The Underlying SccoB Processes: Knowledge Micro Analysis, Exploratory Mapping Processes, and Action Threshold Management

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Six desirable knowledge qualities emerge from an integration of the four-stroke engine and the four-stage model of the diagnostic process. These qualities are implemented by the SccoB process, a knowledge creation process that governs a firm's exploitory and exploratory processes. This requires implementing a KBS development strategy, enabling firms to better govern business processes and provide firms a closer look at their knowledge intensive processes. The structuring cause emits a wealth of knowledge. A way to use this knowledge is described, and this paper suggests that knowledge management be viewed as a quality, human resource, project, and strategic management tool.

INTRODUCTION

Over two decades ago research was undertaken to assess the impact of telemedicine on the medical diagnostic process, and the diagnostic process was studied at a behavioral, cognitive, and epistemological level. From Herbert Simon's (1985) three stage model (intelligence, design, and choice), came a four stage model. Adopting three forms of insight from cognitive psychology and three knowledge types from epistemology, the six stages identified by the medical problem solving.

The aforementioned telemedicine research afforded a tremendous opportunity to analyze the video recordings of teleconsultations between primary care physicians and medical specialists. This analysis revealed that a quick diagnosis of a complex medical problem occurred when the right combination of knowledge (the patient's current medical condition, the patient's medical history, and specialized medical knowledge of illness) was available, and from the aforementioned video analysis emerged the knowledge combustion and vehicle analogy.

The knowledge combustion and vehicle analogy used a well understood physical model to support understanding and description of knowledge's roles. In a paper (that is almost ready for submission), Randles, Miller, and Zhang (2017) extend the 2004 knowledge combustion analogy based on an understanding of the four stroke engine. The aforementioned paper describes a process (the SccoB process – pronounced Scoh-Bee), which integrates the exploratory and exploitory processes of a firm, and is a knowledge creation process. This paper describes the underlying SccoB processes which are designed to raise organizations to greater congruence.

Congruence relates to the level of agreement and consistency, and the underlying SccoB processes provide a KBS development strategy and a knowledge mapping process that lead organizations to greater congruence. The paper proposes that the structuring cause, which is described by Dretske (1988) as the most important knowledge type, provides a wealth of knowledge which can be used to elevate organizations to greater governance and tact. The adoption of a number of knowledge management tools and techniques such as moment models and knowledge requirement fulfillment analyses is advocated, and the underlying SccoB processes should serve as a strategic management tool by elevating the organization to higher, exploratory forms of mapping.

LITERATURE REVIEW

Beginning as a framework to assess the impact of telemedicine on the medical diagnostic process, the four-stage model was related to a well understood mechanical process to describe the process of information dissipation. Over the years, these concepts have been extended. This paper continues this effort, and the research, which the underlying SccoB processes is based, is described next.

The Four-stage Model of the Diagnostic Process

Building upon Simon's (1985) three phase "intelligence-design-choice" decision making sequence, Randles and Thachenkary (2002) provided a four-stage model of the medical diagnostic process. The foundation of the four-stage model was Dretske's definition of knowledge. Dretske (1988) stated that behavior is a causal chain governed by three types of knowledge, with each knowledge type having a different role. The triggering cause is a summary form of knowledge signaling the presence of an external event. The role of the structuring cause is to motivate action by explaining the relationship between a signal and an external event. The third type of knowledge is described as a map, attached to a belief that guides one's actions (Dretske, 1988).

The four-stage model described the role of different knowledge types and forms of insight in the achievement of various diagnostic milestones (framing, formulation, testing, and confirmation), relating epistemological, cognitive, and behavioural aspects of the diagnostic process. Problem framing is the first diagnostic stage of the four-stage model. The problem framing stage relies on Dretske's triggering cause and attains Sternberg's (1987) selective encoding form of insight which identifies relevant information from a large amount of mostly irrelevant information. The second diagnostic stage, problem formulation is introspective, ending with the generation of a problem space map. The hypothesis testing stage requires traversing a problem space in order to select a diagnosis. This is done by comparing collected information to an expected pattern of facts. These cognitive functions correspond to Sternberg's (1987) selective comparison form of insight which relates information that is current to information acquired in the past. The fourth stage is the confirmation stage. Other illnesses that might not be readily apparent from the diagnostic evidence are considered. Confirmation requires Sternberg's (1987) selective combination form of insight in which the relationship between seemingly unrelated things is determined. This requires the processing of a vast amount of textbook knowledge, which is embedded in the structuring cause (Randles & Thachenkary, 2002).

