The Role of Knowledge Management in the Innovation Process

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We argue that current concepts of knowledge management and organizational learning are, by themselves, limited in their ability to improve organizational effectiveness. We show how these concepts may be usefully integrated with organizational creativity and innovation within a single framework that combines the *apprehension* of knowledge with the creative *utilization* of such knowledge. Field research and experience are described showing how this framework has been applied to achieve measurable improvements in effectiveness in a wide range of organizations.

Introduction

Organizations around the world today face a common challenge: the need to improve their performance in order to capitalize on rapid change, and to establish or regain competitive edge. In North America, restructuring and downsizing have become a way of life as organizations struggle to regain market share from global competitors producing higher-quality products. Companies try to become more quality-conscious and customer service-oriented overnight. In Eastern Europe, managers and employees struggle to establish new behaviors and procedures that will allow their companies to compete in the free market. Third World countries hungry for economic development look for growth markets around the world. Manufacturing and information technology jobs are outsourced in massive numbers from developed countries to the emerging low-wage economies of China and India. In Japan, organizations that once had a clear target – to match and surpass North American quality and customer service – now lack a blueprint for further progress.

Organizational Effectiveness

Organizational research suggests that effective organizations display a high degree of three specific characteristics: efficiency, adaptability and flexibility (Mott, 1972). Efficiency allows an organization to implement and follow routines. The efficient organization follows well-structured, stable routines for delivering its core products (goods or services) in high quantities, with high quality and at low cost. In a stable world, efficiency alone would guarantee success. If we still bought buggy whips, the organization's sole concern would be simply to produce lots of high-quality, low-cost buggy whips. But in a changing world, efficiency alone is not enough.

Adaptability is the other side of the coin. While efficiency implies mastering a routine, adaptability means mastering the process of changing a routine. Adaptability is a proactive process: it allows the organization to deliberately and continually change its routines to increase quality, productivity and cost-effectiveness, and also to introduce new products, services, and routines. Adaptable organizations anticipate problems and opportunities, and develop timely solutions and new routines, such as higher-quality buggy whips or, say, automobile self-starters. Adaptability requires looking outside the organization for new technologies, ideas and methods that may improve or completely change its routines. Adaptable organizations are willing to accept new solutions quickly rather than reject them as disruptive. The most effective organizations are both efficient and highly adaptable.

Flexibility allows the organization to react quickly and effectively to unexpected situations. While adaptability is a continual, proactive process, flexibility is intermittent and reactive. It allows the efficient organization to

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deal with unforeseen disruptions while maintaining its routines.

Various Concepts of Knowledge and Innovation Management

Organizational Effectiveness Comes from Superior Thinking

Superior organizational performance – whether based on efficiency, adaptability or flexibility – is becoming increasingly dependant on superior thinking. While assets such as labor, capital, processes, and technology continue to be important, the organization's ability to think is now widely recognised as crucial. Terms such as knowledge management, organizational learning, and intellectual capital are now common in the management literature. Academics discuss, and practitioners attend seminars on, concepts such as the 'Learning Organization'. Major consulting companies are offering sophisticated information systems for knowledge management, and many organizations have established knowledge management or learning systems departments headed up by a 'Chief Knowledge Officer'.

However, these topics are usually seen as different and separate from organizational creativity and innovation. Some companies struggle with innovation, wondering why their continuous improvement programs seem to work smoothly, while they are unable to sustain meaningful innovation programs. Some researchers and practitioners focus on topics such as 'management of technology', viewing information technology as the main source of innovation. Others focus on non-technology methods and tools for helping employees think more creatively (e.g., deBono, 1976). Some consultants provide idea-generation services to help companies create new product concepts, while others help companies evaluate existing ideas and move them through to commercialization (e.g., Cooper, 1993).

The purpose of this paper is to show how knowledge management, and creativity and innovation, fit together. We differentiate between the *apprehension* of knowledge and knowledge *utilization* and unite them into a single framework. We argue that this framework allows organizations to do three things: (1) detect errors and implement changes to restore or improve routines; (2) make sense of sudden unexpected events and crises and convert them into opportunities for innovation; and (3) anticipate and seek out new information, and emerging opportunities to develop new products, services, and routines.

Knowledge Management as Knowledge Sharing

Among consulting companies, knowledge management is largely synonymous with knowledge *sharing*. Here, knowledge management consists of converting tacit knowledge (knowledge in individuals' heads) into explicit knowledge (codeable information suitable for electronic storage and transmission) and developing IT systems to spread this knowledge organization-wide so everyone has access to it. Such knowledge sharing systems require organizations to abandon the 'command and control' method of managing, in which knowledge is the cherished and jealously guarded property of managers, and where employees are told exactly what to do, and are provided with the minimum amount of information they need to do it.

However, although knowledge sharing makes more knowledge available to more people, the mere availability of information is not sufficient. If efficiency, flexibility, and adaptability are to be increased, that information must be put to use, and additional information beyond what is coded in the IT system may be required. We suggest that this requires the adoption of a shared thinking process for using knowledge innovatively. This approach is consistent with Weick and Roberts' (1993) concept of 'collective mind' in which members of an organizational system correlate their actions with those of all the others in the system to achieve optimal results.

Knowledge Management as Organizational Learning

Levitt and March's (1988) review of the literature shows that organizational learning is widely viewed as routine-based. Routines include the procedures and technologies around which organizations are constructed and through which they operate. Argyris and Schon (1978) define two levels of organizational learning, both of which involve detecting and correcting errors in routine. Single-loop learning occurs when the error is corrected without changing the organization's existing norms, policies, or objectives. Double-loop learning occurs when the error is corrected by modifying an organization's norms, policies, or objectives. Thus, both single- and double-loop organizational learning are concerned with organizational efficiency – the maintenance, improvement, and mastery of routine. Single-loop learning restores routine (efficiency), while double loop learning improves or modifies it.

Some organizations derive competitive edge by being superior in efficiency – in continuously restoring and improving routines. Toyota for example employs total quality management tools such as six-sigma and lean manufacturing to find root causes of errors and reduce waste. Others have their own methods; Procter and Gamble is famous for its willingness to devote years of painstaking analysis to understand what went wrong with company routine procedures when failures occur (albeit rarely) (Swasy, 1993). Rely Tampons, which were removed from the market for health safety reasons and Pringles potato chips which did not meet sales expectations are recent examples of such analyses and attempts at organizational learning.

The methodology we propose offers the opportunity to *operationalize* organizational learning, to make it more than just an academic concept. That is, one might ask, 'just how do you *do* double-loop learning?' We suggest people can learn how by becoming skilled in the innovative thinking process and tools we describe.

