THE ROLE OF SCENARIOS IN ALTERING MENTAL MODELS AND BUILDING ORGANIZATIONAL KNOWLEDGE

by

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This article reconceptualizes organizational knowledge as something uniquely personal and temporary. First, a review of knowledge and some perspectives on the meaning of present day knowledge in the business context is offered, including an overview of the problem that presents itself in attempting to transfer highly specialized, personal and contextual forms of knowledge. Core to this problem of knowledge transfer is the idea of information stickiness. Research around information stickiness is presented along with its likely origins. Following this examination of the problem in transferring knowledge, some recent models of knowledge elicitation are offered. Implicit in all of these methods is the notion of mental models. Because mental models provide the assumptions that engrain the personal contextual nuances that allow experts to develop and form tacit knowledge, it is contended that, in fact, mental models *are* knowledge, although some specific assumptions, conditions and limitations are provided to clarify this position.

Once a perspective of mental models as knowledge is established, scenario planning is posited as a tool for provoking and providing alternative mental models in such a way that they can be shared and re-constructed. Thus, scenarios are tools for sharing and re-constructing organizational knowledge.

BACKGROUND AND RATIONALE

The study of knowledge and knowledge management often includes related concepts like experience, information, and application. An abstract idea, present day knowledge in the business context has been defined in different ways. Cook and Brown (1999) made an important distinction between what they term an "epistemology of possession, and an epistemology of practice." Essentially the distinction was between knowledge that is possessed in the heads of individuals and the knowledge that is practiced in the things that people do. Cook and Brown further term what is possessed as "knowledge" and what is practiced as "knowing." What is particularly useful about this perspective is in its classic argument to differentiate between explicit and tacit knowledge in individuals and in groups. "Compared to explicit knowledge, tacit knowledge is

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subjective, personal, and context-specific. It is difficult to describe, examine, and use" (Ford and Sterman, 1998). This article will focus on tacit knowledge because this is precisely the kind of knowledge that is increasing in its value and presents a problem when transfer is investigated.

Some sample definitions of knowledge in this context include:

- "Information that is relevant, actionable and at least partially based on experience" (Leonard and Sensiper, 1998)
- "A fluid mix of framed experience, values, contextual information and expert insight" (Davenport and Prusak, 1998).

Swap, Leonard, Shields and Abrams (2001) suggested that experts use knowledge by calling on years of experience in a variety of contexts to recognize patterns. The recognition of these patterns allows the expert to apply relevant information and guide action in new situations. Most prominent authors in the field acknowledge that tacit knowledge accrues through experience (Davenport and Prusak, 1998; Leonard and Sensiper, 1998; Doyle and Ford, 1998; Ford and Sterman, 1998; Swap, Leonard, Shields and Abrams, 2001; Moss, 2001). Experience builds up over time and leads to expertise. An important distinction should be made between expertise and expertness. Expertise is viewed in this context as a characteristic of knowledge, while expertness is characterized by proficiency and efficiency in a given process domain (Johnson, 2002). As organizations specialize in certain processes and functions, it is inevitable that expertise in these processes and functions must be communicated to and among new and existing members of the organization.

THE PROBLEM OF KNOWLEDGE TRANSFER

Organizations are increasingly relying on knowledge-intensive processes managed and operated by interdisciplinary teams (Ford and Sterman, 1998). Examples of these processes include new product development, product design, and knowledge-intensive work such as specialized consulting, marketing, design engineering and service-oriented delivery. Much of the information about processes and systems in organizations resides as tacit knowledge in the mental models of process experts. Thus, a difficulty arises in making this highly specialized knowledge accessible for new team members or the next generation of process experts. Ford and Sterman argued that effectiveness in such processes requires a dependence on knowledge of critical relationships within the process "which are dynamic, biased by individual perspectives and goals, conditioned by experience, and aggregate many system components and relationships." Descriptions of such relationships are not likely to be found in

traditional company records; rather, such information is most commonly contained in the mental models of these process experts.

Information Stickiness

Stickiness is the core characteristic of specialized, personal, tacit knowledge that inhibits easy transfer (von Hippel, 1998; 1994; Szulanski, 1996). Stickiness refers to the general difficulty in transferring tacit knowledge and has been defined as "the incremental expenditure required to transfer that unit of information to a specified locus in a form useable by a given information seeker. When this cost is low, information stickiness is low; when it is high, stickiness is high" (von Hippel, 1998).