To test the validity of the four-stage model, Randles and Thachenkary (2002) studied the video recordings of teleconsultations and conducted telephone interviews with the consulting physicians. Their empirical evidence indicated that these stages have different information processing and knowledge requirements and that diagnostic confidence was inversely related to the size of the knowledge gap. Furthermore, video analysis revealed that the successful processing of information and provision of explanations increased diagnostic confidence. The understanding of knowledge requirements and knowledge gaps, which was gained from this research, provided the basis of the knowledge combustion and vehicle analogy.

The Knowledge Combustion and Vehicle Analogy

Using descriptions of such engine components as the carburetor and piston, Randles and Fadlalla's (2004) physical model analogy extended the four-stage model by linking cognition to a solid physical science. In their knowledge combustion and vehicle analogy, Randles and Fadlalla (2004) proposed that different knowledge types were required to extract value from information and to generate systematic action. Furthermore, their second proposition of knowledge chemistry stated that four different forms of knowledge combustion are conducted in different orders to permit the solution of myriad problems.

According to the knowledge combustion analogy, the cognitive equivalent of gasoline is a knowledge blend, and Randles and Fadlalla (2004) proposed that Dretske's three knowledge types are used in different proportions to create four knowledge blends. These knowledge blends, which relate to four forms of knowledge combustion, are common to all decision making. One form of knowledge combustion, **formulation** does not correspond to any form of insight but represents the planning processes that precede insight and action. The **framing** form of knowledge combustion corresponds to the selective encoding form of insight, **hypothesis testing** corresponds to selective comparison, and **profound explanation** corresponds to the selective combination form of insight. Each form of knowledge combustion required a different knowledge blend, and the creation of these different knowledge blends required the development of a new approach which was called knowledge chemistry (Randles & Fadlalla, 2004).

Hypothesis Testing Knowledge Blend (HTKB)

From an understanding of the hypothesis testing knowledge blend, and the hypothesis testing form of knowledge combustion, a knowledge creation process was proposed. This process required: 1) the development of pragmatic rules that indicate what to say when, 2) the development of problem space and sub-state maps of complex diagnoses, 3) the development of a set of explanations that motivate diagnosticians to adhere to the sub-state maps, and 4) the development of a system that provides the sub-state maps and communicates the explanations of specialists in a timely manner. These explanations would be captured from the video recordings of teleconsultations, and a process to transform the artifacts of the diagnostic process into valuable specialty knowledge was proposed (Randles, Blades, & Fadlalla, 2008).

The hypothesis testing task is information rather than knowledge-intensive, and the ability to collect and analyze this information (the procedural knowledge requirement) is great. However, procedural knowledge is required to combust a knowledge blend. It is not a component of the knowledge blend, and the creation of the *HTKB* avoids this stringent knowledge requirement. Furthermore, because hypothesis testing is structured and routine, the role of the structuring cause is limited. Only the appropriate explanation from a set of existing explanations must be presented. Because of these factors, the HTKB is easily implemented (Randles, Blades, & Fadlalla, 2008), and one facet of the underlying SccoB processes is the development of HTKB technologies.

The Knowledge Spectrum and Cognitive Force

The knowledge combustion and vehicle analogy explained how myriad decisions are made using three forms of insight, or knowledge combustion, and seven knowledge types (declarative knowledge, rules, signals, maps, technical knowledge, semantic knowledge, and structuring causes). As depicted in figure 1, these knowledge types and forms of insight form the basis of the knowledge spectrum and were placed on a continuum according to their: 1) explicitness (ability to be communicated), 2) technical feasibility, and 3) ability to generate cognitive force. Like the table of elements in chemistry, the knowledge spectrum provides a great deal of information about knowledge (Randles, Blades, & Fadlalla, 2012).

