think of something positive about the problem, and to develop solution possibilities from this.

Relationship-Seeking Strategies

Studies have shown that when individuals combine two or more concepts, new properties can emerge (Hampton, 1997). These findings support theories of creativity (e.g., Findlay & Lumsden, 1988; Koestler, 1964) that focus on mental events in which things, normally not associated with each other, are related or combined. The findings also sustain several idea-generation strategies, *Relationship Seeking* being the most typical. One consciously looks for relationships between two or more things, one of which is part of the problem. The Stimulus Analysis technique has people generate a list of concrete terms, unrelated to the problem; select a term, decomposing it into characteristics; and relate each characteristic to the problem in hopes of finding solution ideas. Relationship-seeking strategies could be constructed around particular types of

relationships. For instance, Analogy can be thought of as search driven by the relationship of similarity. *Structure*, the other strategy in this category, employs a special mechanism for finding relationships. Information is organized to reveal connections between elements of the problem. Affinity Diagrams promote idea generation by grouping ideas and information on the basis of "affinity" or relatedness.

Task-Focused Strategies

Similar to analytical strategies in their focus on the problem, these devices deal with parts of the situation, generating alternatives by thinking about those aspects. They are supported by studies which indicate, for instance, that more decision options are generated when people consider problem attributes one-at-a-time (Keller & Ho, 1988). *Goal Focus* is a typical strategy. It decomposes problem goals into subgoals, generating alternatives that respond to each. Value-Focused Thinking applies this approach within a decision making framework.

With *Boundary Stretching*, one explores extreme values of variables in the situation. Volkema (1983) found that subjects generated more solution alternatives when a problem's scope was increased via a "Problem-Purpose Expansion" heuristic. Designers consider extreme values of properties of existing artifacts when developing new design concepts. The Exaggeration method implements this strategy in a straightforward way. The *Synonyms* device, observed only in the Two-Words Technique, is distinctive: Generate synonyms for words used in the problem definition, exploring the implications of these. The strategy responds to a concern expressed by Koestler (1964): Words overly crystallize and constrain thought. Exploring synonyms can surface conceptual distinctions with idea-generation potential.

A popular strategy, *Combination* asks one to combine elements and attributes of the problem, usually by pairs, in search of ideas. It is exemplified by Circumrelation, which uses concentric disks to generate over 1500 combinations of factors for consideration. A less systematic variation of Combination, *Rearrangement* alters the structure of a situation by rearranging its parts. This strategy is often implemented with lists of relationships, as in Relational Algorithms, a technique using words like "across," "between" and "when" to suggest restructurings of a problematic system. De Bono (1970) described how a motorist couldn't get past a flock of sheep traveling down a country lane bounded by high banks. The shepherd refused to move the sheep to the side, fearing that some would be struck

as the car drove through. A rearrangement of fixed and moving elements solved the problem: The motorist stopped the car while the shepherd drove the sheep back around it.

A final target of attention is the problem's context. The *Context Inclusion* strategy asks one to think about the environment within which a problem exists. Doing so fosters awareness of unnoticed constraints and potential side-effects of solutions. The Listing technique can implement this strategy for new product development: Think of products, objects, or activities found in the target product's context, and consider how a new product might accomodate these.

Development Strategies

The dangers of mental set notwithstanding, existing solutions often contain the seeds of their successors. Finke (1995) expressed this with the term "structural connectedness." Development strategies use the status quo and ideas generated previously. These ideas are analyzed and manipulated to create better alternatives. The simplest of these devices is *Enhancement*, modifying an idea to make it more effective. With Method 6-3-5, each member of a six-person group writes down three ideas that are passed around, every member spending five minutes improving on ideas proposed by others.

Compare and Contrast, a more focused strategy, compares ideas with the status quo, disclosing points of advantage to incorporate in a solution. In Camelot, the status quo is compared with an ideal solution, indicating differences solutions should try to capture. A Compare and Contrast analysis might feed into *Integration*, a strategy of combining alternatives into solutions encompassing the virtues of many. The challenge is to devise coherent combinations. With the SIL Method, each member of a group successively proposes an idea that the group tries to integrate into its emerging solution. The more radical *Bootstrapping* device uses existing ideas as stimuli for generating new ones. Alternatives are analyzed and characterized in order to extend them and to discover unrecognized families of possibilities. The Idea Transformation technique uses a list of transformation terms to generate new ideas from old. More radical still is the *Circumstances* device. Rather than altering an idea to fit current circumstances, it looks for circumstances that fit the idea. Post-it™ notes originated with a 3M scientist trying to think of circumstances requiring a semi-sticky adhesive.