Adaptability and Flexibility Depend on Innovative Thinking

Adaptability and flexibility are not primarily based on either efficient knowledge sharing (making information widely available) or organizational learning (detecting and correcting error to restore or modify routine). Adaptability depends on deliberately seeking out new problems, trends, technologies, and information and using them to create new routines, products and services. Toshiba, for example, deliberately develops adaptability in its employees. Newly hired R&D scientists and engineers start their careers in the sales department to learn that innovation begins by discovering 'the problems of the customer' and to develop their problem finding skills (Basadur, 1992). The 3M Corporation establishes strategic goals for inducing adaptability; for example, one goal is that 30% of the company's products must be new every five years.

Flexibility depends on turning unexpected events, including crises, into opportunities or at least restoring equilibrium quickly. Such opportunities may simply consist of achieving goodwill from the public or even inventing new ways to avoid such a crisis in the future. An excellent example is the Tylenol tragedy in Chicago a few years ago, when several people suddenly died after consuming Tylenol pain relieving capsules. Johnson & Johnson, the manufacturer, quickly removed all Tylenol products from store shelves, reassured the public, confined the danger to the local area, and discovered the root of the problem. Someone had deliberately injected a lethal poison into Tylenol capsules in some stores. The company proceeded to pioneer new innovative tamper-proof packaging that the rest of the industry has since adopted. The public was left with a very favorable image of Johnson & Johnson. The company demonstrated it was both expert about the products it manufactures, and highly skilled in using its knowledge for innovative problem solving.

Putting Knowledge to Use Creatively

Innovative organizations do more than spread knowledge, they make a habit of *using* knowledge creatively. In a crisis, having the necessary knowledge is important, but not knowing how to use it innovatively can render it useless. A major North American Airline discovered this when a snow storm paralyzed their home base airport on a Friday night. The snow had been expected all week, arrived on schedule, and continued through Monday. All but ten of the airline's two hundred scheduled flights were ultimately cancelled as the weekend dragged on. Almost 20,000 increasingly angry customers spent a frustrating weekend in a survival mode: waiting to get more information; trying to find alternative flights; deciding whether to switch to renting a car or taking the train; and wondering if they should try to find a hotel room, sleep on the floor or wait a little longer before deciding anything. All of the airline's hundreds of ground employees knew everything there was to know about the planes, the de-icing plans, the weather and the cancellations, but none of them knew what to do with the information, beyond regurgitating what they did and did not know (mostly from their computers) when asked. None knew how to turn this crisis into an opportunity. None knew how to seize the moment and make their customers feel cared for and important.

The airline's ground employees acted as if they believed that the important challenges for the airline were how to clear the snow as soon as possible, and how to get a few more planes flying in spite of the weather. While important, these challenges are very limiting, and other even more important challenges seemed to be outside their awareness. For example; 'how might we keep our customers feeling well-cared for?'; 'how might we provide our customers with plenty of donuts and coffee?'; 'how might we keep everyone's spirits up?'; 'how might we find sleeping cots for everyone?'; 'how might we make everyone feel as comfortable as possible while they wait?'; and

'how might we get our president in here to shake hands all around, help out and show everyone his concern?' Seeing the big picture and thinking up such innovative challenges converts mere information into creative action, and is one of the most important parts of the innovative thinking process.

Instead, the entire airline 'froze' in its tracks. The next week, the senior executives issued a formal public apology, the government suggested an inquiry into the airline's competency and the airline offered a costly seat sale to try to win back their customers' loyalty. In this example, all the knowledge that was needed was available but a lack of innovative thinking skill on the part of the entire airline, top to bottom, made the knowledge useless. *Nobody knew a common procedure for turning a crisis into an opportunity.*

What if the airline's employees had known how to think innovatively together? What if they knew how to tell each other what they were thinking in a way that the others understood quickly? What if they were skilled in a common problem solving language that permitted quick communication of uncertainties, facts, opportunities, ideas and action steps? What if they had a common thinking process for recognizing opportunities and problems and converting them into positive innovative action? In this paper, we describe such a thinking process. This process recognizes that unused knowledge has little value, and that in organizations, knowledge becomes valuable only when it is used to improve efficiency, flexibility or adaptability.

Learning and Inventing: Two Parts of a Continuous Process

The distinction between the availability and the use of knowledge was recognized by Gordon (1956; 1971). In Gordon's conception of learning and inventing, learning (gaining knowledge or understanding) and inventing (using knowledge or understanding) are regarded as two parts of one continuous process. Gordon suggested that learning and inventing may be regarded as opposite forces which feed each other in turn. Inventing is characterized as a process of *breaking old* connections. Learning is characterized as a process of *making new* connections. When we learn, we 'make the strange familiar' (by making new connections between new (and thus strange) phenomena and our current understanding). This permits us to view new phenomena more comfortably. In contrast, when we invent, we 'make the familiar strange' (by breaking old connections which compromise current understanding). This permits us to view old phenomena in new ways, although this can be uncomfortable at first. Thus the processes of inventing and learning follow one another in a continuous cycle. (see Figure 1)

On the left hand side of Figure 1 new 'paradigms' (ways of thinking and doing) become established. New processes are learned and

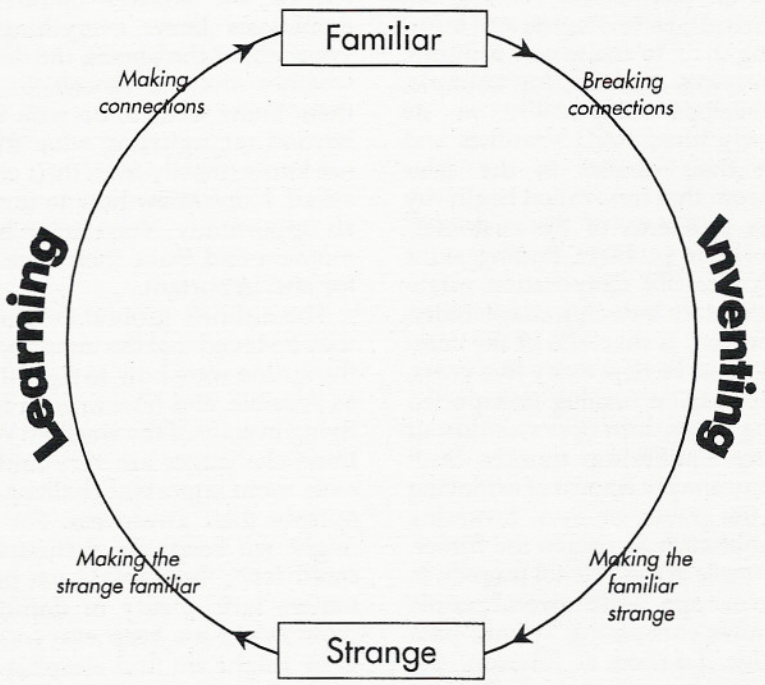

Figure 1. Two Halves of a Continuous Process of Learning and Inventing

become well-known and comfortable habits. On the right hand side such old established paradigms are broken. New processes that produce better quality or new goods or services are invented to replace previous processes. When an old *familiar* paradigm such as a well-established business process is broken, the new one replacing it feels very *strange* and uncomfortable to everyone affected. They are experiencing a process of *un*learning, *breaking* connections with past understanding and letting go of old habits and beliefs. As time goes on, the new process becomes less strange, and more familiar. This is a learning process – *making* new connections and adopting new habits and beliefs.