Research on knowledge stickiness: In an examination of knowledge stickiness, Szulanski identified several important characteristics that affect the knowledge transfer process:

Characteristics of knowledge transferred—
- Causal ambiguity
- Unprovenness

Characteristics of the source of knowledge—
- Lack of motivation
- Not perceived as reliable

Characteristics of the recipient of knowledge—
- Lack of motivation
- Lack of absorptive capacity

Characteristics of the context—
- Barren organizational context
- Arduous relationship.

Szulanski then conducted research to test which of these characteristics were most important in inhibiting knowledge transfer. The findings were that "the three most important origins of stickiness are the lack of absorptive capacity of the recipient, causal ambiguity, and an arduous relationship between the source and the recipient" (Szulanski, 1996).

Lack of Absorptive Capacity of the Recipient: Cohen and Levinthal (1990) suggested that recipients may simply lack the ability to absorb new knowledge based on their pre-existing knowledge. That is, individuals absorb, assimilate, and apply new knowledge based on their previous experiences and knowledge base.

Causal Ambiguity: Lippman and Rumlet (1982) argued that difficulty in transferring tacit knowledge is likely a result of ambigu-

ity about the elements of the process or task to be understood and how they interact. Additionally, it has been argued that causal ambiguity is a result of a failure to view the process or task from a systems perspective (Sweeney and Sterman, 2000).

An Arduous Relationship between Source and Recipient: Nonaka (1994) suggested that knowledge transfer requires several interactions between the expert and novice and that the success of the exchange of knowledge rests heavily on the nature of the relationship between the source unit and the recipient unit.

Addressing these Origins of Stickiness

Scenarios and scenario planning are posited as tools that can solve these three origins of stickiness by: 1) revealing, analyzing, sharing and reconstructing mental models, leading to increased recipient capacity; 2) requiring a view of organizations and their components as systems; and 3) utilizing a process that demands close and frequent interaction between the novice and the expert. Each of these will be reviewed in further detail.

METHODS OF EXPERT KNOWLEDGE ELICITATION

In summarizing methods of expert knowledge elicitation, Vennix, Anderson, Richardson and Rohrbaugh (1994) suggested five key factors that should guide the process:

- The purpose of the modeling effort
- The phase of the model-building process and type of task being performed
- The number of people involved in the elicitation process
- The time available
- The cost of the elicitation methods.

In spite of such a strong recent focus on knowledge elicitation and knowledge management, the problem of knowledge sharing and transfer has yet to be resolved. Ford and Sterman (1998) offered a knowledge elicitation method consisting of three phases: 1) positioning; 2) description; and 3) discussion. The authors specified that their method addressed knowledge elicitation for formal modeling rather than for conceptual modeling or consensus-based decision-making and aimed specifically to improve the mental models of process participants. This distinction is important because it implies that the method aims at eliciting expert knowledge in a form that is more accessible for examination, transfer, and improvement.

Ford and Sterman's Positioning, Description, and Discussion Model of Knowledge Elicitation

With intent to provide a method of expert knowledge elicitation, Ford and Sterman (1998) design and test their method in the context of a modern product development process. Within their model, the *positioning* phase consists of three steps:

1. establish context
2. focus on one relationship at a time
3. illustrate the method.

The *description* phase consists of four steps:

1. visual description
2. verbal description
3. textual description
4. graphic description.

The *discussion* phase consists of two steps:

1. examine individual descriptions
2. compare descriptions.

The authors claim that the method has produced several useful insights including multiple descriptions, expert reasoning behind the descriptions, comparison and testing of parameter descriptions, communication among experts, and the identification of areas of mental model consistency and inconsistency. While it seems that the model offered by Ford and Sterman might be promising, replicable and consistent results have yet to be produced by additional application of their method.

Swanson's Knowledge Task Analysis

Swanson (1994) offered the knowledge task analysis as a method of eliciting expert knowledge. The knowledge task analysis "proceeds along two paths: 1) the collection and analysis of behavior in the workplace; and 2) the collection and analysis of literature by theorists, researchers, and other experts on the subject." By then combining the results of the behavioral search and the literature search, the analyst begins to form a synthesis model. Swanson identified the following types of synthesis models:

- Reflection
- Two-axis matrix

- Three-axis matrix
- Flowchart
- Events network.

The use of one or more of the synthesis models leads to a thorough depiction of the knowledge work under examination. The critical aspect argued by Swanson is the "connection of information and theory to expertise and performance."

