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KNOWING AND THINKING: A NEW THEORY OF CREATIVITY

by
Min Basadur
and
Garry Gelade

Management of Innovation and New Technology
Research Centre

WORKING PAPER NO. 105
March 2002

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A New Theory of Creativity

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Knowing and Thinking:
A New Theory of Creativity

ABSTRACT

Elements of previous models and concepts of cognition, intelligence and learning are integrated with a number of significant themes in creativity research. A simplifying theory of creativity is presented which identifies four basic underlying mental operations (two modes of knowledge apprehension and two modes of knowledge utilization). These four operations in turn are the basis for a dynamic model of the creative process that describes the stages of problem discovery, definition, solution, and solution implementation. The development of a psychological instrument that measures the constructs of the theory is discussed and empirical evaluations of the instrument's psychometric properties in terms of both reliability and validity are presented. Individual preferences for particular stages of this process were found to be related to occupation and to level of organizational responsibility. It was also found that preference for problem discovery, the first stage of the creative process, may be under-represented in industrial and business organizations. Implications are discussed.

Knowing and Thinking: A New Theory of Creativity

INTRODUCTION

Since Wallas (1926) presented his pioneering model of the creative process, psychologists and educators have increasingly debated the concept of creativity. In this article we present a theory of creativity which integrates elements from previous models of cognition, intelligence and learning that have addressed creativity. This theory shows the connections between a number of significant themes in creativity research including Osborn's (1953) model of applied imagination, Guilford's structure of intellect model (SOI, 1967), Kolb's learning theory (1976) and Sternberg's (1985; 1988) concept of triarchic intelligence. We also discuss the development of a psychological instrument designed to measure the constructs of the theory and present empirical evidence of its validity.

We suggest that creative thinking involves two distinct cognitive processes: Apprehension, the acquisition of understanding or knowledge; and Utilization, the application of understanding or knowledge. We shall argue that two different modes of Apprehension and two different modes of Utilization lead to four cognitive orientations, which together delimit the conceptual space of creative thinking.

TWO DIMENSIONS OF CREATIVITY

The recognition of Apprehension and Utilization as distinct mental operations is apparent in the work of Osborn, who pioneered the study of the deliberate development of creativity. Osborn modeled the brain as having four functions: absorb, retain, create, and judge. "Absorb" and "retain" involve the acquisition of knowledge: "create" and "judge" involve the application of knowledge (using imagination and judgment). Osborn advocated the deferral of judgment

principle in which the "create" and "judge" functions are used independently, and also suggested that people learn a three-step process of creative problem solving, beginning with fact finding (Apprehension) followed by idea generation and idea evaluation (Utilization).

Gordon (1956, 1971) also recognized that Apprehension ("learning") and Utilization (for "inventing") represent two different modes of thinking. Learning was characterized as a mental process of *making new* connections (thus making the strange familiar), while invention was characterized as a mental process of *breaking old* connections (thus making the familiar strange). These separate processes of knowledge acquisition (learning) and knowledge application (for inventing) flow continuously into one another in sequence. Field research by Carlsson, Keane and Martin (1976) supported Gordon's approach by showing that the research and development (R&D) process in organizations follows a continuous, circular flow of creating new knowledge to replace old knowledge.

Others have also identified these two dimensions. Myers (1994) identified the bipolar judgment-perception (JP) scale, which represents the degree to which individuals prefer to perceive (Apprehension) or to evaluate and decide (Utilization).

Guilford's (1967) three-dimensional SOI model can also be understood in terms of Apprehension and Utilization. Guilford maintained that the standard single "g"-factor or "IQ" approach to explaining and measuring "intelligence" is inadequate, partly because it ignores thinking skills related to creativity. Using factor analytic methods, Guilford identified 120 different kinds of intelligence based on combining five different mental operations, four different kinds of contents and six different kinds of products. The five operations were labeled: cognition, memory, divergent production, convergent production, and evaluation. Cognition was defined as "the immediate discovery, awareness, rediscovery or recognition of information in various forms; comprehension or understanding." Memory was defined as "the retention or storage, with

some degree of availability, of information in the same form it was committed to storage and in response to the same cues in connection with which it was learned." Divergent production was defined as "the generation of information from given information where the emphasis is upon variety and quality of output from the same source." Convergent production was defined as "the generation of information from given information where the emphasis is upon achieving unique or conventionally accepted best outcomes and the given information (cue) often fully determines the response." Evaluation was defined as "reaching decisions or making judgments concerning criterion satisfaction of information."

Setting memory aside, one way of organizing the other four is that convergent production and cognition represent two contrasting methods of Apprehension and that divergent production and evaluation represent two contrasting methods of Utilization. First, let us consider two contrasting modes of Apprehension. Convergent production can be equated with Apprehension by rigorous thinking – "finding the answer" where "finding" is something more than mere retrieval and "the answer" suggests that the domain is so systematic, ordered, rational and deterministic that there are rules or principles for converging on the solution. Convergent production is the SOI ability that dominates formal education and is almost synonymous with curriculum assimilation (Meeker, 1969). However, the SOI operation called cognition represents a different method of Apprehension: more open; less restrictive; focused on pure knowledge acquisition by non-directed, non-deterministic, non-rational experiencing and absorption through the senses. According to Meeker (1969):

> "Cognition is perhaps the most obvious of all the SOI operations. ... In terms of the dynamics of learning it seems to be the primary process since every other activity presupposes perception and awareness of stimuli with the associated ability to discriminate or attend. Without registration there would seem to be no content for further processing."

Second, let us consider the two contrasting modes of Utilization in the SOI model. Divergent production is non-judgmental and divergent; evaluation is judgmental and convergent. Divergent production generates options without judgment; evaluation evaluates options with judgment. Thus, divergent production and evaluation are polar-opposite operations of the SOI. The former operates on knowledge (information) non-judgmentally to create options focusing on increasing variety; the latter operates on knowledge judgmentally to evaluate options, thus reducing variety.

Thus, the Guilford SOI mental operations axis may be organized into two distinct bipolar dimensions. The first dimension, Apprehension, concerns acquiring knowledge or understanding in two different ways. One (cognition) is relatively more open, non-rational, experiential, non-analytical and divergent and the other (convergent production) is relatively closed, rational, theoretical, analytical and convergent. In a similar vein, Jung also differentiated between irrational and rational mental functions (Hyde & McGuinness, 1994). The former were called "sensation" and "intuition" and the latter "thinking" and "feeling." The two different types of Apprehension are described in greater detail in Appendix 1.

The second dimension, Utilization, concerns applying such knowledge or understanding in two different ways – non-judgmentally creating new information to increase the variety of options (divergent production) and making judgments and reaching decisions about new information to reduce the variety of options (evaluation). The importance of including both divergent, non-judgmental thinking and convergent, judgmental thinking as aspects of creativity is well established in the literature. Farnham-Diggory (1972) suggested that both kinds of thinking are essential to creative performance. The balancing of the divergent production and evaluation operations of the SOI supports Osborn's early call for the separation of the imagination and evaluation functions of the brain. The "creativity equation", $C = f(K \times I \times E)$,

of Parnes, Noller and Biondi (1977) also emphasizes this balanced approach. According to this equation, creativity, (C) is a function of knowledge (K) and both imagination (I) and evaluation (E); the multiplication signs are intended to convey the notion that no creativity results if any of the elements K, I or E are absent. Thus creativity results when imagination is applied to knowledge (however acquired) to create new options, and then judgment is applied to the new options to select appropriate ones. Further discussion of the two different types of Utilization is presented in Appendix 2.

It is important to point out here that much ambiguity exists over the nature of knowledge itself. There are also many different definitions of "learning," or how Apprehension happens. These differing conceptions are discussed in Appendix 3. For our present purposes we equate knowledge with understanding and comprehension. We have also chosen to define learning as "acquiring knowledge, understanding or comprehension," or "Apprehension", and we distinguish this from Utilization, which we have defined as the application of knowledge, understanding or comprehension, however acquired.

INTEGRATING FOUR INFLUENTIAL THEORIES OF CREATIVITY – AND UNCOVERING EXPERIENTIAL INTELLIGENCE

In this section, we show that the two modes of Apprehension and the two modes of Utilization discussed above provide a unifying conceptual framework within which four major theories of creative thinking (Sternberg, 1996; Guilford, 1967; Parnes et al., 1977; Osborn, 1963) can be understood. When discussed in terms of Apprehension and Utilization, similarities between these four theories, and missing mental operations in them, become evident.

Sternberg (1996) suggested that "successful intelligence" requires a combining of three different kinds of "intelligences": "theoretical (or analytical) intelligence"; "creative

intelligence"; and "practical intelligence." "Theoretical intelligence" represents "academic knowledge," which we acquire in school under highly structured conditions. It is what we use to analyze, compare and select. It is what we need to score well on IQ tests, which in turn are used to measure likelihood of success in school. This theoretical (analytical) intelligence is virtually identical to Guilford's (1967) concept of convergent production and represents a form of understanding that is not acquired through concrete experience, but is based on one's ability to process abstract concepts and develop "correct" conclusions. It is also similar to Jung's mental function of "thinking." The thinking "type" is one who prefers to "think things out," or come to conclusions based on logic, order and rationality (Fordham, 1953).

"Practical intelligence" is the ability to apply knowledge acquired in school and in real-world contexts to new or different contexts. Practical intelligence permits one to judge and decide wisely among different "dispositions to act," and is akin to "common sense." It is primarily learned not in school but by "being there," or by real-world experience.

"Creative intelligence" is the ability to produce ideas and is best expressed in unstructured, unconstrained situations. Creative intelligence is used for designing and making. It requires using past experience as the knowledge base to both cope with novel situations effectively and to optimally use one's time and efforts to handle recurring situations efficiently, thus permitting one to move on to more productive pursuits. Sternberg suggests that such creative intelligence can be learned. For example, students can acquire creative intelligence by observing and emulating teachers who model appropriate behaviors, such as questioning standards, risk-taking and allowing for mistakes.