Interpersonal Strategies

The dominant active ingredient in most group methods, these devices rely on interpersonal interaction. People stimulate each other, one person's ideas and criticisms spurring

others to come up with better ideas. *Group Interaction* is the core strategy in this family: Group members verbalize thoughts so one person's ideas can spawn ideas in others. Brainstorming is the strategy's classic embodiment. It is the most widely studied idea-generation technique, though findings as to its effectiveness are not conclusive (VanGundy, 1988).

Nominal Group captures synergies of interpersonal interaction, while avoiding dysfunctional side-effects. Group members share ideas non-verbally to reduce distractions and inhibitions. Members of a Brainwriting Pool write down ideas, sharing them anonymously. Studies have shown that members of nominal groups produce more, though not always better, ideas than members of interacting groups (Stein, 1975). *Dialectic*, the third interpersonal strategy, uses conflict to generate ideas. A debate between opposing sides is conducted; this intellectual combat stimulates idea generation and criticism. The Lion's Den has one group propose solutions and another group criticize them. Mason (1969) presented the rationale for such an approach, and supportive evidence from a field study involving corporate planning.

Special Resource Strategies

Both strategies in this category use a specialized outside resource, enabling idea generation to reach beyond a person's normal mental repertoire. With *Checklists*, the resource is an established set of ideation prompts — words or other stimuli. These can be tailored to idea-generation tasks, like new product development; or they can be general, applicable to many problems. The Manipulative Verbs technique uses words like "multiply," "eliminate" and "squeeze" to suggest ways of transforming problem elements. Ideas can be gotten from *Outside Sources*, including individuals or publications that are acknowledged resources in a field. Alternatively, outsiders may have no special task expertise, as in Tell Me Stranger, which asks ordinary people for ideas concerning a problem. The presumption is that a man-in-the-street perspective can offer insights long since forgotten by experts.

Stimulation Tactics

Tactics work within a strategy, rather than being stand-alone idea-generation mechanisms. They serve a support function, providing mental stimulation that strategies direct to creative purposes. Seven Stimulation Tactics were identified. *Personal Experience* involves the problem solver experientially in the problem so he/she will have a richer understanding of it. Its use is suggested by theories of "situated cognition," which stress the influence of experiential context on thinking activities (Suchman, 1987). An Experience Kit immersed

detergent brand managers in the realities of home laundry operations (Higgins, 1994).

The *Elaboration* tactic employs a similar rationale, the problem solver being prompted to mentally enrich the problem situation to provide idea-generation material. Users of the Storywriting technique are asked to write a story about the problem, and then to analyze it for possible solutions. With the *Changing Environment* tactic, people leave their normal thinking environments, physically and/or mentally, to be exposed to different stimuli. The tactic derives support from arguments advanced on behalf of Habit-Breaking Strategies, discussed earlier. The Get Out of Town technique prompts one to mentally take the problem to another place, exploring it for new ideas. It is probably more effective to "get out of town" physically as well.

Other tactics exploit the attention-grabbing power of concrete and vivid information (Nisbett & Ross, 1980). Methods implementing the *Display* tactic make ideas visible in a graphic array. Presumably, when visually depicted, ideas are more able to inspire new ones. Mindmapping was among the first methods to construct informal diagrams representing one's ideas on a topic. The perceptual capacities exploited by Display favor use of *Concrete Stimuli*. With this tactic, physical things or pictures are employed in idea-generation sessions. The Idea Triggers technique provides group members with tangible probes, related to the problem, that they work with during idea generation.

This technique also suggests the *Related Stimuli* tactic, providing stimuli that are connected to the task. Related stimuli are more likely to prompt generation of task-relevant ideas, which are more likely to solve the problem. Semantic Intuition uses brainstorming to generate words related to the problem. These are combined in hopes of discovering interesting ideas. The opposite argument is made on behalf of *Remote Stimuli*: Use prompts unrelated to the problem to remove the mind from normal patterns so innovative ideas are generated. The tactic's proponents — VanGundy (1988), for instance — contend that stimuli unrelated to the problem are best able to inspire rare insights that are truly creative. Though this rationale is consistent with some theories of creativity (e.g., Koestler, 1964), it has not been tested empirically. The Nonlogical Stimuli technique asks users to expose themselves to experiences unrelated to the problem and to examine these for solutions.