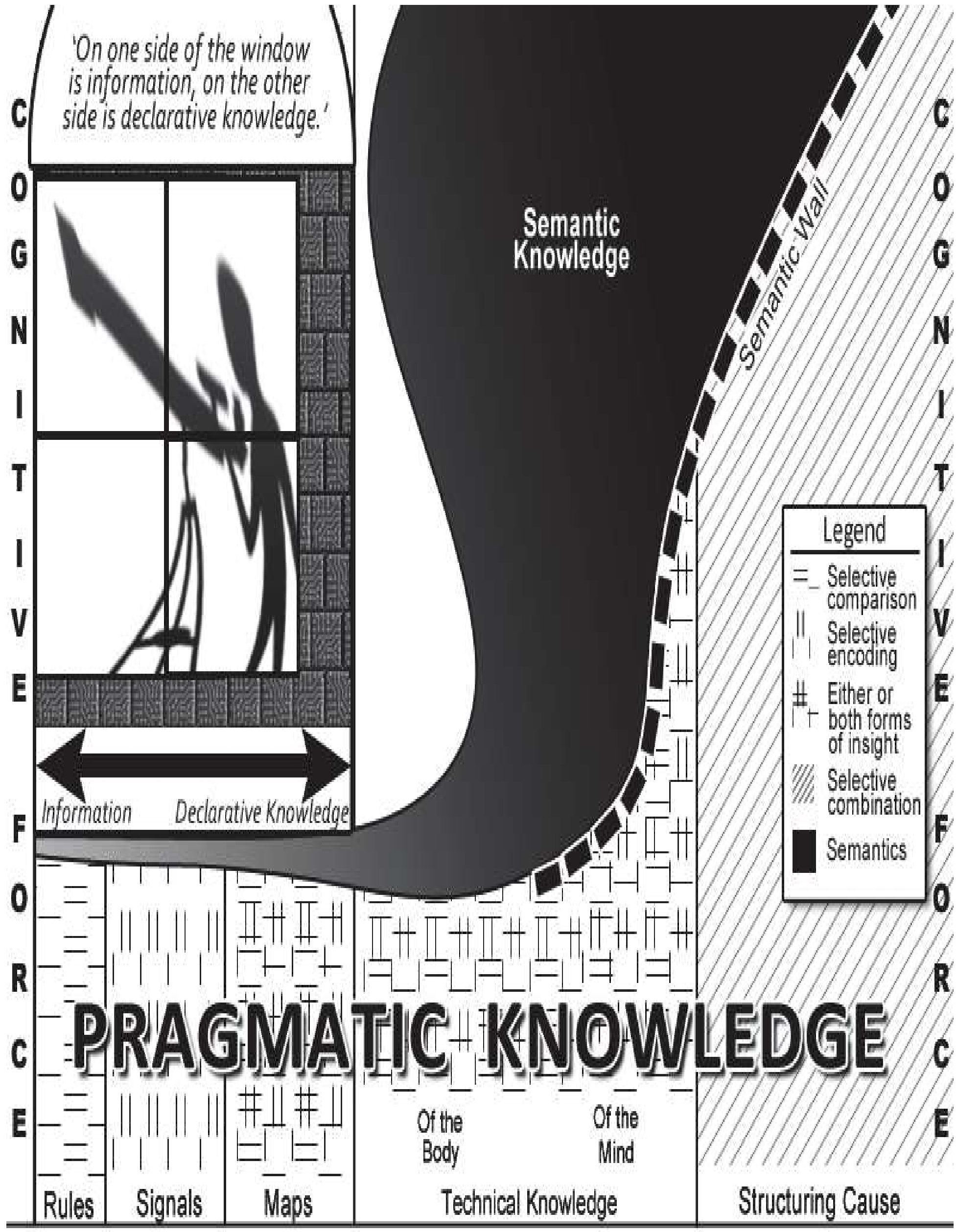

Figure 1: Knowledge Spectrum

Although the knowledge spectrum provides a static view of knowledge, its underlying premises suggest that intelligent behavior requires the interaction of a number of knowledge types. This realization focused our research on knowledge interactions, and in a paper, knowledge micro analysis (Randles, Miller, & Polin, 2017 - that is almost ready for submission), the authors focus on the knowledge interactions that occur **in a moment's time**. This requires an analysis of the links between various knowledge types, and these links represent seven components of cognitive force. The first three components: cohesion, coherence, and synergy form a summary measure. The other four components: complement, initiate, promote, and strengthen provide detail and permit a more in depth description of how cognitive force is generated.