This suggests that a fourth kind of "intelligence" may be buried inside Sternberg's practical and creative intelligences. In Sternberg's descriptions, "practical intelligence" and "creative intelligence" both recognize using a kind of knowledge that is acquired in a different

way from the theoretical or academic knowledge acquired in school. This is knowledge gained by experiencing the world around us, or by "being there." This is the knowledge Guilford calls cognition: the non-judgmental absorption of sensory experience simply for the sake of understanding (Meeker, 1969). Similarly, Jung (Fordham, 1953) defines the sensation function of the psyche as taking everything as it comes: experiencing things as they are without valuation. What counts is the strength and pleasure of the sensation. "Practical intelligence" and "creative intelligence" include the application of two distinct kinds of knowledge: theoretical/analytical/academic, and real-world experience/being there. Creative intelligence uses both kinds of knowledge to create new options. Practical intelligence uses both kinds of knowledge to evaluate options wisely. Sternberg has not labeled this latter form of knowledge, which is in effect "experiential intelligence." This hidden fourth kind of intelligence represents real-world knowledge that we acquire by experiencing, by "being there," by physically encountering unstructured situations and unanticipated stimuli. For example, Mintzberg (1989) related how Japan's Honda Corp. stumbled across an opportunity for its small scooter in North America. The company had sent four marketing managers to Los Angeles to establish the market for Honda's new giant "macho" motorcycles. To reduce taxi costs, the four managers rode errands around the city on Honda's small scooters. (Honda headquarters had assumed there would be little market for such a small vehicle on the open roads of North America.) The scooters attracted attention, something that did not escape the notice of the managers. Rather than decide that no market existed for the large motorcycle (evaluational thinking), they used divergent thinking to pursue their newly discovered opportunity. Their real mission, in retrospect, had been to learn whether they could sell something – anything – in North America. Rather than attempt to cover every base early, the company resisted the lure of over-rationality and came to America prepared to learn by doing, rather than remain in Tokyo using second-hand

information residing in their computers or gathering answers to pre-determined questions by telephone or questionnaire.

Stated another way, the "K" in Parnes et al.'s equation above $(C = f(K \times I \times E))$ is only partly represented by Sternberg's theoretical/analytical intelligence. What is apparently missing is the part that is acquired by experiencing – outside of the classroom, as it were – by simply "being there," being involved in real life: absorbing, sensing and developing a kind of understanding or comprehension that is more tacit and less explicit. It is non-directed, non-analytical and non-judgmental (that is, Guilford's "cognition" and Jung's "sensation"). In contrast, theoretical/analytical understanding or comprehension is developed by remaining detached and producing quantifiable decisions in more structured situations (Guilford's "convergent production" and Jung's "thinking"). Sternberg appears to bury the concept of "experiential intelligence" partly inside the concept of practical intelligence and partly inside the concept of creative intelligence. However, these practical and creative intelligence are primarily methods of explaining different applications of knowledge, not its acquisition. Practical intelligence is primarily the application of knowledge in judging and deciding among options, and creative intelligence is primarily the application of knowledge in the production of options. Some knowledge can be discovered only by first-hand experience of new and unexpected things. When such knowledge is utilized for creating options, new opportunities are discovered.

Thus, if we extract the experiencing ("being there") component of knowledge acquisition from both concepts of (primarily) knowledge application, and then use that component to expand the theoretical/analytical thinking component of knowledge acquisition, we can make Parnes et al's equation more explicit and more in parallel with Sternberg's model.

The same can be done for Guilford's SOI model above, which already has expanded the concept of acquiring knowledge beyond just theoretical/analytical comprehension. Guilford's

concept of cognition emphasizes experiential comprehension, or the open-ended absorption of experience by just "being there." Guilford's convergent production concept, which represents the opposite way of comprehending, is virtually identical to the knowledge acquisition component of Sternberg's theoretical/analytical intelligence concept. Recall that Guilford's memory operation refers to the storage of knowledge (no matter how acquired.) Guilford's other two operations involve not the acquisition or storage of knowledge but the application of knowledge. Guilford's divergent production (of options) and evaluation (of options) are similar respectively to the application of knowledge components within Sternberg's creative and practical intelligences.

Furthermore, adding knowledge acquisition by experiencing (cognition) to knowledge acquisition by thinking (convergent production) produces a more complete match of Guilford's approach with the Osborn (1963) and Parnes et al (1977) models. Table 1 shows how the models of Sternberg, Guilford, Parnes et al. and Osborn fit together using the Apprehension and Utilization framework.

THE DYNAMICS OF THE CREATIVE PROCESS

Many researchers have considered the dynamics of the creative process. Creativity requires more than the generation of a variety of ideas in response to a cue, and often does not begin with or depend on "given information." Guilford (1950) stressed the importance of "sensitivity to problems" in creativity and related it to our everyday notion of curiosity. Wakefield (1991) contrasted the type of thinking that deals with problems that are closed in terms of the problem definition but open in terms of the problem solution (single open) with the type of thinking that involves the "double open" situation of first formulating a previously undefined problem and then generating alternative solutions.

Table 1

Fitting the Sternberg, Osborn, Parnes, Noller and Biondi, and Guilford Models Together Using the Apprehension and Utilization Framework

Theory/Model	Component	Apprehension of Knowledge by		Utilization of Knowledge for	
		Experiencing	Thinking	Creating Options	Evaluating Options
Sternberg	Theoretical/Analytical Intelligence		X		
	Experiential Intelligence[a]	X			
	Creative intelligence	X	X	X	
	Practical Intelligence	X	X		X
Guilford	Convergent Production		X		
	Cognition	X			
	Divergent Production			X	
	Evaluation				X
Parnes, Noller & Biondi	Knowledge	X	X		
	Imagination			X	
	Evaluation				X
Osborn	Absorb	X	X		
	Create			X	
	Judge				X

[a] New

Skills in discovering and defining new important problems to solve ("problem finding") and in implementing new solutions are equally as, or even more important than, creating the solutions, according to many researchers (Mackworth, 1965; Livingston, 1971; Getzels, 1975; Leavitt, 1975; Simon, 1960, Levitt, 1963; Ackoff, 1979). Kabanoff and Rossiter (1994) cited problem finding as one of the most vital and difficult frontiers for creativity researchers -- a

"messy" concept that is hard to define and operationalize yet is a crucial element of creativity, especially real-world creativity in applied settings.

Basadur (1979) identified two separate components of problem finding activity. The first component is problem generation, which involves discovering new problems for subsequent definition. Simon (1977) called this activity "opportunistic surveillance." The second component involves formulating a previously discovered but undefined problem. This second component is called problem formulation (or conceptualization, or definition).

This viewpoint contrasts sharply with research that confines creative thinking merely to generating ideas to presented problems using techniques such as "brainstorming." Such research dominated the literature from the 1950s into the 1980s (see review by Basadur, 1994). Practitioners who employ such limited conceptions of creative thinking seldom attain practical results (Sternberg, O'Hara & Lubart, 1997). More recent literature contains more complete conceptions of applied creativity (Kabanoff and Rossiter (1994), Rickards (1994) and Basadur (1994; 1995)). More complete models include not only multiple stages (beyond simply solving presented problems) but other important individual, group and organizational variables such as motivation, cohesiveness, environment, linkage to goals, and specific skills, behaviors and attitudes. Basadur, Graen and Green (1982) presented evidence that appropriate training can nurture skills in executing multi-stage processes of "creative thinking" (applied creativity) successfully to achieve valuable results in real-world settings.

Kabanoff and Rossiter (1994) review the growth of cognitive models of multi-stage creative thinking and problem solving processes. They credited Wallas (1926) with providing the first influential model to specify four main stages: preparation, incubation, illumination and verification. Later models included the Parnes, Noller and Biondi (1977) five-step process: fact finding, problem finding, idea finding, solution finding, and acceptance finding; Amabile's

(1988) five steps: presentation, preparation, generation, validation and assessment; and Basadur, Graen and Green's (1982) three phases across eight steps: problem finding, fact finding, and problem defining (Phase 1, problem formulation); idea finding, and idea evaluation and selection (Phase 2, solution formulation); and planning for implementation, gaining acceptance and taking action (Phase 3, solution implementation); Isaksen and Treffinger (1985) added an extra step, "mess finding" to the beginning of Parnes et al's (1977) model. All of these models represent a sequential flow through specific stages, phases or steps.

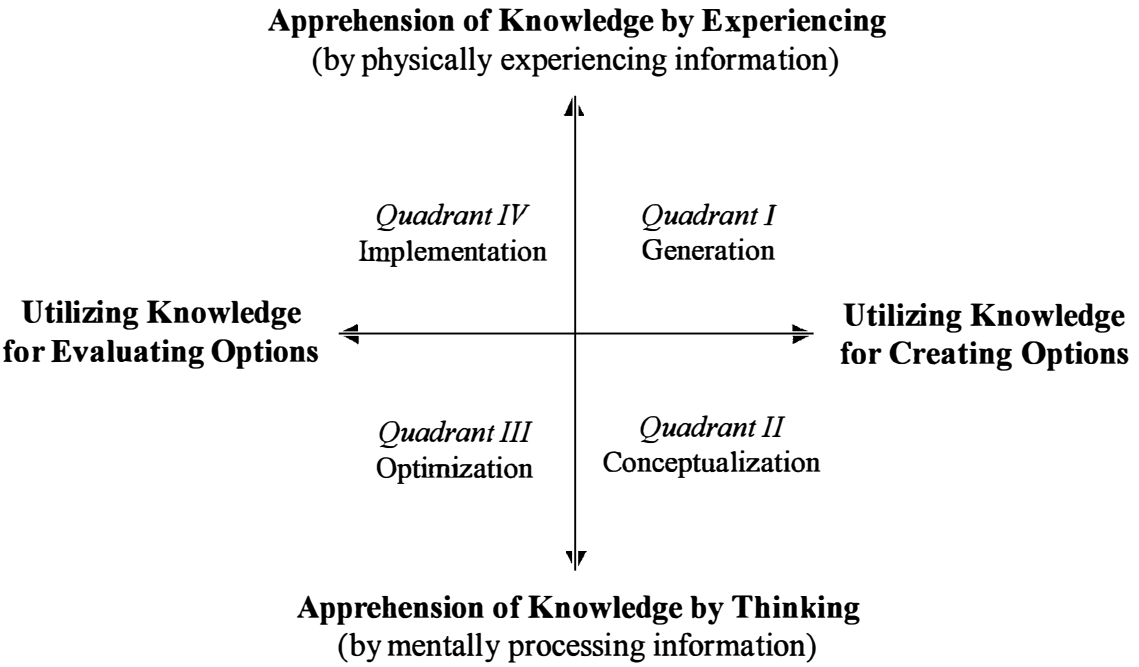
A NEW THEORY OF CREATIVITY

Kabanoff and Rossiter (1994) suggested that cognitive scientists should look deeper to better understand the dynamic multi-stage nature of creative thinking. In this section, we introduce a multi-stage theory of creativity that defines each stage in terms of the two dimensions of Apprehension and Utilization of knowledge. As we have shown above, the Apprehension and Utilization of knowledge can be viewed as two separate bipolar dimensions. If we plot these two dimensions at right angles, we obtain four types of creative activity (quadrants) each defined by a different combination of Apprehension and Utilization as illustrated in Figure 1. Each quadrant can be identified with a specific stage of the creative thinking process. Considered consecutively, these quadrants provide a comprehensive and temporally ordered description of the mental operations involved in real-world creativity and problem solving.