Unlearning

A well-known example of unlearning, that is, the breaking of old patterns, and the adoption of new beliefs, is the demise of the phlogiston theory, first propounded in the 17th century by scientists such as Johann Becher (1625–1682), Georg Stahl (1660–1734) and later by Joseph Priestley (1733–1804). Phlogiston theory, which lasted for about 100 years, maintained that the reason some things burned and others did not was that the some, like wood, contained lots of phlogiston and the others, like metal, did not. Although phlogiston theory made sense and fitted many of the known facts, quantitative experiments gradually convinced chemists that it was incorrect.

According to phlogiston theory, when magnesium is burnt, the residue (magnesium oxide or calx) should weigh less than the original magnesium because phlogiston is lost. In fact the residue actually weighs more than the original magnesium, implying the unlikely possibility that phlogiston has negative weight. Antoine Lavoisier (1743–1794) however showed that the increase in weight of the residue was exactly equal to the weight of air used up, thus removing the need to invoke phlogiston at all. The phlogiston theory officially died on September 5 1775, the day Lavoisier presented his paper 'Memoir on Combustion in General' to the French Academy of Science:

> 'The existence . . . of phlogiston in metals, sulphur, etc., is then actually nothing but a hypothesis, a supposition which, once admitted, explains, it is true, some of the phenomena of calcination and combustion; but if I am able to show that these phenomena may be explained in just as natural a manner . . . without supposing that . . . phlogiston exists in combustible materials, the system . . . will be found to be shaken to its foundations.'

The birth of modern chemistry can be said to begin with the breaking of the familiar phlogiston paradigm, and the adoption of the strange new oxidation paradigm of Lavoisier. Should a better explanation for combustion ever be discovered in the future, scientists will have to break the old familiar paradigm of oxidation, and begin making a new strange paradigm more familiar by making new connections once again.

The Thinking Organization

We can define a thinking organization as one that a) recognizes the value of breaking old and out-dated paradigms and replacing them with new and better ones, and b) knows how to do so. A thinking organization can both unlearn and invent. It is proficient in efficiency thinking (perfecting current routines), adaptability thinking (breaking old routines and creating brand new ones) and flexibility thinking (operating effectively when there are no routines to follow in ambiguous, unexpected circumstances). Thinking organizations engage the innovative abilities and creative aptitudes of all of their employees.

Few organizations however have the skills or expertise to do this, and in particular, they lack a framework for sustained and disciplined creative thinking. In this paper, we describe a structured innovation process that allows organizations to think creatively in a collective, synchronized way, not only to improve routine work (efficiency) but also for the non-routine work of adaptability and flexibility. This process combines the *apprehension* of knowledge (understanding) with the creative *utilization* of such knowledge, thus integrating the concepts of knowledge management and organizational creativity into a single framework.

Our proposed process consists of four stages (Figure 2). Stage 1 is the proactive acquisition and generation of new information, and the sensing of trends, opportunities and problems. This is what Simon (1977) called 'opportunistic surveillance'. Stage 2 is the conceptualization of new challenges and ideas, Stage 3 is the development and optimization of new solutions, and Stage 4 is the implementation of the new solutions.

The Two Dimensions of the Innovation Process: Knowledge Apprehension and Knowledge Utilization

As shown in Figure 3, the innovation process can be considered in terms of two orthogonal

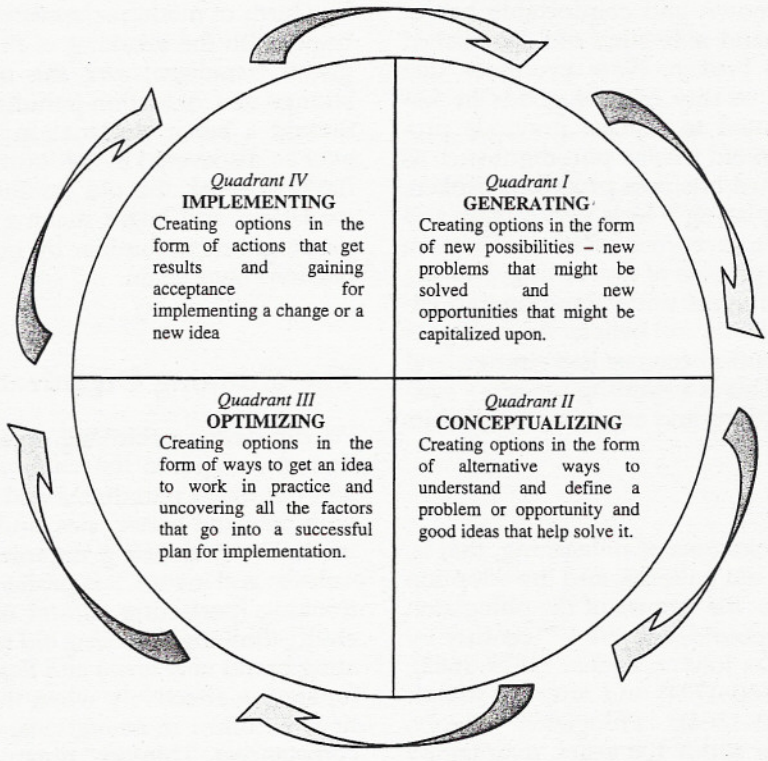

Figure 2. The Four Stages of the Innovative Thinking Process

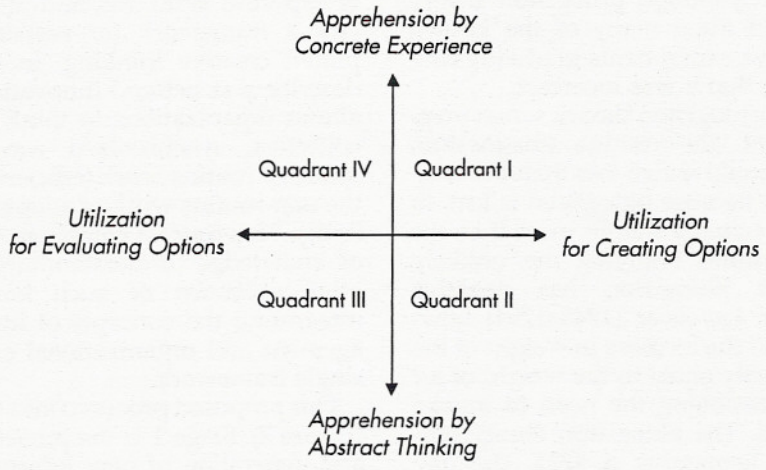

Figure 3. The Two Dimensions of the Innovation Process: Apprehension and Knowledge Utilization

dimensions. The first dimension, shown on the vertical axis, represents the Apprehension of knowledge, and the second dimension, shown on the horizontal axis, represents the Utilization of knowledge. Both dimensions are bipolar, giving rise to four different combinations representing the four successive stages of the innovation process.