In addition to modeling knowledge interactions and measuring cognitive force, knowledge micro analysis has several other objectives which are to catalog a firm's knowledge resources, determine business process knowledge requirements, develop benchmark measures of cognitive force, perform knowledge forecasts, and conduct knowledge requirement fulfillment analyses. Just as data flow and activity diagrams support efforts to improve information flow within an enterprise; the graphical and mathematical techniques of knowledge micro analysis should provide organizations with a closer look at their critical knowledge intensive business processes (Randles, Miller, & Polin, 2017).

The SccoB Process

In developing the SccoB process narrow definitions of exploitory and exploratory were adopted from Lavie, Stettner, and Tushman (2010) with exploitation involving the use and development of things that are known and exploration involving the pursuit of new knowledge. The SccoB process extends the engine/vehicle analogy of Randles and Fadlalla (2004) integrating the cycles of the four-stroke engine (intake, compression, combustion, and exhaust) and the four stages of the diagnostic process (framing, formulation, hypothesis testing, and confirmation). Six desirable qualities of knowledge are derived from this integrated model and are implemented by the SccoB process which integrates the exploitory and exploratory processes of a firm in a way that is simultaneous, continuous, complementary, ordered, and balanced. It is believed that an understanding of these qualities should improve the design of knowledge intensive organization processes (Randles, Miller, & Zhang, 2017).

The SccoB process is an overarching process that is compartmentalized into a dozen challenging but manageable tasks, as depicted in figure 2. Each compartmentalized task requires different types of knowledge and expertise, and the SccoB process provides two perspectives. The inward perspective (the internal sub process) focuses on operational information and the identification and explanation of operational anomalies. The external perspective (the external sub process) constructs theories regarding critical events, develops search and response maps for plausible hypotheses, and conducts hypothesis testing in order to detect emerging critical events.