The methods offered by Ford and Sterman (1998) and Swanson (1994) are two of a growing number of tools that aid in the transfer of knowledge. However, given the availability of such tools, modern knowledge transfer is still misunderstood, inaccurate, and quite clearly, a problem. Many scholars have argued that knowledge transfer is a problem in spite of such elicitation methods, because of this core characteristic of tacit knowledge called stickiness (von Hippel, 1998; 1994).

MENTAL MODELS

Perhaps the most important component of the knowledge elicitation methods offered by Ford and Sterman (1998) and Swanson (1994), among others, is the notion of mental models. Allee (1997) stated that mental models are "important cornerstones for building knowledge and defining some of the cognitive processes that support change and learning." Originally introduced by Forrester (1961), mental models are the lenses through which we see the world. Mental models incorporate our biases, values, and beliefs about how the world works. Senge (1990) defined mental models as "deeply ingrained assumptions, generalizations, or even pictures or images that influence how we understand the world and how we take action. Very often, we are not consciously aware of our mental models or the effects they have on our behavior."

Doyle and Ford (1998) explored the concept of mental models in detail: "Mental models are thus the stock in trade of research and practice in system dynamics: they are the 'product' that modelers take from students and clients, disassemble, and reconfigure, add to, subtract from, and return with value added." After providing a comprehensive literature review of the terms from both the systems dynamics and cognitive psychological perspectives, and some discussion in *Systems Dynamics Review*, Doyle and Ford (1999) eventually offered the following revised definition: "A mental model of a dynamic system is a relatively enduring and accessible, but limited, internal conceptual representation of an external system (historical, existing or projected) whose structure is analogous to the perceived structure of that system." Further, Weick (1979; 1985; 1990; 1993) has argued consistently that mental models guide, shape, and

provide the basis on which individuals interpret and make sense of organizational life.

Given this review of the problem of knowledge transfer, a key argument in this article is that mental models—when they fit with the dynamic environment—constitute knowledge. This argument rests on several assumptions about how mental models work to guide human thought and action:

- Mental models exist for the purpose of taking action (Weick, 1990; Wack, 1985c).
- Mental models provide us with decision premises in situations where we don't know what to do (Simon, 1957).
- We are not confronted with the components (or the possibility of examining the components or premises) of our mental models until we take some action. Usually this action is in the form of a decision.
- Decisions occur in dynamic contexts (Brehmer, 1990; 1992) and such contexts dictate that:

    1. There is a series of decisions rather than a single decision.
    2. The decisions are interdependent—current decisions constrain future decisions.
    3. The environment changes autonomously and as a result of decisions made.
    4. It is insufficient for the correct decisions to be made in the correct order—they must also be made at a precise moment in real time.

- We don't feel that we have knowledge until we can make a decision that produces favorable results or outcomes. For example, decision failures don't often result in the declaration that the decision agent had knowledge of the situation, or knew what to do.

The Logic of Mental Models as Knowledge

Consider Dorner's (1996) research that revealed an overwhelming amount of failure in decision outcomes in dynamic contexts. One of the reasons for such failure was determined to be the application of the wrong mental model, or a misfit between the mental model in use and the mental model required by the dynamic environment (Dorner, 1996; Morecroft, 1983). Given the considerable decision error evident in such research, it follows that knowledge is rare, fleeting, highly contextual, and highly personal. This leads to the possibility that knowledge exists when the mental model (the relatively enduring and accessible, but limited, internal conceptual representa-

tion of an external system—whether historical, existing or projected—whose structure is analogous to the perceived structure of that system) establishes "fit" with the dynamic environment and therefore guides decisions that produce favorable decision outcomes.

The further argument is that, by providing the product development agent, decision maker, or knowledge worker with a more accurate, more complete mental model that fits with the dynamic environment of the process and its interrelatedness to other organizational processes, decisions that result in more favorable outcomes, and performance at higher levels of efficiency and effectiveness can be expected. In this context, then, *knowledge is the temporary fit between individually or collectively constructed mental models applied to problems for which they provide successful solutions.*

REVEALING, ANALYZING, SHARING AND RECONSTRUCTING MENTAL MODELS

The elements advocated by Vygotsky (1978; 1986) come together to form the building blocks of mental models, or personal cultures (Harkins, 2002). While the links between scenario planning and constructivist learning are described in detail by Chermack and van der Merwe (2003), it will suffice for the purposes of this article to assert that mental models can be revealed, extracted and reconstructed based on constructivist learning principles. Carley and Palmquist (1992) offered a computer-driven method for extracting, representing and analyzing mental models. Their method will be outlined, and then scenarios and scenario planning will be advocated, as an additional, more qualitative and intuitive method of revealing, analyzing and reconstructing mental models.