As shown in Figure 3, one mode of knowledge Apprehension is via direct, concrete experiencing (doing). Some people gain knowledge by such 'physical processing'. (They do not understand something until they have experienced it.) The contrasting way of gaining knowledge is through detached, abstract thinking (pondering). Some people gain knowledge by such 'mental processing'. (They are reluctant to experience something until they first understand it.) All individuals and organizations gain knowledge in both ways but the relative amounts (ratios) differ from those of others.

Also shown in Figure 3 are the two modes of knowledge Utilization. One way to use knowledge is to *create* options (such as alternative opportunities to pursue, possible solutions to investigate etc.). The contrasting way to use knowledge is for *evaluating* options. Again, all individuals and organizations use their knowledge in both ways but the relative amounts (ratios) differ from those of others.

The operations axis of Guilford's (1967) three-dimensional Structure of Intellect (SOI) model can also be understood in terms of bipolar Apprehension and bipolar Utilization. Guilford identified five different mental operations labeled as memory, cognition, convergent production, divergent production, and evaluation. Memory is defined as 'the retention or storage 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.' Cognition is defined as 'the immediate discovery, awareness, rediscovery or recognition of information in various forms; comprehension or understanding.' Convergent production is 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.' Divergent production is defined as 'the generation of information from given information where the emphasis is upon variety and quality of output from the same source.' Evaluation is defined as 'reaching decisions or making judgments concerning criterion satisfaction of information.'

Setting memory aside, the other four SOI mental operations can be organized as follows. Convergent production and cognition represent two contrasting methods of information (knowledge) Apprehension, and divergent production and evaluation represent two contrasting methods of information (knowledge) Utilization. First, let us consider two contrasting modes of Apprehension. Convergent production can be equated with Apprehension by rigorous theoretical 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 dominates learning in formal education and is almost synonymous with curriculum assimilation (Meeker, 1969). However, 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. Similarly, 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.

Thus, the first dimension in our model, Apprehension, concerns acquiring knowledge or understanding in two different ways. One (cognition) is relatively more open, non-rational, non-analytical, and *experiential* and the other (convergent production) is relatively closed, rational, analytical, and *theoretical.* Some educators advocate learning approaches that emphasize both ends of this bipolar spectrum of knowledge apprehension (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 analytical, theoretical learning phases. The Kolb cycle begins (concrete experience) and ends (active experimentation) experientially. Between these two experiential phases are two theoretical/analytical (non-experiential) phases (reflective observation and abstract conceptualization).

The second dimension in our model, Utilization, concerns applying knowledge or understanding, however apprehended, 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). There is ample support from the literature for this second bipolar dimension which 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). For example, 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 gen-

eration 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) 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.

We suggest that thinking organizations are those which build strengths in each of the bipolar dimensions and each of the four stages of the process in Figure 2. They realize that both dimensions in Figure 3 are vital, nurture the dynamic tension between the polar opposites on each dimension, and acknowledge the importance of each stage of the innovation process. Following is a description of each stage.

The Four Stage Innovation Process

Stage 1: Generating

Generating involves getting the innovation process rolling. Generative thinking involves imagining possibilities, questioning, sensing new problems and opportunities, viewing situations from different perspectives and gathering information through direct experience. People strong in generating skills prefer to come up with options, or diverge, than to evaluate and select, or converge. They see relevance in almost everything and think of good and bad sides to almost any fact, idea, or issue. They dislike becoming too organized or delegating the complete problem, but are willing to let others take care of the details. They enjoy ambiguity and are hard to pin down. They delight in juggling many new projects simultaneously. Every solution they explore suggests several new problems to be solved. Thinking in this quadrant includes problem finding and fact finding.

Stage 2: Conceptualizing

Conceptualizing keeps the innovation process going. Like generating, it involves divergence. But rather than gaining understanding by direct experience, it favors gaining understanding by abstract thinking. It results in putting new ideas together, discovering insights that help define problems, and creating theoretical models to explain things. People strong in conceptualizing skills enjoy taking diverse, often disconnected, information emerging from the generator stage and making sense of it. Dervin (1992) emphasizes the importance of the study of sense-making, that is, how information is conceptualized. Conceptualizers need to 'understand': to them, a theory or explanation must be logically sound and precise. They prefer to proceed only when they have a clear grasp of a situation or when the problem or idea is well-defined. They dislike having to choose a single option, if it means discarding others, preferring to incorporate as many ideas as possible into a single conceptual scheme, which for them provides closure. They like to play with ideas and are not overly concerned with moving to action. Thinking in this stage focuses problem defining and idea finding.

Stage 3: Optimizing

Optimizing moves the innovation process further. Like conceptualizing, it favors gaining understanding by abstract thinking. But rather than diverge, an individual with this thinking style prefers to converge (evaluate or select). This results in developing practical solutions and plans from abstract ideas and alternatives. People who favor the optimizing style rely on mentally testing ideas rather than on trying things, and like to create optimal solutions. Given a well-defined problem, they are able to sort through large amounts of information to pinpoint the critical factors. They are usually confident in their ability to make a sound, logical evaluation and to select the best option or solution to a problem. They often lack patience with ambiguity, and are unwilling to consider more then one problem at a time. They see little value in 'dreaming' about overly radical ideas. Once they have decided they know what a problem is, they are eager to drive towards the solution as quickly as possible. Thinking in this stage focuses on idea evaluation and selection, and planning the implementation process.

Stage 4: Implementing

Implementing completes the innovation process. Like optimizing, it favors convergence, but unlike optimizing it favors learning by direct experience rather than by abstract thinking. Implementers rely on trying things out

rather than mentally testing them; they like to get things done. People strong in implementing excel in situations in which they must somehow make things work. They do not need complete understanding in order to proceed, and adapt quickly to changing circumstances. When a theory does not appear to fit the facts, they will readily discard it. Some perceive them as enthusiastic about getting the job done, but others as impatient or even pushy. As they try to turn plans and ideas into action, implementers will try as many different approaches as necessary; they will try to bring others on board and follow up or 'bird dog' as needed to ensure that the new procedure will stick. Thinking in this stage focuses on gaining acceptance and implementing.

Toward More Complete Thinking in Organizations: All Four Stages are Necessary

Individuals, teams, and organizations can be characterized by their relative preferences for operating in these four stages. However, effective innovation requires strength in all four stages. In teams for example, the members must learn to combine their individual preferences and skills in complementary ways. Basadur and Head (2001) showed that heterogeneous teams composed of people with different preferences outperformed homogeneous teams whose members had similar preferences.