Mental Readiness Enablers

Enablers are devices that facilitate, but do not directly provoke, idea generation. Unlike tactics, they are stand-alone devices that don't necessarily support particular strategies. This category of enablers promotes a state of mental readiness, as might one's morning cup of coffee. They are not specific to particular thinking tasks. Research on attention suggests that such stimuli can improve performance by increasing one's general level of arousal (Kahneman, 1973). *Provocation* is an alerting or attention-grabbing device, exemplified by de Bono's (1992) use of the word "po." A provocation draws attention to a problem and may call for idiosyncratic thoughts on the issue.

Block Removal is a broad enabler that includes situation-specific components. Typified by the work of Adams (1979), it tries to remove mental barriers that inhibit idea generation. Block Removal can be viewed as a less aggressive version of Habit-Breaking Strategies. As such, it is supported by research on set-breaking (Schooler & Melcher, 1995). The Creative Whack Pack, developed by von Oech, is a set of cards offering admonitions like "Get out of the dogma house." Methods assume that awareness of a block is tantamount to removing it. This assumption may not be valid.

Motivational Enablers

Motivational enablers operate on the assumption that individuals or groups may not be adequately motivated to solve problems. Research on the relationship between creativity and motivation supports this assumption. However, Amabile (1996) has argued that intrinsic motivation — pursuing a task for its own sake — is the key, whereas extrinsic motivators — those sought for external reasons — can actually degrade idea-generation performance. Unfortunately, intrinsic motivation is difficult to manipulate through a technique. Since the devices in this family of enablers tend to rely on extrinsic motivators, it is not clear how effective they are likely to be.

The *Goal Setting* strategy uses output goals as motivators. Techniques set quotas for the number of ideas to be generated or establish time deadlines for task completion. The Lotus Blossom technique implements this strategy in an interesting way. It uses a diagram with eight circles around a central problem or issue. An idea must be entered in each circle, which becomes a starting point for new iterations. Thus, the diagram implicitly sets a quota for idea generation. *Competition* is another motivator; people exert themselves to win games. The Force-Fit Game involves two teams who take turns suggesting remote ideas or developing practical solutions from ideas proposed by opponents. A referee

awards points for successful ideas; the team accumulating the most points wins the contest. *Personal Involvement* is the weakest but most widely used of these enablers, at least informally. It motivates idea generation by fostering feelings of belonging between individuals and an organization having a problem. Systematized Direct Induction is a large group method using this enabler.

Extra Effort Enablers

Similar to Motivational Enablers, these devices are distinctive in that they don't inspire creative effort, they demand it. *Mass Production* is based on the assumption that quality follows quantity. To generate good ideas, generate lots of ideas. Empirical studies have supported this "extended effort" or "quantity" principle (Basadur & Thompson, 1986; Nezu & D'Zurilla, 1981). Related techniques require people to spend more time on idea-generation tasks, or to come up with ideas beyond what they've already produced. Using many people — the Crawford Slip Method can be implemented with 5000 participants — is another way of implementing the device.

The other extra effort enabler has a different rationale: Rather than valuing the quantity of ideas, *Force Fit* prizes the remoteness of idea-generation stimuli. Forcing together unrelated ideas, it is argued, helps achieve creative breakthroughs. Hard-to-discover relationships may have fruitful solution implications; such relationships can be discovered through sustained effort. Though this rationale is suspect, the device is employed in many techniques, usually in conjunction with the Remote Stimuli tactic. Catalog asks one to randomly select two words from a dictionary or other printed material and "force" them together to produce a problem-relevant idea.

Anti-Rutting Enablers

This category consists of passive habit-breaking devices. It is underwritten by a strong psychological rationale: Thinking is susceptible to an anchoring effect in which initial ideas on a topic remain mentally present despite efforts to set them aside so other ideas can be explored (Smith, 1995). Ideas create patterns of neural activation that aren't erased simply because an idea has been rejected. So we fall into mental ruts. The most useful device in this family is *Incubation*, setting the problem aside until ruts have been smoothed over. In addition to its deanchoring aspect, Incubation has been proposed as a means of putting unconscious mental processes to work. This is a less persuasive rationale that is inherently hard to validate (Perkins, 1981). Idea Tracking is one of several methods employing the device. With this technique, idea generation transpires over a period of days, during which one is encouraged

to set the problem aside at times, to clear the mind and to allow unconscious processes to operate.