Carley and Palmquist's Method for Extracting Mental Models

Carley and Palmquist offered a computer-driven method for extracting, representing, and analyzing mental models based on four core components, namely: 1) concepts; 2) relationships; 3) statements; and 4) maps. In this view, mental models are networks of concepts and the relationships between them. The method presented by Carley and Palmquist requires texts as its primary form of data for analysis. Thus, interviews must be transcribed into textual format.

Terminology: Presented here are some terms utilized by Carley and Palmquist in their four-step method of mental model extraction:

- Concepts—"Concepts are nothing more than symbols which have meanings dependent on their use, i.e., their relationship to other symbols."
- Relationships—Relationships tie two concepts together. "The

relationship can have directionality, strength, sign and meaning."
• Statements—Statements simply involve two concepts and the relationship between them. "If it rains then the sun will not shine" is an example offered by Carley and Palmquist.
• Maps—Simply stated: "A map is a network formed from statements."

The Four-Step Process of Mental Model Extraction

The four steps proposed by Carley and Palmquist are as follows: 1) identify the set of concepts that will be used in coding the texts; 2) define the relationships that exist between and among the concepts; 3) use a computer-assisted approach for coding the texts as statements using concepts and relationships; and 4) construct the resultant map graphically and analyze it statistically. Essentially, the computer software asks the researcher to define the concepts, relationships, and to form statements. The software analyzes the texts according to the specifications set by defining the concepts, relationships, and statements. The software then compiles a graphic interrelationship map and also has the capacity to output specific statistics about the data.

The method of extracting mental models offered by Carley and Palmquist is a highly quantitative approach that uses computer-driven analysis of transcribed interviews and texts to provide a general map of the mental models in use according to specifications set by the researcher. While this approach has been successful in some situations, a more narrative approach to revealing, analyzing and reconstructing mental models is suggested through the use of scenarios and scenario planning.

SCENARIO PLANNING

Scenario planning is presented in this context as an additional or alternative approach for revealing, analyzing and reconstructing mental models. This argument is based primarily on the assumption that organizations are systems of cognitive loops that perpetuate and spread the dominant mental model, language, and culture through interaction (Weick, 1990). This section will elaborate on this assumption and provide the basis from which it can be argued that scenarios and scenario planning are appropriate and, in fact, important tools for transferring tacit, implicit organizational knowledge.

Scenarios have been defined as "tools for ordering one's perceptions about alternative future environments in which one's decisions might be played out. Alternatively: a set of organized ways for use to dream effectively about our own future" (Schwartz, 1991). Scenario planning has been defined as "a process of positing several informed,

plausible and imagined alternative future environments in which decisions about the future may be played out, for the purpose of changing current thinking, improving decision-making, enhancing human and organization learning and improving performance" (Lynham and Chermack, 2002). Some key outputs of the scenario planning process are plausible alternative stories about the future, or scenarios, which are used as building blocks for designing *strategic conversations*—dialogue within the organization that leads to continuous organizational learning about key decisions and priorities (van der Heijden, 1997; Schwartz, 1991).

In their research on storytelling for knowledge transfer in organizations, Swap, Leonard, Shields and Abrams (2001) suggested that narratives, including accounts of employee interactions, successes, failures, and intra- or extra-organizational events, can be effective tools for transferring tacit knowledge about how things are accomplished within the organization. The authors do not advocate the use of stories or narratives to transfer specific skill sets, rather they argue for the use of narratives in transferring tacit knowledge about organizational culture and non-task forms of knowledge.