A lack of completeness in thinking is evident in many organizations. Some organizations display excellent skills in one or two stages of the innovation process while being weak in the others. This can lead for example to decisions which appear attractive in the short run, but which have negative consequences in the longer term. Figuring out, for example, how many jobs a new piece of equipment can eliminate is relatively easy. Much harder is convincing head office not to lay people off but to reassign them into other important positions to build future business or improve operations and quality. Recognizing that such a situation requires more than mere mathematical calculations is a sign that the organization is engaging all four of the stages of the innovation process, that is, operating as a complete thinking organization.

Following are some real world examples of the application or misapplication of the four stages of the innovative process described above. Try to step into the minds of the individuals in these examples. Can you identify with their puzzlement, success, frustration or elation? Do their experiences remind you of examples from your personal or business life?

Stage 1 Example: Trusting Myself and My Colleagues

One recurring pattern in organizations is the inability to trust oneself and one's colleagues. People are reluctant to raise interdepartmental problems and to involve others in solving problems in their own area of responsibility. As a result many problems fall 'between the cracks' and remain unidentified and unresolved. Some thoughts that run through employee's heads are:

- 'I fear asking for help as it might be seen as incompetence.'
- 'I don't dare mention my real problem before my fellow managers. That would be displaying weakness.'
- 'I don't think the group's members trust one another enough to share what is really going on.'
- 'This isn't really my problem, so why risk bringing it up?'

A manufacturer's top management team once asked the senior author (MB) to demonstrate how the four stage innovative thinking process (Figure 2) works. They agreed to apply the process to their own team's problems. The first stage in the process – generating – requires surfacing problems and anticipating, seeking and sharing opportunities for improvement. However, the team members were reluctant to venture any of their problems. It soon became obvious that each individual feared that one of their *own* problems might be selected and that they risked exposing themselves to negative judgments about their handling of the problem to date. So it was better to not say anything. Obviously surfacing organizational problems was frowned upon in this top team, and quite likely, throughout the company.

Stage 1 Example: Discovering a New Problem

Woody Allen, the famous American comedian, once remarked that '80% of anything is just showing up'. The notion is that if you show up, you never know what new opportunities might come your way, often totally unexpectedly. Being on the lookout for and proactively sensing new problems and opportunities is the first stage of the innovation process. Edwin Land (1972), in a Life Magazine cover story told the tale of his invention of the Polaroid camera, which can be seen as a remarkable example of what can transpire by just 'being there'. Having snapped the last exposure on

his film, he suggested to his three-year-old daughter that they take the film for processing so they could see the pictures in about a week's time. Her frustrated response was, 'why do I have to wait a week to see my picture?' Like a flash bulb going off in his mind, her simple question sparked a challenge that had never occurred to him: 'How to make a device that yields instantaneous pictures?' Within about an hour, he had formulated several directions toward a solution. And within about four years he had commercialized a product that has changed our lives. Looking back, the then-chairman of Polaroid said the most important part of the process was not finding the solution itself – the camera – but finding the problem – how to get instantaneous pictures. If Land had not experienced the chance encounter he might never have created the problem to be solved. Land thus demonstrated the generation stage of the creative process – the initiating of problems to solve instead of waiting for problems to be provided.

Stage 2 Example: Working on the Wrong Problem

Procter & Gamble's fledgling Industrial Division had decided to go after a developing market for automatic car wash products in the early 1970s. In their product development department, a small team of chemists and engineers was rushing to fill out our existing product line. MB was asked to take over the car wash section to speed up their product development efforts, especially in a floundering 'hot wax' project.

Fortunately for MB, he could hardly spell hot wax, let alone profess to be an expert on the product. As a young engineer MB rarely took his own car through an automatic wash, saving money by washing his car by hand. Why 'fortunately'? Because he knew nothing about hot wax, and was free to display his ignorance, keeping an open mind, and asking lots of questions to try to get a handle on what needed to be done and why the project had bogged down. Thus, the first question for the team was a very simple one: 'What's hot wax?'

The team explained that hot wax was a relatively new but potentially profitable idea. It was a liquid spray applied as an optional service at the end of an automatic car wash. Automatic washes dispense all their products in water-soluble form and, of course, wax doesn't dissolve in water. However, a small competing company had found a way to combine wax from the South American carnauba tree with certain solubilizing ingredients and water, yielding a stable fluid that could be sprayed onto cars. (Carnauba wax already had gained a reputation as the best wax for polishing shoes.) The competitor had received a patent for its product.

When asked why the team had been bogged down for 18 months, the members explained that they couldn't come up with a combination of carnauba wax, solubilizers and water sufficiently different from the competitor's to avoid violating its patent. The team had tried countless combinations, and had even recruited a carnauba wax supplier to help, without success. What gradually became evident was that the team had focused its efforts on a specific challenge: 'How might we develop a carnauba wax formula that does not violate the existing patent?'

Continuing fact finding, the team was asked how well the competitor's product performed. To the response that it performed very well, they were asked how they knew. They said that, since the product was a hot seller, it was obviously doing a good job. When asked what their test methods showed about the product's performance, they replied, 'What test methods?' It turned out that, because the team had been in such a headlong rush to enter the market, it had neglected to develop test methods. The team's understanding of the competing product's performance consisted of a single fact: a lot of people were buying it. The team agreed that they needed to broaden their understanding.

Testing the competitor's product during lab simulations showed that it did not adhere to car bodies at all. Testing the product in a commercial automatic car wash confirmed the lab results. A new fact had been discovered: the team had been trying for 18 months to duplicate a product that didn't work! Inadequate fact finding had led the team to define its problem too narrowly. The problem was redefined: 'How might we develop a hot wax product for a spray-on water system that will adhere to car bodies and provide a worthwhile benefit?' This new challenge opened up the search for a new, water-soluble, active ingredient that eventually led to the discovery of a totally different hot-wax formula that provided protection to car surfaces.

Stage 2 Example: Redefining the Problem

Again at Procter & Gamble, MB was asked for help by a product development team formed at short notice to respond to a competitor's new product. Colgate's green-striped Irish Spring had been the first striped soap bar introduced to North America. With its aggressive advertising campaign emphasizing

'refreshment,' Colgate's new product was finding ready consumer acceptance.

Procter & Gamble worked by the rule that, when it was the second entrant into a new market, it had to demonstrate a product's competitive advantage before carrying out a market test. However, the team explained that it had been unable to produce a green-striped bar that was preferred to Irish Spring in a consumer blind test. The team had experimented with several green-striped bars, all of which merely equaled Irish Spring in blind testing. It became evident that the team had chosen, probably unconsciously, to define its challenge as, 'How might we make a green-striped bar that consumers will prefer over Irish Spring?'