An appealing, though less widely-used, anti-rutting device is *Non-Disclosure*. It assumes that the problem itself can induce rutted thinking. A group leader withholds stating the problem at the outset of idea-generation sessions; people are asked to think about related or more general topics. The Gordon/Little method implements this device effectively, gradually drawing idea generation closer to the true problem, which is eventually revealed. *Suppressed Alternatives* is equally well grounded psychologically, though it can be difficult to implement. The device argues that standard solutions that immediately surface during idea generation have anchoring effects. To overcome this, the device keeps obvious ideas from being generated or sweeps them away once they appear. Synectics includes a "purge" stage during which standard solutions are surfaced, criticized, and dismissed so attention can move on to other possibilities.

Anti-Inhibition Enablers

The final category of active ingredients only applies to group idea-generation sessions. As noted earlier, group interaction is a powerful creative force. Unfortunately, group processes often include inhibiting dynamics that negate that force. Devices in this family try to keep members from experiencing social inhibitions during group creativity sessions. *Deferred Evaluation* is the practice of withholding criticism of ideas so as not to inhibit their generation. People shrink from exposing themselves, through their ideas, to negative assessments by others. The device is based on evidence that inter-member criticism in groups retards the flow of ideas (Stein, 1975). However, recent research suggests that the effects of evaluation on creativity are more complex (Amabile, 1996). Brainstorming was the first technique to employ this device. It is also used in the Trigger Method: Members generate, share, and discuss ideas, no evaluation being allowed until later in the session.

Anonymity makes it so ideas can't be traced to their originators. The Collective Notebook technique achieves anonymity by having a coordinator serve as a collection-and-dispersion point for member-generated ideas. The use of group decision support systems that allow member contributions to appear, unattributed, on central displays is a means of securing anonymity with methods like the Nominal Group Technique.

Idea-generation methods may use active ingredients beyond those identified in Table 1 and discussed in this section. How-

ever, this set of fifty constitutes an impressive arsenal of idea-generation devices.

IMPLICATIONS

The formulary of active ingredients has important implications for idea-generation research and practice. Three lines of development will be discussed: Promoting the prescriptive side of creativity research; facilitating the evaluation of idea-generation methods; and enabling the selection of techniques suited to particular idea-generation tasks.

Creativity has been the subject of much thinking and research, especially during the past several decades. The topic's practical importance implies that creativity research should aim at improving things, not just understanding them. Though it could be argued that all creativity research pursues a practical goal, a strong case can be made that the great majority of past research has had little impact on idea-generation practice.

As in most scientific fields, prescriptive ends have been pursued by descriptive means: If we understand creativity, we can improve it. Admitting the past achievements and potential value of descriptive research on creativity, it is argued that a more direct prescriptive strategy should also be pursued. This strategy focuses on methods, heuristics, and other artifacts used to improve idea-generation performance. It asserts that these must also be a primary research target. The present paper promotes this prescriptive strategy through the formulary, a systematic account of the underlying mechanisms by which people have tried to aid idea generation.

One stream of creativity research that has had a prescriptive orientation is work evaluating the effectiveness of techniques (Maier, 1970; Stein, 1974, 1975). However, of the hundreds of existing methods, only brainstorming has been subjected to a substantial battery of performance tests. Moreover, these assessments have generally been inconclusive in their results. By identifying the active ingredients on which techniques are based, the present paper promotes more productive studies of their effectiveness. By focusing on active ingredients, rather than methods, researchers can conduct efficient empirical tests of what works and what doesn't.

Arguably, a major cause of inconsistent findings by researchers evaluating creativity methods is inadequate attention to idea-generation tasks. A technique might work well in some tasks and poorly in others. It is obvious that a checklist devised for developing new product ideas won't help a person think of novel ideas for a birthday present. It is less apparent,

but perhaps no less true, that a technique based on decomposition won't be effective with tasks that don't involve decomposable core objects; that methods using mental simulation are most helpful when the problem has a strong experiential component; and that a method like Bionics is best suited for problems involving functions with natural analogues.

The formulary of active ingredients provides a basis for proposing and testing hypothesized task-device interactions. If interactions are discovered, the formulary offers a framework for selecting task-appropriate idea-generation methods. It suggests the value of "packaged" interventions encompassing various devices, along with guidelines indicating when each is to be employed. Arguably, there is no one best creativity device or technique, but rather a set of devices likely to be effective in certain idea-generation tasks. Interventions consisting of a well-designed repertoire of devices can provide users with the required range of idea-generation support.