Scenario Planning to Reveal, Analyze, Share and Reconstruct Mental Models

Allee (1997) stated that: "Another powerful collaborative learning and knowledge-creation process is scenario building. Scenario building can help companies rethink much more than long-term strategy. It can help a company reframe their identity, their operating assumptions, their values, and their vision for the future." Senge (1994) identified three stages of an effective organizational learning process: 1) mapping mental models; 2) challenging mental models; and 3) improving mental models. Scenario planning has been shown to meet all three of these stages (Georgantzas and Acar, 1995). The planners at Royal Dutch/Shell Oil had several insights as they pioneered the scenario planning technique. After becoming masters at designing technically magnificent scenarios, they realized that, by focusing on the scenarios themselves, they were overlooking the core purpose of their work—to alter the mental models of the management teams for whom they were developing plans (Senge, 1994). Thus, it can be argued that scenario projects that fail, often fail because client organizations do not have the mental model that allows them to comprehend uncertainty, or a serious threat to their organization. Therefore, a core aim of the scenario planning process is to alter the mental models of managers. But *how*?

Scenarios for Prediction or Learning?

De Geus (1991) made an important point in recalling a story told to him by Pierre Wack.

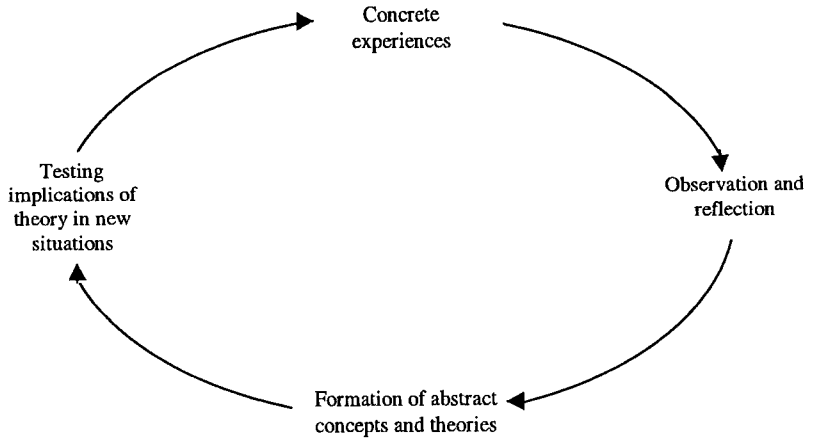
> "In this story, the listener is invited to assume that a person with absolute powers to predict the future is visiting the Mayor of Rotterdam in 1920. The visitor tells the Mayor in vivid detail what is going to happen to his town and its German hinterland over the next 25 years (the period covered by a scenario). It is thus, during an otherwise perfectly normal working day in 1920, that the Mayor hears about the advent of the Republic of Weimar, about hyper-inflation, the crash of the stock exchange in 1929 followed by the Great Depression, the rise of Nazism in Germany with its (for Rotterdam) damaging economic policies of autarchy, the outbreak of World War II with the carpet bombing of his town's whole city center and, finally, the systematic destruction of the town's port installations during the calamitous winter of 1945. The question is: what does the reader think that the Mayor is going to do with this information which reaches him in 1920, amidst all the other opinions and facts which he hears in the course of executing his complicated task of running one of the world's biggest ports? The quasi-unanimous reply which I receive to this rhetorical question is: *nothing*—even if our Mayor would give this prediction a higher degree of credibility than much of the other information reaching him, he would have neither the courage nor the powers of persuasion necessary to take the far-reaching decisions required by this prediction."

The point of this story is that "the future cannot be predicted and, even if it could, we would not dare to act on the prediction" (De Geus, 1992). Thus, De Geus concluded that the intent of modeling such as in scenario planning and simulations is to learn—and learning is the primary means by which individuals and groups can become aware of and change their mental models.

Both De Geus (1997) and van der Heijden (1997) have made considerable use of Kolb's (1984) learning loop in their explanations about how learning takes place for individuals and groups during the scenario planning process (see Figure 1). "The learning loop describes the strategy development process in its integration of experience, sense-making and action into one holistic phenomenon" (van der Heijden, 1997). The strategic conversation is an example of scenario planning and strategic thinking that have become a part of organizational life. These tools, when operating as constant processes

occurring in the organization, provide what van der Heijden has called the strategic conversation. This conversation is essentially based on the notion of Kolb's learning loop.