During a creative problem solving meeting, a problem definition technique called the 'Why – what's stopping? analysis' was applied (Basadur, Ellspermann, & Evans, 1994). This technique helped develop alternative ways to conceptualize the team's challenge. Repeatedly asking why? and why else? (did we want to make a green-striped bar that consumers would prefer over Irish Spring) and what? and what else? (was stopping us) yielded many alternative challenges. The flash of inspiration came from an answer posed from a consumer's point of view: 'We want to make a bar that makes people feel more refreshed.' This led us to the new challenge: 'How might we better connote refreshment in a soap bar?'

This less restrictive challenge, which included no mention of green stripes, gave more room for creative solutions. The team members visualized scenes, images and situations that suggested refreshment. One pictured himself at the sea coast. Another imagined sitting on a beach and looking at a blue sky and white clouds. Later, when the team sat back to evaluate its many solutions, these two ideas were selected and combined. The result was a blue- and white-swirled bar, which quickly achieved market success under the brand name Coast. Solving this problem once it had been properly defined took the team mere hours. By leaping prematurely into solutions, the team had wasted almost six months before coming up with that problem definition.

Successful teams and individuals are not necessarily the 'smartest' or most 'gifted' or the 'best' problem solvers. More often, they're the ones that take the time to ask good questions and find exciting ways to define their problem before looking for solutions. They invest sufficient time and energy in creating fresh, creative definitions of the problem on which they can agree.

Stage 3 Example: Breaking through Patent Barriers

After solving the refreshment bar problem, the team still was not finished, and needed to conduct another round of innovative problem solving. Before it could sell the new soap formula, the company had to overcome a patent problem in the machinery design. There were already no fewer than six worldwide patents restricting how you could blend soap pastes of different colors. The team had to find a machine design to make their new product without infringing on anybody else's technique.

Diverse points of view were assembled in a small technical team consisting of engineers, technicians, lawyers and even a few people who were unfamiliar with soap technology. After this team had spent some time in fact finding, including discussing sketches of the patented processes, a breakthrough solution soon came from a simple observation by the team member with the least technical knowledge and education. This person noted a small detail that the others had completely overlooked in their search for more complicated solutions. The lesson: it's important to value the input of each member of a team, no matter their level of experience. Sometimes the best ideas come from people unencumbered by 'too much' knowledge, people who can ask the simple questions that the so-called experts overlook.

Stage 3 Example: Evaluating with an Open Mind

A grocery products company was looking for a way to help consumers better handle their household trash. The company felt it could improve upon the polyethylene bags that most people used. A product development team was assigned to the challenge: 'How might we improve the handling of household trash?'

One of several interesting and imaginative solutions that the team had developed was a cardboard product that resembled a pizza box. Pushing its top made the box telescope into a free-standing trash container with several polyethylene bags nested inside it. This stand-alone device eliminated many of the disadvantages of single polyethylene bags. It hid the trash beneath a hinged cardboard top, and was convenient and decorative to boot. When one of the bags was filled, you simply pulled a cord to tie its top and took it out of the box, leaving the next bag ready to use. The team members appeared excited about the possibilities of this idea, and were eager to move into evaluation. Even though this

was a very unusual idea, the evaluation was performed using a standard company screening technique for new product ideas: the market research department had written a single-paragraph description of the idea and presented it along with several others to a group of consumers. The department had included in its description the fact that the new product would add about 10 cents to the cost of each bag. Asked for comments, consumers said the product sounded like a good idea but that they would probably balk at paying the 10-cent premium for it. Without further consideration, the group abandoned the idea.

After putting considerable effort into generating ideas, the group had devoted little time to an appropriate evaluation process. For example, they could have stopped to consider that in the past when paper grocery bags cost nothing, if consumers were simply asked whether they would buy a new kind of bag for 10 cents each, most would probably have said no. Under that scenario, we might never have seen polyethylene bags at all. However, given the chance to experience the advantages of polyethylene bags rather than just read about them, consumers might have given a very different answer. If the market researchers had been as creative in evaluating this radical idea as the team had been in developing it, they might have discovered that people were willing to pay the extra cost and perhaps more.

This story demonstrates the importance of keeping an open mind not only when conceptualizing new ideas but also when evaluating them. Here, the first stages of the innovation process had been successfully executed to produce a unique product idea; however because the latter stages were poorly executed, the overall thinking process was still incomplete. Possibly, the team members had been almost afraid of their own idea, and were relieved to find a reason not to proceed with it.

Stage 4 Example: Getting Bogged down in Implementation and Overcoming Fears

Teams often get bogged down in the implementation stage, and fail to put good solutions into action. A team in a manufacturing company gathered several years' worth of test results on a new, less costly, shipping method. It was clear the new method would save large amounts of money, and the purpose of the testing was to ensure that the new method was as good as the old one in every other respect. However, the tests continued to be inconclusive, with minor differences from tests to test. Even after it became obvious that the team would never pin down all of the method's pros and cons, it continued to run more tests. The team finally defined its main problem not as how to collect more information, but as how to overcome its fear of making a recommendation for implementation with less than conclusive data.

Some thoughts running through this team's heads might include:

- 'My manager talks a good game about not killing ideas, but he challenges almost everything I say as soon as I've said it. I find myself choosing my words carefully every time we speak and getting ready to defend myself.'
- 'We have taken the problem as far as we can, but will senior management be happy with our results?'
- 'Good ideas and projects languish in this system because people fear they have to perfect their idea before they will share their project.'
- 'I don't want to be told I didn't do my homework.'

The team finally faced up to their fears and expanded their thinking to define their problem as 'How might we make our recommendation to senior management explaining the risk and asking them to share the risk with us?' In a matter of hours the team created just such a recommendation, which was approved the next day.

Stage 4 Example: Wanting a New Management Style, but . . .

In the first Stage 1 example above, the manufacturer's top management team finally owned up to about one problem apiece. Eventually, they were willing to select an important recurring problem that everyone shared responsibility for. With the tension now reduced, the fact finding and problem definition steps went very well and an excellent solution emerged after very careful evaluation. This solution was simple, novel and something the team had never tried. But as the team tried to develop a plan to implement this solution, some members began to back away from it. Under this new solution, non-management employees would have a chance to participate in developing the final specific method of implementing the solution. This worried some of the team members, even though they had often stated a desire to 'push down decision-making' to lower levels. After some discussion, they realized they were actually afraid of straying into unfamiliar territory.

Some thoughts that probably were running through these managers' heads were:

- 'I want employee involvement. But if I allow too much leeway for self-management and creativity, I don't know where employees will take it.'
- 'Deep down, we fear getting involved. We fear the unknown. We might not be ready for more innovation.'
- 'I'd rather stick with the unacceptable solution we've accepted for the last five years than take the risk of trying a new idea even though it looks good.'