The first two quadrants of Figure 1 represent the two components of problem finding. The third and fourth quadrants of Figure 1 represent problem solving and solution implementation, or the final two stages of the creative process. This recognizes that solving defined problems, and understanding ways to overcome resistance to change and procrastination, are also important parts of creative thinking (Leavitt, 1975; Basadur et al, 1982).

Figure 1

Four Combinations of Different
Methods of Gaining and Using Understanding



Quadrant 1

The first quadrant combines gaining knowledge by experiencing with using such knowledge for creating options. Creative activity in this quadrant involves gaining knowledge and understanding by physical contact and involvement in the real world and utilizing this knowledge by active divergence to convert it into problems and opportunities that are potentially worth defining and solving or projects worth undertaking. Quadrant I activity thus consists of sensing, seeking or anticipating problems and opportunities, and is called Generation. An outcome of this stage is a problem worthy of investigation but not yet clearly defined or understood.

Quadrant II

The second quadrant combines gaining knowledge by mental processing with using such knowledge for creating options. Creative activity in this quadrant involves gaining knowledge and understanding by working in the abstract -- analyzing, pondering and theorizing about the information received to create a sound conceptualization or model of the problem domain, and utilizing this conceptualization divergently to formulate solution ideas. Quadrant II activity consists of turning a problem recognized in Quadrant I into a well understood problem definition and some fledgling solution ideas and, thus, is called conceptualization.

Quadrant III

The third quadrant combines gaining knowledge by mental processing with using such knowledge for evaluating options. Creative activity in this quadrant involves gaining knowledge and understanding by working in the abstract – thoroughly analyzing a defined problem and fledgling solution ideas and utilizing this knowledge to develop, evaluate and optimize a practical solution. This stage is called Optimization. At this point, a good solution to an important, well-defined problem exists, but has not yet been implemented.

Quadrant IV

The fourth quadrant combines gaining knowledge by experiencing with using such knowledge for evaluating options. Apprehension in this quadrant involves gaining knowledge and understanding by physical contact and involvement in the real world. Utilization consists of employing evaluation to convert this knowledge into implemented solutions that work and accomplish valuable results. Creative activity in this quadrant thus consists of making

adjustments to successfully implement an untried solution. Thus this stage is called Implementation.

More extensive descriptions of the four quadrant styles are included in the Appendix 4.

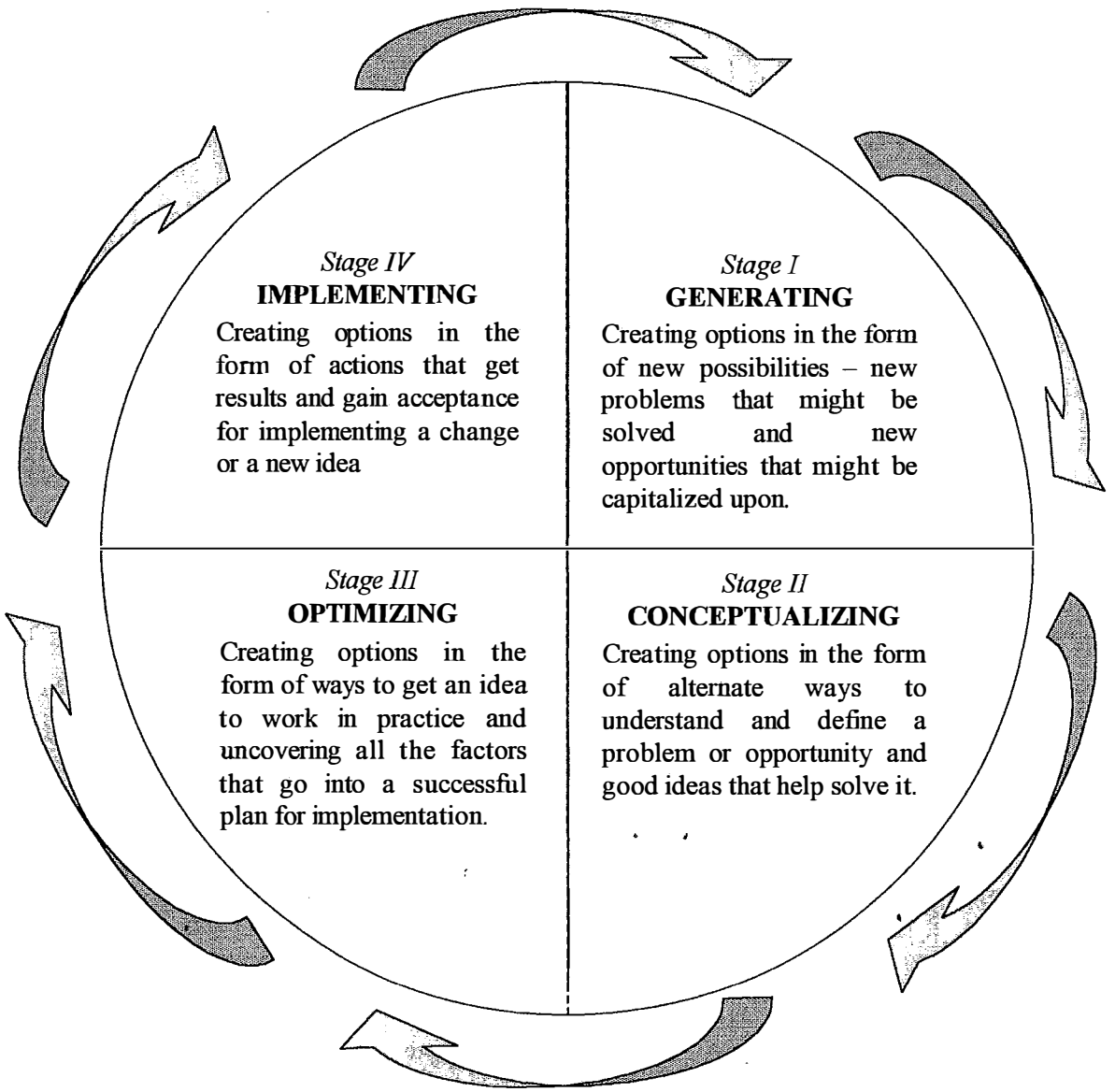
Circular Nature of the New Theory

Based on extensive field research and practical experience within business organizations -- and on both Gordon's (1956, 1971) theory and Carlsson, Keane, and Martin's (1976) empirical evidence -- Basadur (1974; 1979; 1981; 1983) introduced the concept of the creative process as an ongoing cycle. Here the different stages of the creative process are arranged in a circle, recognizing that as new problems are sought and discovered and new solutions subsequently implemented, new problems and opportunities arise. For example, the automobile's invention provided not only a new solution to an old problem (improving transportation) but created many brand-new problems (eg., pollution, energy and accidents). This model, which emphasizes continuous creativity and problem finding, reflects Mott's (1972) research which showed that effective organizations synchronize two vital but very different characteristics: efficiency and adaptability. Efficiency means mastery of routine (standard, prescribed methods by which the organizational unit carries out its main tasks). Efficiency involves optimizing and implementing current products and methods to attain the highest quantity and quality for the lowest possible cost. Adaptability means mastery of deliberate change of routine for innovation. Adaptability means continually and intentionally changing routines and finding new products and methods. Adaptability includes scanning the environment to anticipate new opportunities and problems (opportunistic surveillance (Simon, 1977)). Adaptability begins with generation and conceptualization. Generation focuses on proactively seeking out such new problems to define and solve. Conceptualization means insightfully defining such newly discovered problems and

forming ideas on how to solve the challenges so defined. Adaptability also requires creating optimal solutions (optimization) and taking action on solutions (implementation). Thus adaptability may be represented as a continuous four-stage process of creativity as shown in Figure 2.

Figure 2

The Four Stages of the Creative Process.



MEASURING THE CONSTRUCTS OF THE THEORY

The Creative Problem-Solving Profile (CPSP) inventory

As stated above, the creative problem solving process can be characterized as a continuous circular process (Figure 2) involving two opposite ways of apprehending knowledge and two opposite ways of utilizing knowledge. These two dimensions may be portrayed as two perpendicular axes defining four quadrants or dominant creative-problem solving styles as shown in Figure 1. An individual's creative problem-solving profile can be defined as his or her relative preference for each of these four dominant styles. The purpose of the CPSP inventory is to measure an individual's profile and to display it graphically in an easily accessible form.

Development of the CPSP

A class of 20 graduate business students used divergent thinking to generate a list of descriptors for each of the four concepts representing opposing ways of gaining and using knowledge, that is, Apprehension by Experiencing (denoted X) or by Thinking (T), and Utilization for Ideation (I) or for Evaluation (E). Next, the group reached consensus on the 12 words from each of the four lists that most appropriately described the four concepts. One important criterion for selecting a word was its ability to be matched with a suitable word from the bipolar opposite list (i.e. X versus T; I versus E). The words were then combined into four-item sets, each set containing one word from each of the X, I, T and E lists. Finally, six distractor sets were constructed. These contained unrelated words and were intended to prevent respondents from identifying a pattern and responding stereotypically.

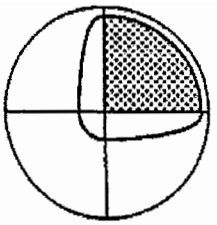
Figure 3

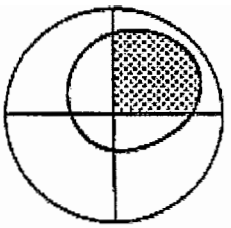
Examples of Different Creative Problem-Solving Profiles.