REFERENCES

ADAMS, J. L. (1979). *Conceptual blockbusting: A guide to better ideas* (2nd ed.). New York: Norton.

ALLEN, M. S. (1962). *Morphological creativity*. Englewood Cliffs, NJ: Prentice-Hall.

AMABILE, T. M. (1996). *Creativity in context*. Boulder, CO: Westview.

ARMSTRONG, F. A. (1960). *Idea tracking*. New York: Criterion.

BASADUR, M., GRAEN, G. B., & GREEN, S. G. (1982). Training in creative problem solving: Effects on ideation and problem finding and solving in an industrial research organization. *Organizational Behavior and Human Performance, 30*, 41-70.

BASADUR, M., & THOMPSON, R. (1986). Usefulness of the ideation principle of extended effort in real world professional and managerial creative problem solving. *Journal of Creative Behavior, 20*, 23-34.

BOSTICCO, M. (1971). *Creative techniques for management*. London: Basic Books.

BRASSARD, M. (1989). *The memory jogger plus+*. Methuen, MA: GOAL/QPC.

BUZAN, T. (1983). *Use both sides of your brain*. New York: Dutton.

CLARK, C. H. (1978). *The Crawford slip writing method*. Kent, OH: Charles H. Clark.

CROVITZ, H. F. (1970). *Galton's walk*. New York: Harper & Row.

DE BONO, E. (1970). *Lateral thinking: Creativity step by step*. New York: Harper & Row.

DE BONO, E. (1985). *De Bono's thinking course*. New York: Facts on File.

DE BONO, E. (1992). *Serious creativity*. New York: HarperCollins.

DOMINOWSKI, R. L. (1995). Productive problem solving. In S. M. Smith, T. B. Ward, & R. A. Finke (eds.), *The creative cognition approach* (pp. 73-95). Cambridge, MA: MIT Press.

DUNCKER, K. (1945). On problem-solving. *Psychological Monographs, 58* (Whole No. 270).

FINDLAY, C. S., & LUMSDEN, C. J. (1988). The creative mind: Toward an evolutionary theory of discovery and innovation. *Journal of Social and Biological Structures, 11*, 3-55.

FINKE, R. A. (1995). Creative realism. In S. M. Smith, T. B. Ward, & R. A. Finke (eds.), *The creative cognition approach* (pp. 303-326). Cambridge, MA: MIT Press.

FINKE, R. A., WARD, T. B., & SMITH, S. M. (1992). *Creative cognition: Theory, research, and applications*. Cambridge, MA: MIT Press.

GETZELS, J., & CSIKSZENTMIHALYI, M. (1976). *The creative vision: A longitudinal study of problem finding in art*. New York: John Wiley.

GLASER, B. G., & STRAUSS, A. L. (1967). *The discovery of grounded theory*.Chicago: Aldine.

GROSSMAN, S. R., & WISEMAN, E. E. (1993). Seven operating principles for enhanced creative problem solving training. *Journal of Creative Behavior, 27*, 1-17.

HAEFELE, J. W. (1962). *Creativity and innovation*. New York: Reinhold.

HAMPTON, J. A. (1997). Emergent attributes in combined concepts. In T. B. Ward, S. M. Smith, & J. Vaid (eds.), *Creative thought: An investigation of conceptual structures and processes* (pp. 83-110). Washington, DC: American Psychological Association.

HIGGINS, J. M. (1994). *101 creative problem solving techniques*. Winter Park, FL: New Management Publishing Company.

HOLYOAK, K. J., & THAGARD, P. (1995). *Mental leaps: Analogy in creative thought*. Cambridge, MA: MIT Press.

ISEN, A. M., & NOWICKI, G. (1980). *Positive affect and creative problem solving*. Paper presented at the Annual Meeting of the Cognitive Science Society, Berkeley, CA.

KAHNEMAN, D. (1973). *Attention and effort*. Englewood Cliffs, NJ: Prentice-Hall.

KEENEY, R. L. (1992). *Value-focused thinking: A path to creative decision making*. Cambridge, MA: Harvard University Press.

KELLER, L. R., & HO, J. L. (1988). Decision problem structuring: Generating options. *IEEE Transactions on Systems, Man, and Cybernetics, 18*, 715-728.

KOBERG, D., & BAGNALL, J. (1974). *The universal traveler*. Los Altos, CA:William Kaufman, Inc.

KOESTLER, A. (1964). *The act of creation*. New York: Dell.

LAVERTY, F. (1974). Creative ideas through circumrelation. *Journal of Creative Behavior, 8*, 40-46.