The team preferred the relative safety of their customary, but incomplete thinking. They would rather leave an admittedly important problem unresolved than to implement an admittedly good but risky solution.

Discussion

The above examples illustrate both competent and incompetent execution of the four stages of the innovation process of Figure 2. Thinking organizations execute all four stages competently. Non-thinking organizations do not. In these organizations, people wait for problems to be identified for them rather than actively seeking them out. Even when a problem has been identified, they fail to ask good fact finding questions, to properly define the problem. They often tackle the wrong problems, dealing instead with mere symptoms or with the first version of the problem that occurs to them or that is presented to them. They won't risk trying new solutions because they can't be guaranteed success.

Thinking organizations are aware of these deficiencies in thinking and find ways to overcome them. They go beyond simply sharing knowledge, and put their knowledge to use. They solve immediate problems quickly, before they turn into crises. They continuously seek out new opportunities to use their knowledge, improving their existing products and services, developing new ones, and creating new customers. They continuously improve their internal processes and create new processes to better achieve their objectives. In other words, thinking organizations understand the importance of all stages of the innovation process; they know that innovation is not something you can turn on and off; they make innovative thinking routine.

How Do Organizations Become Thinking Organizations?

In order to make continuous, deliberate change for the better, organizations need to overcome shortcomings in thinking skills that affect individuals and teams. For many individuals, problem finding is a foreign concept. For example, people usually wait for others to find problems to solve rather than actively seek out problems or avoid important problems that cross departmental lines ('That's not our problem'). Even after finding and defining problems, they find it difficult to solve them creatively and imaginatively. Individuals are critical of new ideas, for example, and thus prevent productive thinking. While many people may be able to implement routine solutions to routine problems, few can implement creative solutions to new, unprogrammed problems. Teamwork is also often uncreative. Group members are unable to communicate clearly in simple terms, for example. Unaware of variations in individual thinking styles, groups fail to synchronize these differences, jump into 'solving the problem' without first considering what the real problem is, and then flounder. Interfunctional teams get stalled arguing about territorial issues. Meeting leaders steer toward their own points of view rather than facilitating the group to work open-mindedly and cohesively. Some organizations publicly display slogans such as 'Innovation is our most important goal' but when asked 'what are you doing about it?' their top managers reply, 'why, nothing'.

Developing Skills in the Innovation Process

Research and practical experience strongly indicate that the thinking skills required for executing the innovation process described and illustrated above can be learned, nurtured and managed. Using a multiple method, multiple measure field experiment, Basadur, Graen, and Green (1982) found that participants from an industrial organization made gains after experiential and practice-oriented training on specific cognitive, attitudinal and behavioral measures such as 'more likely to pause to try new, unusual approaches'; 'less likely to jump to conclusions as to what is the real problem'; 'more open-mindedness to new ideas and approaches'; 'more positive reaction to new, unusual ideas'; 'deferral of premature critical judgment'; 'less time spent in negative evaluation during idea generation'; 'increased quantity and quality of problems found'; and 'increased number of different problem definitions developed'. Other field research on the effects of training is summarized in Basadur (1995; 2004).

Managing and Nurturing the Innovation Process

At the organizational level, top management can also be trained to apply these skills in their

work as individuals and as members of executive teams. Furthermore, they can be taught how to model and encourage the use of these new skills throughout the organization (Basadur, 1994). It is not sufficient to merely train employees in the innovation process. The top management of the organization must develop specific strategies to maintain the thinking skills in daily work life. The top managers must lead the way by learning and *visibly* using the process and create new managerial activities and new organizational structures to engage the rest of the members of the organization in applying the process daily. Examples of new managerial activities within such a strategic plan include publicizing, rewarding, modeling, providing resources, coaching and teaching, and visibly taking risks to promote the change-making process. These new activities enable subordinates to experiment without feeling afraid, learn from mistakes, act as problem and challenge finders, take ownership of problems, understand how their jobs fit with other peoples' jobs and with organizational goals, share the ambiguity and uncertainty that their managers are experiencing due to accelerating environmental change, and accept the fact that there is no 'grand scheme' guiding the organization into the future. Managers must get used to 'managing challenges' rather than 'managing solutions'. By involving subordinates in the early stages of the process, as the challenges are being sensed and formulated, the manager can manage many new change projects simultaneously.

Motivation and Commitment are Outcomes of Creative Activity

Establishing adaptability as a daily, continuous process of problem finding and defining, problem solving, and solution implementation to complement efficiency increases employee commitment and motivation. Top Japanese organizations manage their world-class employee suggestion systems to induce creative behavior and to derive creative output including cost savings and new products and procedures. The primary objective of these suggestion systems is not to improve economic outcomes directly but to motivate people and increase their commitment (Basadur, 1992). Permitted to engage in creative problem solving (as it has been described here), workers become extremely motivated and desire even more participation in creative activity. They work harder at perfecting their routine jobs to increase quality and quantity and reduce costs, thus increasing organizational efficiency and short-term organizational effectiveness. Creative activity also stimulates team-building as people help each other to solve problems. This connection between creative activity and employee motivation is supported by motivational literature in industrial and organization psychology. For example, two important motivational need sets – the need for competence and the need for curiosity and activity – provide the most direct explanations of how creativity motivates people (White, 1959; Berlyne, 1967). When people face new, challenging situations, their need for competence can be satisfied by performing creatively. Many people find that exercising their curiosity and exploring new things is intrinsically motivating. Herzberg, Mausner and Snyderman's (1959) research also suggested that the way to truly motivate people at work was 'job enrichment', or redesigning jobs to require creativity. More recently, the research of Amabile (1993), Deci and Ryan (1985), and Hackman and Oldham (1980) has supported the link between creative work and motivation.

Creative Process Skills, Business Need and Infrastructure

The organization can build skills in the complete innovation process (as described above) as a training intervention in one of two ways. It might integrate the training to boost an existing corporate improvement initiative like a total quality management program when a well-defined business need and infrastructure already exist. Alternatively, the organization might implement the training within a brand new innovation initiative created for the organization based on the process itself. In the latter case, the organization's leaders must identify a clear business need and establish an infrastructure to ensure that employees use their new creative skills (Figure 4).