(All Four Examples Below Have The Generator Style Dominant)

(All Four Profiles Below Have Different Styles Dominant)

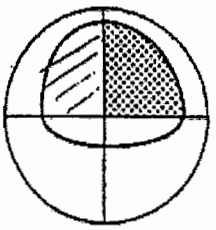
Generator style dominant with all three other quadrants relatively small.

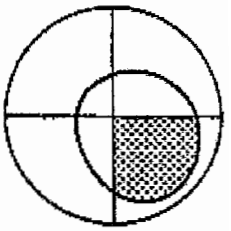




Generator style dominant with all three other styles relatively small.

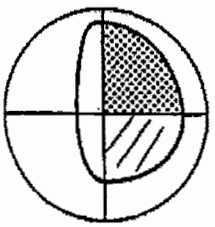
Generator style dominant with Implementer style as strong secondary.

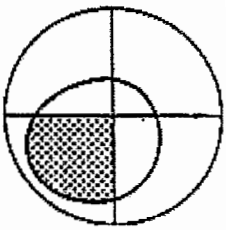




Conceptualizer style dominant with all three other styles relatively small.

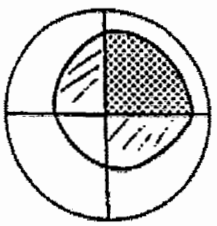
Generator style dominant with Conceptualizer style as strong secondary.

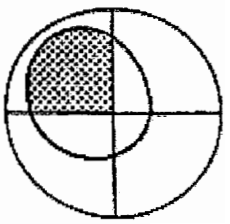




Optimizer style dominant with all three other styles relatively small.

Generator style dominant with Conceptualizer and Implementer as secondary styles of significant and equal strength.





Implementer style dominant with all three other styles relatively small.

Scoring and Plotting

A forced-choice response scale was used. Respondents were instructed to rank the words within each four-item set from 1 to 4, where 1 represented the word "least characteristic of me as a problem-solver" and 4 represented the word "most characteristic of me as a problem-solver"

The inventory is scored as follows: all the items except the distractors are summed to yield four scores denoted X, I, T and E (Experiencing, Ideation, Thinking and Evaluation respectively). Each score is plotted on the appropriate axis of Figure 1. Connecting the four points in sequence with curved lines makes an irregular circle that represents one's creative problem-solving profile (see Figure 3 for examples). Four identical scores would result in a perfect circle. This is unlikely to occur (but is a perfectly legitimate profile). The quadrant in which the profile is most dominant indicates one's strongest orientation or style. The other quadrants represent secondary orientations.

Preliminary Screening

The inventory was tested for face validity with several different training groups. Virtually all of the respondents reported that they understood the inventory and its purpose, and reported that the instrument was accurate in assessing their dominant creative-problem solving style. In addition, CPSP scores demonstrated satisfactory internal consistency and test-retest reliability. (Basadur, Graen & Wakabayashi, 1990).

CPSP RELIABILITY

Since the original version of the CPSP (termed CPSP1) was established, an ongoing program to improve its psychometric properties has been under way. The procedures used to identify the more and less robust items in the inventory are fully described in Basadur (1991;

1998a; 1998b; 2000). Including CPSP1, five progressively improved versions of the CPSP have been completed. Coded CPSP 1, 2, 8, 9 and 11, each version has been evaluated by the method summarized in the following section.

Method

The CPSP is an ipsative questionnaire. Because ipsative scales are inherently intercorrelated, the use of many standard psychometric techniques is rendered inappropriate. One statistic that may, however, be used to evaluate the consistency of ipsative (ranked) scores is Kendall's (1955) coefficient of concordance, denoted W. W is usually applied to the case of k judges ranking N separate targets, and ranges between zero and one. Increasing values of W indicate increasing degrees of consistency between the judges. Here, we may regard each set of four words in the inventory as an independent judgment, and calculate the consistency of judgment (W) across the 12 sets of non-distractor words. (i.e. $N = 4$, $k = 12$.) Kendall's W was calculated for each respondent following the method described in Seigel and Castellan (1988, p. 263) and the average W over all respondents was calculated for each version of the CPSP.

Further psychometric properties of the CPSP were evaluated using a scoring system that produces uncorrelated Apprehension and Utilization scales. In this system, two variables are created from each set of four words. One variable (XT) is constructed by subtracting the T-item score from the X-item score, and the other (IE) by subtracting the E-item score from the I-item score. The 12 XT scores constitute a bipolar scale of Apprehension, which represents the preference for experiencing over thinking; the 12 IE scores constitute a bipolar scale of Utilization representing the preference for ideation over evaluation. For each inventory row, XT and IE can take values of ± 3, ± 2, or ± 1. Furthermore, XT and IE are uncorrelated under conditions of random responding. (To see this, note that the expected value of IE is zero for all

values of XT and vice versa.)

Because the Apprehension and Utilization scales are theoretically uncorrelated, it is possible to analyze their psychometric properties using standard statistical methods such as factor analysis.

Results

Table 2 shows the results for successive versions of the CPSP.

Table 2

Psychometric Properties of Successive Versions of the CPSP

CPSP Version	1	2	8	9	11
Number of Respondents	1,536	2,122	394	830	692
Kendall's W	.16	.21	.22	.33	.32
Reliability[a]					
Apprehension (XT)	.614	.727	.776	.800	.800
Utilization (IE)	.683	.776	.776	.811	.803
Mean inter-item correlation					
Apprehension (XT)	.12	.18	.22	.25	.25
Utilization (IE)	.15	.22	.22	.26	.25
Correlation between XT and IE	.11	-.30	-.27	-.25	-.20
FACTOR ANALYSIS					
% Variance explained					
Factor 1	14.9	17.1	17.5	18.0	17.4
Factor 2	11.2	12.5	14.4	15.8	16.1
First six eigenvalues	3.77	4.62	4.76	5.00	4.78
	2.51	2.49	2.90	3.13	3.26
	1.39	1.47	1.40	1.30	1.20
	1.30	1.10	1.16	1.09	1.10
	1.07	1.05	1.08	1.05	.98
	1.01	1.00	1.00	.96	.96

[a] Cronbach standardized item alpha

The increases in $\underline{W}$ with successive versions of the CPSP indicate that modifications to the instrument produced a general improvement in the consistency of ranking assignments, leveling off at CPSP 9.

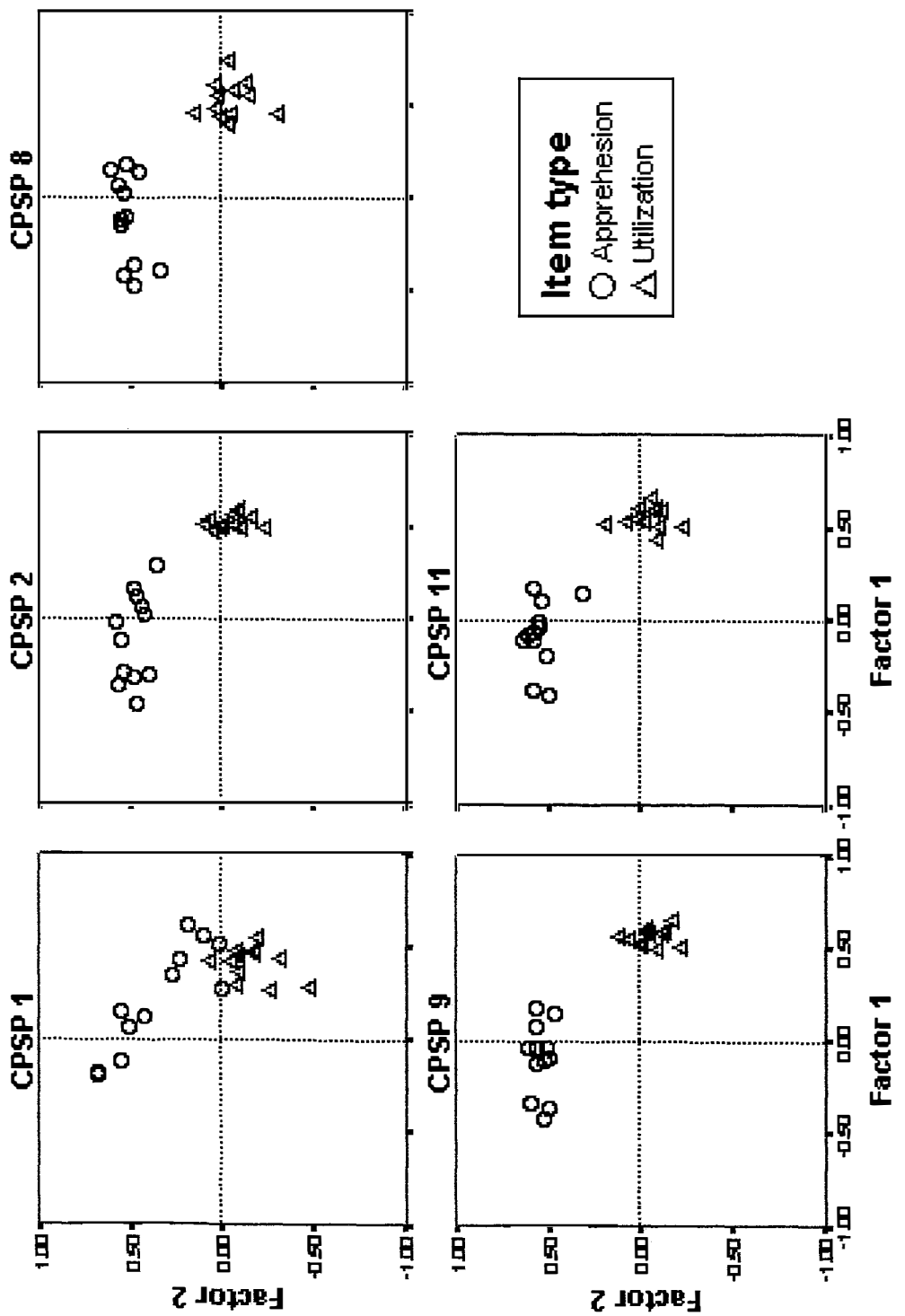
For both the XT and the IE scales, successive modifications lead to a general improvement in the mean inter-item correlation and standardized item alpha that levels off at CPSP9. The change from CPSP1 to CPSP2 leads to an increased correlation between the scales, which then decreases with successive modifications.