MACCRIMMON, K. R., & WAGNER, C. (1994). Stimulating ideas through creativity software. *Management Science, 40*, 1514-1532.

MAIER, N. R. F. (1970). *Problem solving and creativity in individuals and groups*. Belmont, CA: Brooks/Cole.

MASON, R. O. (1969). A dialectical approach to strategic planning. *Management Science, 15*, B403-B414.

MUMFORD, M. D., & GUSTAFSON, S. B. (1988). Creativity syndrome: Integration, application, and innovation. *Psychological Bulletin, 103*, 27-43.

NEZU, A., & D'ZURILLA, T. J. (1981). Effects of problem definition and formulation on the generation of alternatives in the social problem-solving process. *Cognitive Therapy and Research, 5*, 265-271.

NISBETT, R., & ROSS, L. (1980). *Human inference: Strategies and shortcomings of social judgment*. Englewood Cliffs, NJ: Prentice-Hall.

OSBORN, A. F. (1963). *Applied imagination* (3rd ed.). New York: Scribner.

PERKINS, D. N. (1981). *The mind's best work*. Cambridge, MA: Harvard University Press.

PERKINS, D. N. (1983). Novel remote analogies seldom contribute to discovery. *Journal of Creative Behavior, 17*, 223-239.

PRINCE, G. M. (1967). The operational mechanism of synectics. *Journal of Creative Behavior, 2*, 1-13.

RICKARDS, T. (1974). *Problem-solving through creative analysis*. Essex, UK: Gower Press.

SANDS, S. (1979). Techniques for creating new product ideas: Which to choose? *Management Decision, 17*, 202-213.

SCHOOLER, J. W., & MELCHER, J. (1995). The ineffability of insight. In S. M. Smith, T. B. Ward, & R. A. Finke (eds.), *The creative cognition approach* (pp. 97-133). Cambridge, MA: MIT Press.

SMITH, S. M. (1995). Fixation, incubation, and insight in memory and creative thinking. In S. M. Smith, T. B. Ward, & R. A. Finke (Eds.), *The creative cognition approach* (pp. 135-156). Cambridge, MA: MIT Press.

SOUDER, W. E., & ZIEGLER, R. W. (1977). A review of creativity and problem solving techniques. *Research Management, 20*, 34-42.

STEIN, M. I. (1974). *Stimulating creativity: Volume 1, Individual procedures*. New York: Academic Press.

STEIN, M. I. (1975). *Stimulating creativity: Volume 2, Group procedures*. New York: Academic Press.

STEIN, M. I. (1989). Memory and creativity. In J. A. Glover, R. B. Ronning, & C. R. Reynolds (eds.), *Handbook of creativity* (pp. 163-176). New York: Plenum Press.

STRAUSS, A. L. (1987). *Qualitative analysis for social scientists*. Cambridge, UK: Cambridge University Press.

SUCHMAN, L. A. (1987). *Plans and situated actions: The problem of human-machine communication*. Cambridge, UK: Cambridge University Press.

TATSUNO, S. M. (1990). *Created in Japan: From imitators to world-class innovators*. New York: Harper & Row.

TAYLOR, D. (1969). Creative design through functional visualization. *Journal of Creative Behavior, 3*, 122-127.

TAYLOR, J. W. (1961). *How to create ideas*. Englewood Cliffs, NJ: Prentice-Hall.

THOMPSON, C. (1992). *What a great idea!* New York: Harper.

VANGUNDY, A. B. (1987). *Creative problem solving*. New York: Quorum Books.

VANGUNDY, A. B. (1988). *Techniques of structured problem solving* (2nd ed.). New York: Van Nostrant Reinhold.

VOLKEMA, R. J. (1983). Problem formulation in planning and design. *Management Science, 29*, 639-651.

VON OECH, R. (1992). *Creative whack pack*. Stamford, CT: U.S. Games Systems.

WALLAS, G. (1926). *The art of thought*. New York: Harcourt.

WARFIELD, J. N., GESCHKA, H., & HAMILTON, R. (1975). *Methods of idea management*. Columbus, OH: The Academy for Contemporary Problems.

WERTHEIMER, M. (1982). *Productive thinking* (enl. ed.). Chicago: University of Chicago Press.

WHITING, C. S. (1958). *Creative thinking*. New York: Reinhold.

Gerald F. Smith, Department of Management, College of Business Administration, University of Northern Iowa, Cedar Falls, IA 50614-0125