Many worthwhile initiatives flounder because the organization lacks at least one of these three components: business need, infrastructure, and creative process skills. When it introduces a training intervention, the organization must spell out what specific business need it intends to address – lower costs, higher sales, fewer defects or customer complaints, shorter turn-around time or time to market, better products or services – in order to ensure that employees buy-in to the intervention and can measure success. The organization might lack an effective infrastructure such as performance appraisal systems and teamwork in order to encourage people to use the new philosophies and tools regularly. Even when the organization establishes clear business needs and infrastructures for implanting new initia-

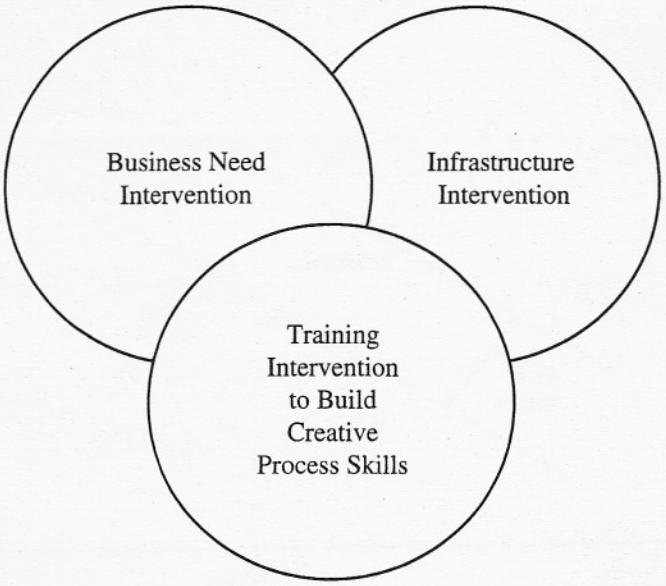

Figure 4. The Three Necessary Components of a Successful Organizational Development Effort to Mainstream Innovation

tives – it might underestimate the effort required to alter people's innovative skills, attitudes, and behaviors, and thus fail to provide adequate training. In order to mainstream innovation, adaptability, and commitment, an organization must integrate innovative thinking skills with a clear-cut business need and infrastructure to encourage employees to use those skills.

An Example of Creating a Thinking Organization

By 1982, senior managers at Frito-Lay based in Dallas, Texas, had decided that they needed to further improve the company's productivity, Frito-Lay had always been profitable. During the inflationary '70s, the company's strategy had been to produce the highest quality snack foods and maintain its profit growth by simply increasing its prices to cover annual cost increases. By the early '80s, however, facing lower-cost, lower-quality competition, the company recognized that it had to do more than simply increase prices each year in order to retain customers. If it didn't make some imaginative changes, it could expect to see slower revenue growth even as costs continued to rise, resulting in a profit squeeze (Figure 5). The managers had already discussed standard solutions to their productivity problems with several consultants. But none had seemed suitable. Frito-Lay approached MB to help them better define what the company needed.

The first two stages of the innovative thinking process of Figure 2 were employed to develop a three-part strategy. First, to help senior managers, the company's desire to improve productivity was distilled into a simple, clear business need: to learn to offset inflationary cost increases in order to flatten costs. Second, managers aimed to encourage employees to find creative ways of meeting this business need by giving them training in the innovation process and skills described above. Third, the company decided to create interfunctional teams of upper and middle managers; these teams would use the innovation process to identify ways to save money, and spend money more effectively (Figure 6). These interfunctional teams would then hand off challenges to lower-level teams that had also received the training. To make the business need more concrete, the company president set a specific goal: to save a total of $500 million cumulatively over the next five years. The goal was developed with careful analysis to ensure that it was a reasonable one.

To implement this strategy, senior managers visited the company's various locations to explain the business need and to introduce the new initiative (called the 'Off$et Process'). More than 50 internal line managers eventually received training so that they could teach the innovation process and skills to other employees and lead the organization in continually finding, defining, and solving problems and implementing solutions. Because they understood the overall strategy, Frito-Lay

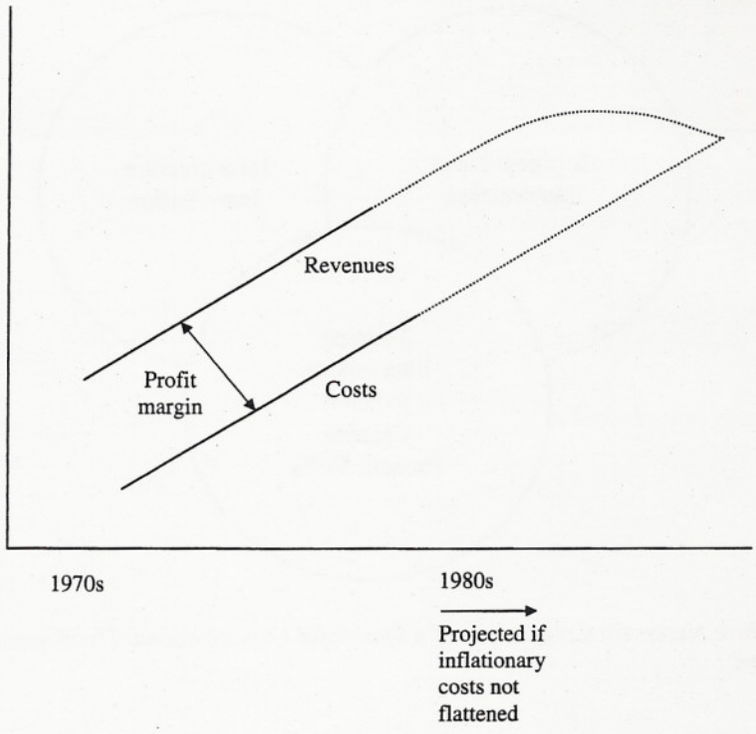

Figure 5. Frito-Lay's Business Need

Figure 6. Frito-Lay's Strategy for Mainstreaming Innovation

employees were very willing to undergo this training and to apply it within the new teams.

The teams completed many kinds of projects, including the following: increasing equipment capacity; reducing rework; rolling out a new product in record time; shortening new technology installation time; and accelerating the introduction of new product and packaging ideas. Progress was tracked and publicized. The company realized its goal of

$500 million in savings a full year ahead of schedule. At this point, Frito-Lay revised its business need from merely flattening costs to actually reducing them regardless of inflationary pressures.

The company might have found it a much less difficult task to integrate this innovation process with an existing initiative. Without an initiative already in place, Frito-Lay faced a lot of up-front work in convincing employees to understand and commit to mainstreaming innovation. But positive results and continued encouragement from senior managers eventually won their acceptance of the process.

Summary and Future Research

Many companies still regard innovation as an irritant, something that gets in the way of the 'real work'. They are content to turn out standard quantities of standard products and achieve the sales, cost and profit goals for this month, this quarter, this year. Their response to greater competition is to cut staff, reduce costs, lower service levels and, in some cases, lower quality. Too few respond creatively. Sometimes this is because they simply do not know how to go about it.

In this paper, we have tried to demystify various concepts of knowledge management and innovation by integrating them into a single simplified approach focused specifically on improving organizational performance short and long term. Perhaps, more managers would be willing to give this simplified approach a try, especially if they could be shown how it helps them achieve even short term results more efficiently. Perhaps, future research could focus on strategies for helping managers grasp and increase comfort with the innovation process, skills, techniques and styles described.

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