Factor analysis of the Apprehension and Utilization scores (Principal Components extraction with Varimax rotation) was conducted for each version of the instrument. The Velicer Map test for factor extraction quantity (Velicer, 1976) indicated a two-factor structure in each case, as did a Scree plot of the eigenvalues (Cattell, 1966). As shown in Table 2, in successive versions of the inventory, the first two factors explain successively higher percentages of variance, leveling off at CPSP9. Furthermore, inspection of the factor loading matrices showed that successive modifications of the questionnaire generally decreased the loadings of items on to non-keyed factors. The factor loading plots in Figure 4 illustrate this effect: the association between the items and their keyed factors is visibly stronger in CPSP 2 and subsequent versions than in CPSP 1.

Overall, these results demonstrate satisfactory psychometric properties in terms of consistency, scale reliability and scale discrimination in the most recent CPSP versions and substantial improvements in the subsequent versions of the CPSP.

Figure 4

Factor Loading Plots for Successive Versions of the CPSP.



CPSP VALIDITY

Previous research bearing on the validity of the CPSP has been reported in full elsewhere, and is summarized briefly here. First, individuals' assessments of their own CPSP style by themselves alone and in conjunction with an expert partner, agree with the assessments made by the inventory itself (Basadur, 1998a), demonstrating face-validity. Secondly, CPSP scores show convergent validity with both the Kirton Adaption-Innovation Inventory (KAI) (Basadur, Takai, & Wakabayashi, 1990; Basadur, 1991; 1998a) and the Myers-Briggs Type Indicator (MBTI) (Basadur, 1991; 1998a; 2000). For example, CPSP Generators have elevated innovation scores on the KAI; furthermore a preference for CPSP Evaluation (as compared to Ideation) is associated with elevated Sensing on the MBTI Sensing-Intuition scale and with elevated Judging on the MBTI Judging-Perception scale. Thirdly, the CPSP has predictive validity in creative problem-solving situations; teams with a heterogeneous mix of CPSP styles significantly outperform teams with a homogeneous mix of styles in innovative work (Basadur & Head, 2001).

Perhaps the most influential career development theory in occupational psychology is Holland's (1959 , 1985) theory of vocational personalities and work environments. According to this theory, people and work environments can be meaningfully classified into different types, and "people search for [work] environments that will allow them to exercise their skills and abilities, express their attitudes and values, and take on agreeable problems and roles" (Holland, 1985 , p. 4). The occupation that people will find most satisfactory, and the one in which they will be the most successful, is the one that maximizes the congruence between the demands of the work environment and their vocational personality. This theory suggests that an individual's occupation might be predicted from knowledge of his or her CPSP style, and this possibility is examined below.

First we predict a relationship between dominant CPSP style and organizational level. As individuals assume increasing levels of responsibility in an organization, the less important it is to implement day-to-day operational tasks and the more important it is to create vision and policy, to think strategically about the future, to conceptualize the "big picture" and to create appropriate goals for others to achieve. According to this logic, we might expect to find a higher proportion of Conceptualizers at higher organizational levels. We further suggest that highly specialized technical and professional people, including economists, scientists and planners, who are employed by their organizations primarily to think rather than to execute would also tend to be Conceptualizers rather than Implementers.

Similar reasoning suggests a relationship between dominant CPSP style and occupation. Some (but not necessarily all) occupations are characterized by an emphasis on one of the four stages of the creative process depicted in Figure 2. According to Holland's theory of vocational choice, we might thus expect to find certain occupations to be disproportionately populated by individuals with a matching creative thinking style (dominant CPSP quadrant).

Occupations that require people to initiate change, recognize opportunities and new possibilities, start projects, and to work with people in unstructured situations might thus be expected to contain a relatively high proportion of Generator (Quadrant I dominant) individuals. Typical occupations here would be the artistic and academic professions, training and teaching, and marketing. Similarly, fields such as strategic planning and research and development, where defining problems, understanding situations, and creating direction and strategy are important, might be expected to contain a relatively high proportion of Conceptualizers (Quadrant II dominant). Quadrant III (Optimizer) activities involve solving problems with precision and evaluating and optimizing products and procedures. This should be characteristic of fields such as engineering, IT systems development, finance and accounting. Quadrant IV (Implementer)

fields of endeavor would likely emphasize shorter-term implementation work, for example sales, manufacturing production, secretarial or administrative support, and project management.

Method

A total of 6091 CPSP inventories were collated (CPSP version 1, n = 1536; CPSP version 2, n = 2122; CPSP version 8, n = 441; CPSP version 9, n= 883; CPSP version 11, n = 1109). Respondents were either attendees at in-company and public training courses in creative thinking, (the vast majority in full-time employment), or MBA or business students who completed the CPSP as an element of course-work. Respondents were given the option of reporting their name, job title, department and employing organization or of completing the inventory anonymously. Job title, department and employing organization was used to classify each respondent where possible by occupation and organizational level. Of all respondents in employment, 3,942 could be categorized into one of 38 occupations (minimum n = 27), and 3,783 into one of five organizational levels. The first four organizational levels (non-manager, supervisor/team leader, middle manager, upper manager) represented increasing levels of organizational responsibility, and hypothetically, increasing demand for strategic thinking. The fifth category comprised specialist technical and professional jobs.

Apprehension (XT) and Utilization (IE) scores were calculated for each respondent. For ease of interpretation, the scores were converted to T-scores (mean = 50, standard deviation = 10) by standardizing the raw scores within each inventory version. Respondents were then assigned to one of four CPSP style quadrants according to their XT and IE scores. Thus, if XT was greater than 50 and IE was greater than 50 the individual was assigned to the Generator quadrant; if XT was less than 50 and IE was greater than 50 the individual was assigned to the Conceptualizer quadrant; if XT was less than 50 and IE was less than 50 the individual was

assigned to the Optimizer quadrant, and if XT was greater than 50 and IE was less than 50 the individual was assigned to the Implementer quadrant. The overall percentage of respondents in each quadrant was: Generator, 20.1%, Conceptualizer, 26.2%, Optimizer, 21.7%, Implementer 32.0%.

Results and Discussion

Table 3 shows the results for organizational level. For each level, table 3 reports the mean XT and IE scores and their standard errors, and the percentage of individuals in each CPSP quadrant.

Table 3

CPSP Scale T-Scores and Mix of CPSP Styles by Organizational Level.

		Apprehension (XT)		Utilization (IE)		Percentage of			
	n	Mean	S.E.	Mean	S.E.	Generators	Conceptualizers	Optimizers	Implementers
Organizational Level									
Non-manager	449	51.6	0.45	47.6	0.40	19.4	16.9	22.3	41.4
Supervisor/Team Leader	1073	51.9	0.29	47.8	0.26	19.9	17.3	21.8	40.9
Middle Manager	843	50.3	0.34	49.7	0.34	19.5	24.4	22.3	33.8
Upper Manager	357	48.7	0.55	51.6	0.52	17.9	35.9	17.4	28.9
Technical/Professional	1061	48.7	0.32	51.6	0.33	22.8	30.2	23.3	23.8

Analysis of variance shows that both the XT and the IE scale scores vary significantly by organizational level, (XT, $F = 17.8$, $df = 4$, $p < .001$; IE, $F=29.2$, $df = 4$, $p < .001$). Linear contrast tests show that the XT scale scores decrease ($t = -7.04$, $p < .001$) and the IE scale scores increase ($t= 9.57$, $p < .001$) with increasing level of organizational responsibility for strategic thinking. This indicates an increased demand for Thinking (as opposed to Experiencing) and for Ideation (as opposed to Evaluation) at higher organizational levels.

This is further reflected in the percentage figures which are also plotted in figure 5, where we see that as predicted, the percentage of Conceptualizers increases ($\chi^2 = 87.5$, df = 4, $p < .001$), and the percentage of Implementers decreases ($\chi^2 = 88.0$, df = 4, $p < .001$) with increasing levels of strategic thinking responsibility. The percentages of Generators and Optimizers on the other hand are relatively stable across organizational level (Generators, $\chi^2 = 6.03$, df = 4, ns; Optimizers; $\chi^2 = 5.6$, df = 4, ns).

Figure 5

Mix of CPSP Styles by Organizational Level.

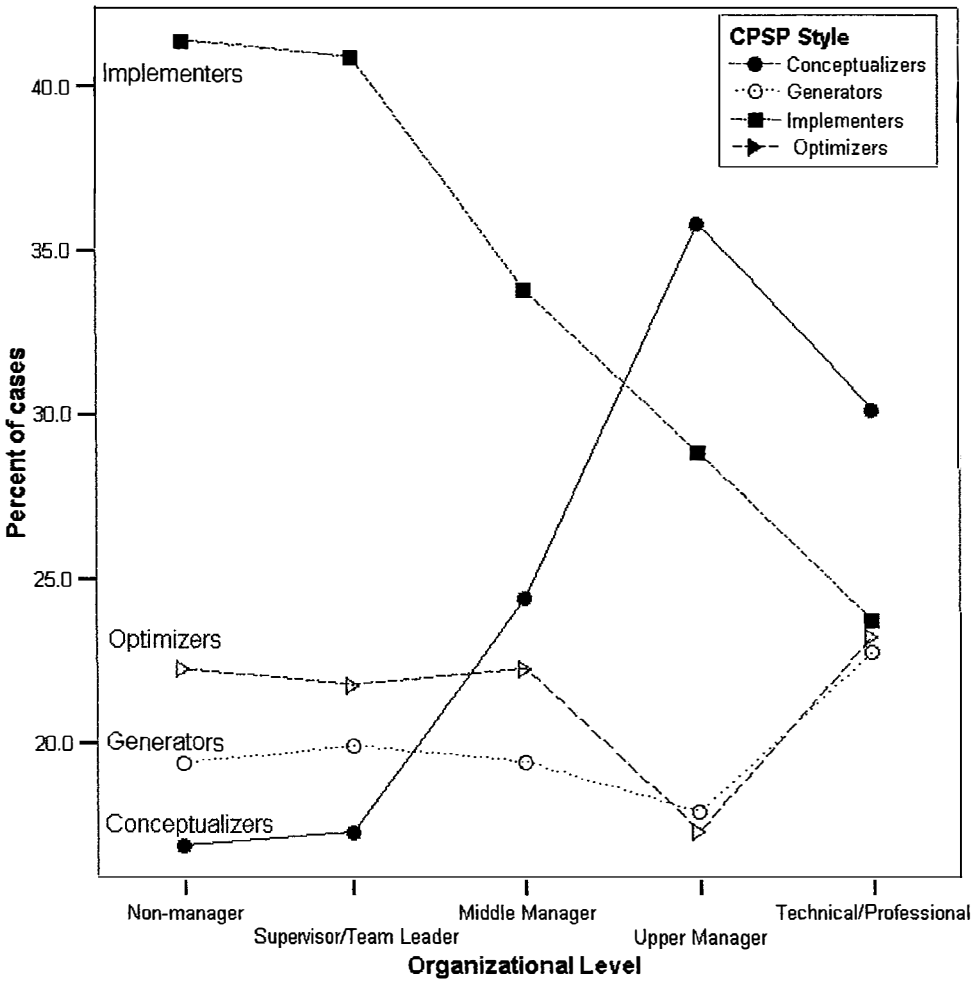


Table 4 shows the mean scale scores and their standard errors for individuals in various occupations, and the percentages of individuals in each CPSP quadrant.