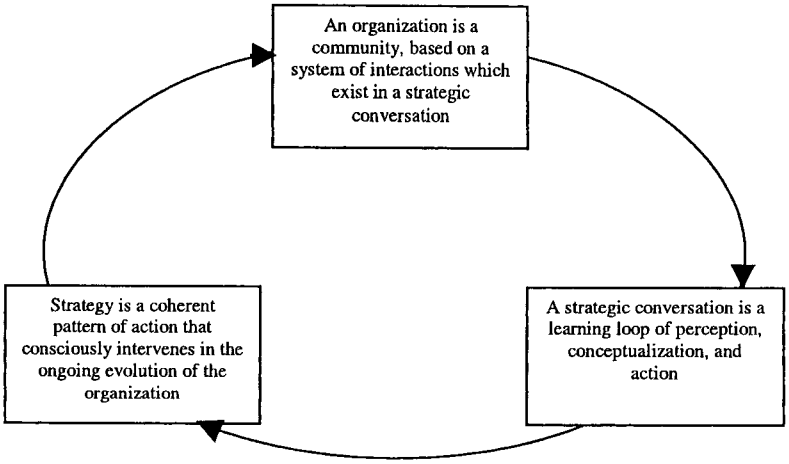
FIGURE 1 - KOLB'S LEARNING LOOP (KOLB, 1984)



van der Heijden incorporated the learning loop in to a model of what he termed a strategic conversation: "An effective strategic conversation must incorporate a wide range of initially unstructured thoughts and views, and out of this create shared interpretations of the world in which the majority of the individual insights can find a logical place." The strategic conversation creates the organizational dialogue through which individuals can reveal, analyze, share, and reconstruct their mental models, thus opening their minds to consider new possibilities. "If action is based on planning on the basis of a mental model, then institutional action must be based on a shared mental model. Only through a process of conversation can elements of observation and thought be structured and embedded in the accepted and shared organizational theories-in-use." (See Figure 2 for a model of the strategic conversation).

Engaging in a process of strategic learning and using scenarios for the purpose of learning to alter managers' mental models is one way in which scenarios and scenario planning provide new insights and different ways of seeing the world, such that knowledge about implicit processes and functions can be shared. Another key feature in scenarios and scenario planning regarding the transfer of tacit, implicit knowledge is in their aim to uncover structure.

FIGURE 2 - THE ART OF STRATEGIC CONVERSATION (VAN DER HEIJDEN, 1997)



Making Assumptions Explicit

Scenario planning starts with the systems assumption that events are driven by structures (Ringland, 1998; Schwartz, 1991). Scenarios are also used to differentiate among three levels: 1) events; 2) patterns; and 3) structure. The assumption is that events are not random; rather, they are related to each other through a structure in which causes drive effects and one event leads to another. The future is fundamentally uncertain (Schwartz, 1991). Scenarios operate in the area of structural uncertainty, which means that the future looks vastly different depending on the structure that is used as the foundation of a given scenario. Adjustments to the structure of the system under examination produce various scenarios through which organizational planners may play out the implications of certain decisions.

By defining three layers of events, scenario planning forces managers to think about the patterns and structure that underlie events. In order to effectively examine the patterns and structure that underpin events, it is necessary to declare one's assumptions about how the world operates. In brief, participation in scenario planning forces managers to be explicit about their assumptions regarding the way they view the world. These assumptions constitute the mental models in use. Thus, mental models can be revealed by examining the assumptions being made about the manner in which a process or domain of knowledge work exists and operates.

IMPLICATIONS

The implications of the arguments presented here are fourfold. If the assumptions made in this article are accurate: 1) scenario planning participants will likely have a more complete mental model not only about their environment in general, but also about key processes requiring tacit knowledge within the organization; 2) tools such as scenario planning that incorporate and involve mental models will become preferred tools in this context; 3) from a knowledge perspective, prediction is useless and therefore tools such as scenario planning that prompt the users to adopt a view of possibilities and options are preferred; and, finally, 4) small tacit knowledge-oriented work teams may become a useful additional realm of practice and application for scenarios and scenario planning tools.

In essence, this article suggests the use of scenarios and scenario planning at the process level—for use among process experts to incorporate novices into their knowledge-based work. The format of the scenario planning process addresses the three core causes of information stickiness that inhibit knowledge transfer by increasing the recipient capacity for tacit knowledge through mental model adjustment. This requires a systems view of knowledge-intensive processes and issues, and also frequent and intense interaction between and among novices and experts of the process.

While there may be some important thought-provoking arguments presented in this article, its preliminary and conceptual nature is fully acknowledged by the author, and a key limitation is identified in the assumption that knowledge can be equated with mental models. This is the assumption on which these arguments are situated. In light of this, a series of case studies is proposed as a means to examine the utility of scenarios and scenario planning in the context of knowledge transfer among teams managing tacit knowledge intensive processes.

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