Table 4

CPSP Scale T-Scores and Mix of CPSP Styles by Occupation.

		Apprehension (XT)		Utilization (IE)		Percentage of			
	n	Mean	S.E.	Mean	S.E.	Generators	Conceptualizers	Optimizers	Implementers
Occupation									
School Teacher	27	51.9	2.1	60.4	2.1	55.6	22.2	11.1	11.1
Academic	58	47.9	1.6	58.5	1.6	37.9	39.7	10.3	12.1
Artistic	32	47.4	2.0	60.9	1.7	34.4	46.9	12.5	6.3
Non-Profit/University Admin.	89	51.5	1.0	53.1	1.1	32.6	28.1	13.5	25.8
Training	240	49.2	0.7	55.6	0.7	32.5	32.5	17.9	17.1
Marketing	172	49.0	0.8	53.6	0.7	30.2	33.7	19.8	16.3
Design	73	47.6	1.0	57.3	1.0	30.1	47.9	12.3	9.6
Health Mgmt. Exec.	37	50.4	1.6	52.0	1.5	29.7	21.6	21.6	27.0
Advertising Mgr.	68	50.2	1.0	50.9	1.2	26.5	30.9	17.6	25.0
Tech. Customer Support	46	51.5	1.5	46.9	1.3	23.9	10.9	28.3	37.0
Sales	379	53.8	0.4	47.9	0.4	23.7	14.0	15.6	46.7
Logistics	94	53.1	0.9	47.1	0.8	22.3	12.8	22.3	42.6
Product Dev.	45	48.9	1.7	55.5	1.7	22.2	44.4	8.9	24.4
Personnel/HR	144	50.1	0.8	50.2	0.8	21.5	28.5	20.1	29.9
Business Consultant	63	50.0	1.2	50.9	1.2	20.6	28.6	20.6	30.2
Mfg Prodn.	386	52.1	0.4	48.0	0.4	20.2	18.4	17.1	44.3
Fund Raising/PR	37	51.0	1.4	51.1	1.5	18.9	32.4	18.9	29.7
R&D	95	45.1	1.1	55.1	1.2	17.9	47.4	18.9	15.8
Organization Dev.	81	44.9	1.1	59.6	1.2	17.3	60.5	12.3	9.9
Qual. Assurance	87	50.3	1.1	49.1	1.1	17.2	21.8	24.1	36.8
Mfg. Maintenance	54	49.7	1.3	48.0	1.0	16.7	24.1	22.2	37.0
Project Mgr.	78	53.3	1.1	45.7	0.9	16.7	12.8	21.8	48.7
Operations	45	52.7	1.5	46.9	1.2	15.6	20.0	22.2	42.2
Gen. Mgmt-Small Co./Div.	84	52.0	1.1	48.0	1.0	15.5	21.4	21.4	41.7
IT Prog/Analyst	194	49.7	0.7	46.9	0.6	15.5	17.5	31.4	35.6
Secretarial/Admin	159	52.6	0.8	45.7	0.7	14.5	13.2	22.0	50.3
Accounting	105	48.9	0.9	47.7	0.8	13.3	22.9	30.5	33.3
Market Research	23	45.1	2.3	52.0	2.5	13.0	52.2	17.4	17.4
Purchasing	69	51.3	1.0	46.6	1.1	13.0	15.9	24.6	46.4
Customer Relations	65	52.2	1.2	46.3	1.1	12.3	15.4	21.5	50.8
Social/Health Services	131	48.9	0.9	48.1	0.8	12.2	24.4	28.2	35.1
IT Operations	117	53.9	0.8	44.6	0.7	12.0	6.8	17.1	64.1
IT Sr. Consultant	85	45.3	1.2	50.2	1.2	10.6	40.0	27.1	22.4
Finance	110	46.9	0.9	47.1	0.8	10.0	26.4	36.4	27.3
IT Systems Developer	199	46.7	0.7	48.7	0.7	9.5	31.2	36.2	23.1
Mfg Engineering	32	45.4	1.8	46.9	1.4	9.4	34.4	37.5	18.8
Strategic Planning	46	42.8	1.4	53.8	1.6	8.7	56.5	28.3	6.5
Engineering/Eng. Design	93	47.7	0.9	46.4	0.8	7.5	21.5	43.0	28.0

Analysis of variance shows that both XT scores ($F = 8.2$, $df = 37$, $p < .001$) and IE scores ($F = 18.5$, $df = 37$, $p < .001$) vary significantly by occupation. Maximum likelihood estimates of variance show that occupation and job level together account for 6.2% of the variance in XT scores and 18.2% of the variance in IE scores.

The CPSP styles associated with different occupations are most clearly seen in table 5.

In the first column of table 5, the occupations are ranked (in descending order) by the percentage of Generators in each. Thus the occupation with the highest proportion of Generators is School Teacher, and the occupation with the next highest proportion is Academic. In the second column, occupations are ranked by the percentage of Conceptualizers. Here we see that Academics (ranked 9th) are more likely to be Conceptualizers than are School Teachers (ranked 23rd); the occupations that contain the highest proportion of Conceptualizers are Organization Development, Strategic Planning and Market Research. In the last two columns occupations are ranked by the percentages of Optimizers and Implementers respectively. Inspection of these two columns shows that few School Teachers and Academics are either Optimizers or Implementers; the occupations that contain the most Optimizers are Engineering and Finance, and the occupations that contain the most Implementers are IT Operations, Customer Relations and Secretarial/Administrative support.

In general these results support the hypothesis of compatibility between an individual's occupation and his or her preferred creative problem-solving style. This may be because individuals with certain CPSP styles are attracted the kinds of jobs that emphasise their existing preferences. On the other hand, an individual's natural preferences might be modified by exposure to work experiences that reward types of cognitive activity appropriate to the job. Similar reasoning can be applied to the relationship between CPSP style and organizational level. Individuals demonstrating a preference for conceptual thinking may be more likely to be

Table 5

Occupations Ranked by Occurrence of Each CPSP Style.

Rank	Generators	Conceptualizers	Optimizers	Implementers
1	School Teacher	Organization Dev.	Engineering/Eng. Design	IT Operations
2	Academic	Strategic Planning	Mfg Engineering	Customer Relations
3	Artistic	Market Research	Finance	Secretarial/Admin
4	Non-Profit/University Admin.	Design	IT Systems Developer	Project Mgr.
5	Training	R&D	IT Prog/Analyst	Sales
6	Marketing	Artistic	Accounting	Purchasing
7	Design	Product Dev.	Strategic Planning	Mfg Prodn.
8	Health Mgmt. Exec.	IT Sr. Consultant	Tech. Customer Support	Logistics
9	Advertising Mgr.	Academic	Social/Health Services	Operations
10	Tech. Customer Support	Mfg Engineering	IT Sr. Consultant	Gen. Mgmt-Small Co./Div.
11	Sales	Marketing	Purchasing	Tech. Customer Support
12	Logistics	Training	Qual. Assurance	Mfg. Maintenance
13	Product Dev.	Fund Raising/PR	Logistics	Qual. Assurance
14	Personnel/HR	IT Systems Developer	Mfg. Maintenance	IT Prog/Analyst
15	Business Consultant	Advertising Mgr.	Operations	Social/Health Services
16	Mfg Prodn.	Business Consultant	Secretarial/Admin	Accounting
17	Fund Raising/PR	Personnel/HR	Project Mgr.	Business Consultant
18	R&D	Non-Profit/University Admin.	Health Mgmt. Exec.	Personnel/HR
19	Organization Dev.	Finance	Customer Relations	Fund Raising/PR
20	Qual. Assurance	Social/Health Services	Gen. Mgmt-Small Co./Div.	Engineering/Eng. Design
21	Mfg. Maintenance	Mfg. Maintenance	Business Consultant	Finance
22	Project Mgr.	Accounting	Personnel/HR	Health Mgmt. Exec.
23	Operations	School Teacher	Marketing	Non-Profit/University Admin.
24	Gen. Mgmt-Small Co./Div.	Qual. Assurance	R&D	Advertising Mgr.
25	IT Prog/Analyst	Health Mgmt. Exec.	Fund Raising/PR	Product Dev.
26	Secretarial/Admin	Engineering/Eng. Design	Training	IT Systems Developer
27	Accounting	Gen. Mgmt-Small Co./Div.	Advertising Mgr.	IT Sr. Consultant
28	Market Research	Operations	Market Research	Mfg Engineering
29	Purchasing	Mfg Prodn.	Mfg Prodn.	Market Research
30	Customer Relations	IT Prog/Analyst	IT Operations	Training
31	Social/Health Services	Purchasing	Sales	Marketing
32	IT Operations	Customer Relations	Non-Profit/University Admin.	R&D
33	IT Sr. Consultant	Sales	Artistic	Academic
34	Finance	Secretarial/Admin	Organization Dev.	School Teacher
35	IT Systems Developer	Logistics	Design	Organization Dev.
36	Mfg Engineering	Project Mgr.	School Teacher	Design
37	Strategic Planning	Tech. Customer Support	Academic	Strategic Planning
38	Engineering/Eng. Design	IT Operations	Product Dev.	Artistic

Note: Occupations ranked 1 contain the highest percentages of the relevant style.

promoted; alternatively, individuals seeking promotion to higher levels may modify their preferred style to increase their chances of advancement.

Individuals preferring the Generator style were predominantly found in non-industrial occupations; few business and industrial occupations in this study had a high proportion of Generators. This finding is perhaps the most provocative for business and industry, whose most perplexing challenge today is how to be more innovative in the face of accelerating change. Indeed, many leading management consultants exhort corporations to "begin their revolutions" ....to expand their thinking and do things differently. Improving current methods and procedures is no longer sufficient, they say; instead they advocate deliberate change and advise corporations to explore new markets rather than defend old ones. The new rule seems to be "if it ain't broke, break it anyway." While many corporations find this an appealing strategy, they also find it difficult to implement. Perhaps one reason for this difficulty is the lack of employees with a preference for the Generator style of thinking.

If indeed organizational success depends so critically on deliberate change, and if Holland's theory of vocational choice is correct, why are employees with Generator characteristics apparently under-represented in business organizations? Perhaps many companies have yet to learn how to retain and motivate individuals who prefer the Generator style. Generators are the farthest away from work that is visibly measurable. In contrast to people in sales and manufacturing for example, Generators do not produce tangible and measurable results such as sales completed or goods produced. Rather, they initiate work that others carry forward and complete. It is therefore perhaps more difficult for organizations to recognize their contributions and reward the kind of work that they do.

CONCLUSIONS

Theorizing about creativity in psychology has until now been characterized by a proliferation of models and a diversity of construct definitions. A central problem for creativity researchers has been how to distinguish between the merits of these various conceptions. Although scientific diversity is laudable, the accumulation of evidence and understanding can be hindered considerably when different theories each use their own language, and scientific progress in this area seems to have been limited by, amongst other things, our inability to test competing theories of creativity against each other. What is now needed is a recognition that many features of these alternative theories are in fact redundant, and that many of the apparent differences between them are simply differences of nomenclature.

The present paper has sought to address this issue by identifying four basic underlying mental operations (two modes of knowledge Apprehension and two modes of knowledge Utilization) and showing that several of the most influential theories of creativity can be successfully discussed in terms of these operations. We further suggest that these four operations provide a sound basis for a dynamic model of the creative process that adequately describes the stages of creative problem discovery, definition and solution, and solution implementation.

This work is far from complete. In particular, the primacy of these four operations would be greatly strengthened by demonstrating that they are mental dispositions that either persist over time or change in predictable ways; that they may be identified in multiple cultural or ethnic groups irrespective of language; and that they may be demonstrated to have either a biological or a developmental basis.

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APPENDIX 1

MORE ABOUT THE DUAL NATURE OF APPREHENSION

In academia, many students are still primarily exposed to (and graded upon) the theoretical/analytical (convergent production) method of acquiring understanding and comprehension rather than the experiential, non-analytical (cognition) method. For example, SAT scores are used to admit students to many North American universities. GMAT scores are used for admission to most North American business schools. The scoring of both SAT and GMAT is performed mainly by computers. In contrast, some thinkers have placed primacy on learning by the experiencing/non-rational (cognition) method. For example, the educator Quine concluded that "a person can only understand the world empirically, that is, through his or her direct experience in it" (Lehmann-Haupt, 2000). The poet Keats once wrote "nothing is real until it is experienced."

The recognition of this dual nature of knowledge Apprehension is longstanding. The philosopher Kant divided cognition into two components: sensory and intellectual (Hatfield 1998; Dowdell, 1978; Kant, 1798). Sensory and intellectual representations of cognition are fundamentally different and were labeled "intuition" and "concept." Kant held that cognition requires both active elements (concepts) and passive elements (intuitions). Intuitions arise from sensations while concepts perform the active function of ordering intuitions. Descartes (1641/1984) separated sensory receptivity from intellectual judgment and stated that "the senses do not err because they do not judge." Thorndike (1931) distinguished between "learning by trial and error" and "learning by ideas," the former being characterized by association and the latter being characterized by analysis.

McTaggart (1997) further explored these two forms of acquiring understanding using Stake's (1978) presentation of differing viewpoints as follows. First, Stake quoted Francis Bacon as stating:

> "There are and can be only two ways of searching and discovering truth. The one flies from the senses and particulars to the most general axioms... this is now the fashion. The other derives axioms from the senses and particulars, rising by a gradual and unbroken ascent, so that it arrives at the most general axioms last of all. This is the true way, but as yet untried."

Second, Stake quoted William Blake as offering an opposing view:

> "To generalize is to be an idiot. To particularize is the lone distinction of merit. General knowledges are those that idiots possess."

Stake brought the two viewpoints together as follows:

> "Generalization may not be all that despicable, but particularization does deserve praise. To know particulars fleetingly is to know next to nothing. What becomes useful understanding is a full and thorough knowledge of the particular, recognizing it also in new and foreign contexts. That knowledge is a form of generalization too, not scientific induction but *naturalistic generalization*, arrived at by recognizing the similarities of objects and issues in and out of context and by sensing the natural covariations of happenings. To generalize in this way is to be both intuitive and empirical and not idiotic."

Some educators advocate learning approaches that emphasize both ends of this bipolar spectrum of knowledge acquisition (eg., Flavell, 1963; Bruner, 1960; 1966; Harvey, Hunt & Shroeder, 1961). Kolb (1976) emphasized the importance of using experiential learning to complement theoretical learning. Kolb suggested a four-phase learning cycle with two concrete, experiential learning phases and two theoretical, analytical learning phases. The Kolb cycle begins (concrete experience) and ends (active experimentation) experientially. Between these are two phases that are both theoretical/analytical, or non-experiential (reflective observation and abstract conceptualization).

Eisenhardt and Tabrizi (1995) investigated strategies for accelerating product development under uncertainty and distinguished between understanding through direct contact and through compressing already well understood system links. Similarly, Cheng and Van de

Ven (1996) distinguished between learning from chaotic patterns of interaction and learning by analytical coupling of outcomes and consequences.

McGrath (2001) recommended a contingency approach to knowledge acquisition. At one contingency pole lies learning by discovery through enactment to create variety. This represents high "exploratory learning." At the opposite contingency pole is learning by directed search, a process of homing in and deepening initial insights. This represents low exploratory learning. The greater the need for coping with increasing complexity and rapid change, the greater the need for "exploratory learning" (McGrath, 2001; Eisenhardt, 1998). In highly novel situations, experimentation is necessary to create a variety of information that cannot be obtained in any other way, since no base of cause-and-effect understanding exists. Weick (1979) suggested that, before such an analytical understanding can exist, organizational members must first enact a base of knowledge. As more knowledge is enacted in this way, greater effort can be focused on developing increasingly systematized, codified, and well-understood procedures (Nelson & Winter, 1982). Guidebooks come to replace improvisation, roles and jobs become more clearly defined, and rules for "how we do things here" gradually replace trial and error. The overall gist of these writings on the contingency approach is to promote the ability to move along a continuum of knowledge acquisition ranging from experiential learning to learning by thinking according to changing situations.

In summary, there is ample support for the dual nature of acquiring knowledge and certainly for expanding this concept beyond the limits of acquiring knowledge only by theoretical/analytical (Convergent Production) means. Perhaps Thorndike's "trial and error learning," Guilford's "Cognition," and Descartes' "sensory receptivity" could be categorized as "learning by non-rational, non-analytical, physical processing of information," while Thorndike's "learning by ideas," Guilford's "convergent production," and Descartes' "intellectual judgment" could be categorized as "learning by rational, analytical, mental processing of information."

What is suggested is a bipolar dimension. At one pole is acquiring understanding physically, by experiencing ("by just being there" to non-directively experience, absorb, and discover). At the other is acquiring understanding mentally, by thinking (analyzing and manipulating thoughts in one's mind to create explanations and theories).

APPENDIX 2

MORE ABOUT THE DUAL NATURE OF UTILIZATION

As documented above, there is also ample support from the literature for a second bipolar dimension of mental operations, that of the application of knowledge. This second dimension concerns applying understanding (however acquired) in two different ways – creating new information and options (as in divergent production) and judging new information and options (as in evaluation).

Osborn (1953) advocated "deferring judgment," which means separating the process of non-judgmentally *creating* options from the process of judgmentally *evaluating* options. Other researchers have also bipolarized option-producing and option-judging thinking processes (Joyner & Tunstall, 1970; Maier, 1967; Simon, 1960; Simon, Newell & Shaw, 1962; Parnes, Noller & Biondi, 1977). Kirton (1976) dichotomized creative thinkers into two polar opposite types – adaptors, who tend to use disciplined thinking and rely on evaluation to stay within rules and boundaries; and innovators, who tend to divergently break rules and boundaries. Basadur, Graen and Green (1982) identified a separated, sequenced two-step thinking process called "ideation-evaluation." They defined ideation as the generation of options without judgment and evaluation as the application of judgment to those options. During ideation, all judgmental, rational, convergent thinking is deliberately deferred in favor of non-judgmental, imaginative, divergent thinking. During evaluation, the reverse takes place. Basadur and Finkbeiner (1985)

identified and created measures for attitudinal factors related to one's preferences for non-judgmental (diverging) and judgmental (evaluating) modes of knowledge Utilization.

Meeker (1969) emphasized the importance of distinguishing between "divergent production" with "creativity." In their review, Kabanoff and Rossiter (1994) credit Guilford with introducing the concept of divergent production, but emphasize research that positions the concept as only one element of applied creativity. Cooper (1993) and his colleagues have written extensively about the vital importance of evaluation skills in creating successful new products. Meeker (1969) suggested that the desire for adequate measures of creativity has prompted some to erroneously equate divergent production with creativity. According to Meeker, while the association may be close, a distinction between the two must be maintained. Divergent production should be considered as a necessary, but insufficient, condition for creative thinking. The worthwhile generation of information requires discipline and guidance. Meeker suggested that creativity includes flexibility, individuality, and an ability to break away from the conventional, but that it also includes evaluation to ensure quality, relevance, and discipline. Similarly, Jackson and Messick (1964) balanced "unusualness" with "appropriateness" as two opposing criteria for judging the creativity of a product.

APPENDIX 3

THE AMBIGUOUS NATURE OF KNOWLEDGE

Although we have discussed apprehending and utilizing knowledge in this article, we must acknowledge that there is no universally agreed-upon definition of "knowledge." For example, Schwab (1969) maintained that all of the social and behavioral sciences are marked by competing schools of thought and enquiry, and because each subject is so complex and intimidating, each school selects only the small fraction of the whole with which it can deal. This produces multiple, co-existing and incomplete theories as ways of understanding such "fields of

knowledge." McTaggart (1997) suggested managers must build an understanding of how three different kinds of knowledge interact: distilled knowledge (theories), knowledge of the situation, and knowledge embedded in experience. Some researchers and practitioners emphasize distinctions between information, data, and knowledge (Akbar, in press). To Davis and Botkin (1994), information is the "meaningful conversion of an unorganized sludge of data." Strydom (1994) considered knowledge as the sum of information acquired, and Machlup (1984) described knowledge as the "stock of expertise" and described information as the "act of informing." Knowledge has been also positioned as the intervening variable between "mere information" and "relevant and purposeful information" (Drucker, 1998).

Knowledge has also been differentiated in terms of its private or collective nature, and its explicit and tacit forms. Organizational (collective) knowledge refers to the sharing and distribution of individual (private) knowledge among organizational members (Lam, 2000). Such collective knowledge is stored in the goods and services of an organization (Davis & Botkin, 1994) or in its rules, procedures, routines and shared norms (Lam, 2000). Explicit knowledge refers to hard, codified data (Nonaka, 1991), including an organization's routines, procedures, practices, know-how and conduct (Leroy & Ramanantsoa, 1997). Such knowledge is formal and structured (Kim, 1993), and can be aggregated at a single location and stored in objective forms (Lam, 2000). Tacit knowledge, on the other hand, refers to the highly subjective insights, intuitions and hunches (Nonaka, 1991), and the skills and experiences that a person accumulates over time (Leroy & Ramanantsoa, 1997). Tacit knowledge is personal (Chesbrough & Teece, 1996; Howells, 1996; Lall, 1985) and often is too specific and singular in nature (Leroy & Ramanantsoa, 1997) to be easily formalized or organized (Kim, 1993) or easily aggregated at a single location (Lam, 2000). The interest in tacit knowledge dates back to Polyani's (1962; 1966) consideration of all knowledge as either being tacit or rooted in the tacit component. Over the years, such knowledge is recognized as playing a significant role in sustaining a firm's

competitiveness (Winter, 1987), technological innovation (Howells, 1996), and overall success (Nonaka, 1991).

Some have modeled knowledge as a process. Nonaka (1994) suggested that knowledge is a dynamic process of "justifying personal belief" as part of an aspiration for truth (rather than an absolute, static and non-human end state that is equated with "truth" in traditional epistemology). According to Lam (2000) and Nonaka and Takeuchi (1995), new knowledge is created through dynamic interactions between explicit and tacit knowledge. Others have offered the following views. The transformation of explicit knowledge can be achieved through practice, repetition, reinforcement, imitation and socialization (Leroy & Ramanantsoa, 1997). The transformation of tacit knowledge is more problematic because it is difficult to codify (Leroy & Ramanantsoa, 1997). Such knowledge is transmitted through experience and trial-and-error (Leroy & Ramanantsoa, 1997); "learning by doing" and practical experience in the relevant context (Lam, 2000); observation, imitation and practice (Nonaka, 1991); or the process of immersion (Baumard, 1999). Critical to this acquisition is the active involvement of the individual in the "context" (Nonaka, 1994) and a close interaction among the knowing subjects (Lam, 2000).

Other approaches to defining knowledge include concepts such as "single loop vs double loop learning" and behaviorism vs cognitivism. Argyris (1976; 1977) suggested that true learning organizations go beyond understanding the "what" and the "how" (single loop) to understanding the "why" (double loop). Debate has gone on for decades between theories of organizational learning that split along behaviorism and cognitivism lines. The latter school insists on the importance of the individual's internal cognitive and affective uniqueness in mediating learning while behaviorism insists on considering only external variables based on observable experience.

"Organizational learning" has been defined as the process of detecting and correcting errors (Argyris, 1977), gaining experience (Dibella, Nevis & Gould, 1996), improving actions (Fiol & Lyles; 1985), the acquisition and development of cognitive and behavioral skills (Leroy

& Ramanantsoa, 1997), and knowledge about action-outcome relationships and the external effects on these relationships (Shrivastava, 1983). These definitions are usually used in terms of improved performance or action as the objectives of "organizational learning."

APPENDIX 4

PREDICTED CREATIVE PROCESS PREFERENCES BY QUADRANT

Quadrant Preference Descriptions

It is reasonable to predict that different people may prefer creative activity in certain quadrants above that in other quadrants. Following are more complete descriptions of preferences for each quadrant.

Quadrant I Preference

The Quadrant I orientation toward creative problem solving is called Generation. In a Generator mode, one's dominant creative problem solving inclinations are: (1) learning by direct concrete experience (sensing the environment; absorbing knowledge; experiencing and gathering information personally) and (2) using knowledge for ideation (imagining possibilities and sensing relevance in almost everything; seeing many different points of view; dreaming about what might be; wondering why things seem to be what they are; speculating about the future). Combining these two inclinations would indicate a preference for problem-sensing and fact-finding activities in the creative process. When operating as a Generator, one is an initiator, a proliferator of opportunities, problems, facts and feelings. Sensitive to the environment, Generators absorb diverse information and possibilities that might pertain to their interests and goals. Generators would be expected to be relatively comfortable with high ambiguity, unstructured information and potential opportunity. In a Generator mode, people would enjoy starting things, be comfortable in the early phases of creative problem solving, and act as

problem starters and challenge finders. They would anticipate and sense new problems, changes and opportunities, and enjoy fact finding. To some, such people appear to be continually discontented with the status quo – never seeming to leave well enough alone. They are in fact problem finders rather than solution finders.

Quadrant II Preference

The Quadrant II orientation toward creative problem solving is called Conceptualization. People who prefer this combination create theories to explain how elements of a situation might fit together and then are not satisfied until a complete picture of understanding has been achieved. Quadrant II people enjoy nurturing and playing with these ideas. Only when such understanding is achieved is the Quadrant II person willing to proceed. These people resist proceeding to solutions if they remain unsatisfied that the problem has been defined sufficiently well. They are especially resistant to those who wish to implement knee-jerk solutions without sufficient patience to think through the definition of the problem carefully and consider alternative options.

When one is operating in a Conceptualizer mode, one's dominant creative problem-solving inclinations are: (1) using knowledge for ideation (as above) and (2) gaining knowledge by detached abstract thinking (trying to understand or explain a situation cognitively; being detached and objective; making sense of things in the abstract). The Conceptualizer's combination of these two inclinations would be predicted to indicate a preference for problem formulation or definition and idea generation. Conceptualizers tend to absorb a wide range of seemingly unrelated facts or idea fragments and possibilities, and assimilate them into an integrated explanation, hypothesis, theory, question, challenge, problem definition or idea. They like viewing the big picture and extracting and defining the essence of the opportunity or

problem, and generating ideas to solve it. They are problem definers and idea developers and are comfortable in the early to middle phases of creative problem solving.

Quadrant II people are not satisfied until all the ideas fit together into a coherent explanation, especially when many pieces and ideas must be created to make the picture more complete. There is always room for one more element of the problem definition or for one more idea that might contribute value before proceeding toward choosing or optimizing a solution or implementing a solution. This quadrant style of dealing with problems then could be termed problem formulation or conceptualization. Albert Einstein reputedly said that merely formulating a problem is often far more essential than its solution, which usually is merely an exercise in mathematical or experimental skill. He said that, given one hour to save the world, he would spend 55 minutes defining the problem and only five minutes solving it. John Dewey stated: "A problem well stated is half solved."

Quadrant III Preference

The Quadrant III orientation toward creative problem solving is called Optimization. When one is operating in an Optimizer mode, one's creative problem-solving inclinations are: (1) learning by detached dominant abstract thinking (as above) and (2) using such knowledge primarily for evaluation (developing criteria for assessing alternatives, being aware of possible pitfalls and deficiencies in potential solutions, and looking for a single optimum or best answer). These two inclinations indicate a preference for being involved in the practical solutions of a well-defined problem, and planning and organizing concrete steps to implement them. Thus, Optimizers are problem solvers, and are more comfortable in the middle to later phases of creative problem solving.

The third quadrant also is characterized by gaining understanding by theoretical, analytical, and mental processing of ideas and concepts. However, rather than divergently create

a large, diverse multi-element picture of a problem, Quadrant III people prefer to use judgment and analysis to zero in on the most important features or facts of a problem. They lack patience with problems that are fuzzy and not well defined. They prefer to attack a well-defined problem and develop an optimal solution. They enjoy evaluating several optional solutions and selecting the single best one. They often assume that a problem passed on to them has already been thought through and defined well. Their job is to apply theoretical analytical understanding, determine cause and effect, and create a few options based on clear criteria. Where the Quadrant I style is focused on "What?" and Quadrant II is focused on "Why?", the Quadrant III style is focused on "How?".

Quadrant IV Preference

The Quadrant IV orientation toward creative problem solving is called Implementation. When one is operating in an Implementer mode, one's combination of inclinations toward using knowledge for evaluation and gaining knowledge by direct concrete experience indicates a preference for implementation activity – gaining acceptance from others for new solutions and changes, and taking action to make sure those solutions and changes work and stick. In an Implementer mode, one does not generally dwell on understanding the theory behind a new idea or plan. Instead, one wants to "run with it," experience it, work with it, show others how to use it, shape it and fit it to needs, adapt it to various changing circumstances, and try and retry it (and not worry about why it didn't work the first way). In a strong Implementer mode, people will do whatever it takes (including alteration) to implement the plan, idea, new product or new solution. They will become directly involved and experiment until implementation is complete. Implementers are problem finishers and are most comfortable in the later phases of creative problem solving.

People who favor the fourth quadrant are interested in the "when? and where?". They prefer taking a clear focused solution or plan and implementing it for immediate results. The fourth quadrant style is to use physical experience to understand (like the first quadrant). But rather than create diverse new opportunities from such experience, they use it to find a way to implement a solution or plan successfully. They are less interested in the "what", "why" and "how" than in the "when" and "where."

Quadrant IV people would be predicted to get concrete results "by hook or by crook," rather than conforming to theory or rigid procedures. They evaluate ongoing implementation progress by what they and others are experiencing, then make adjustments until a satisfactory solution has been implemented. They use their experientially gained understanding to drive toward and achieve a satisfactory result. What is finally implemented may be somewhat different from what was originally planned but still satisfactory to those involved.

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