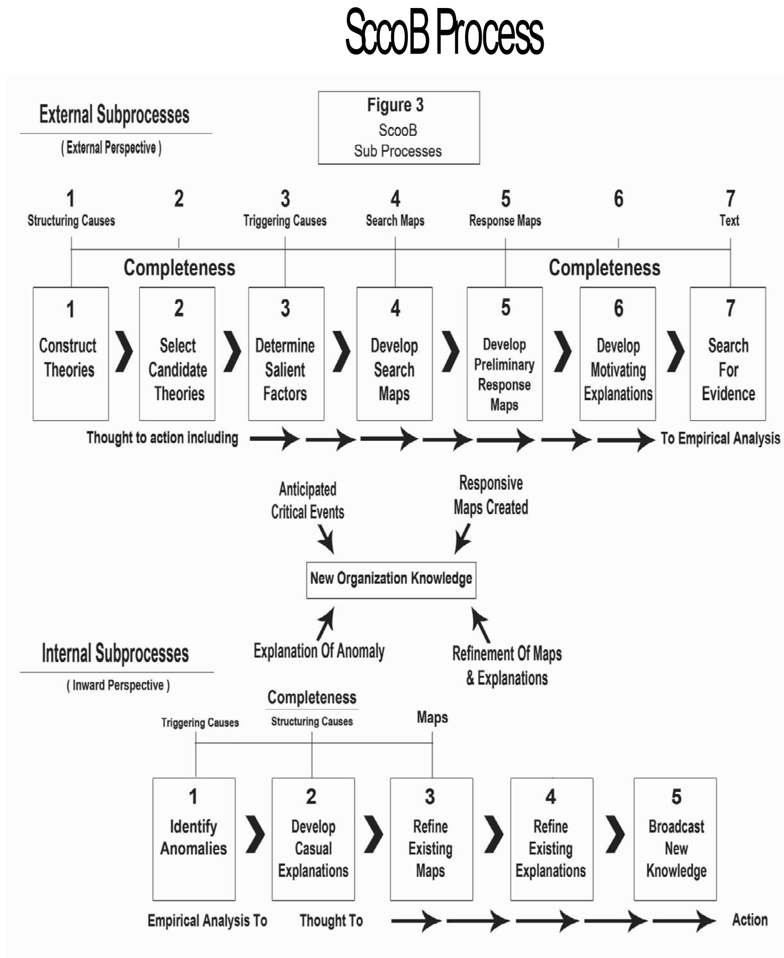

Figure 2: SccoB Process

EXTENDING THE SCCOB PROCESS

The exploitory processes of the firm generate the information which is required to identify anomalies (Randles, Miller, & Zhang, 2017). However, knowledge of what is expected – the expected value – is also required. Establishing these expectations is the role of management, which defines expected outcomes over time, as well as for varied conditions. This level of mapping is called codification. Expectations are established; their performance is evaluated, and a response is formulated. Another mapping level, the procedural level, provides standard operating procedures, best practices, and how-to training programs to prepare and support agents of the firm in the conduct of business processes. These mapping levels (codification and procedural) represent existing (exploitory) mapping processes.

On the surface, the SccoB process can be considered - *just a way of thinking*. However, underlying this way of thinking is a mapping process. This mapping process would move organizations from the codification and procedural mapping levels to the governance and tact levels of mapping. This would be done by implementing a set of exploratory mapping processes that elevate the firm to greater agreement and consistency (congruence).

One facet of the underlying SccoB processes is the development and implementation of HTKB technologies. Another facet of the underlying processes is a mapping of knowledge intensive business processes. This would be done using moment models and knowledge requirement fulfillment analyses and would provide the firm a closer look at its knowledge intensive business processes. Finally, in designing the underlying SccoB processes, the value of the structuring cause was recognized. In addition to explanations, which are an explicit aspect of the structuring cause and an integral component of HTKB technologies, there are tacit aspects that can serve the firm. For example, emotions lie deep in the depths of the structuring cause. These emotions are difficult to explain. However, they can be felt, and the underlying SccoB processes would systematically use these tacit thoughts to recognize opportunity or risk.

An understanding of the four-stage model, the knowledge combustion and vehicle analogy, and the knowledge spectrum provides many insights regarding the development of knowledge-based systems. As shown in figure 1, the rules and maps of the HTKB are low level knowledge types, while complex technical skills extend from the midpoint of the knowledge spectrum toward the structuring cause. Replication of these complex skills is our long term objective and we propose that knowledge-based systems development should move incrementally across the knowledge spectrum, beginning with the development of HTKB technologies.

According to the composition property of knowledge, the knowledge spectrum's higher order knowledge types are composed of lower order ones. For example, a map is composed of declarative knowledge, rules, and signals (Randles, Miller, & Polin, 2017). It is the level of control and semantics that determines what is low, moderate, or exceptional regarding the intellectual (of the mind) aspect of a technical skill (Randles, Blades, & Fadlalla, 2012). The problem space maps, sub-state maps, and information processing and pragmatic rules of the HTKB are critical components of all complex technical skills. Consequently, the development of HTKB technologies should serve as a stepping-stone toward the replication of complex technical skills.

From our telemedicine research came another insight concerning KBS development. For many years, knowledge acquisition has been a significant hurdle for knowledge-based systems developers, and the aforementioned telemedicine research suggests that organizations should provide specialist support via teleconferencing and use the video recordings of these teleconsultations to create HTKB technologies. Although video analysis has long been considered an excellent knowledge acquisition tool, it is considered intrusive. When providing support, it is not. This is a simple but important idea that should enable organizations to move to greater levels of congruence through implementation of HTKB technologies.

To move the firm to the exploratory levels of mapping (governance and tact), the underlying processes will also implement several tools of knowledge micro analysis. According to Randles, Miller, and Polin (2017), the aforementioned nomenclature is succinct and should allow the graphical representation and mathematical calculation of cognitive force. An example of a moment model representing the interaction between a physician and medical expert system is presented in figure 3. At the top of the diagram is the ring link. This part of the moment model shows that the process is coherent but is not complete (lacks the structuring cause which generates explanations and motivates action). It also shows that the rule-based knowledge of the system and physician are redundant. The lower diagram depicts the interaction of several different knowledge types over a three minute span with the physician collecting and entering data for the system to analyze. This an early representation and the moment modelling methodology is being refined. These refinements will be presented in Randles, Miller, and Polin (2017).

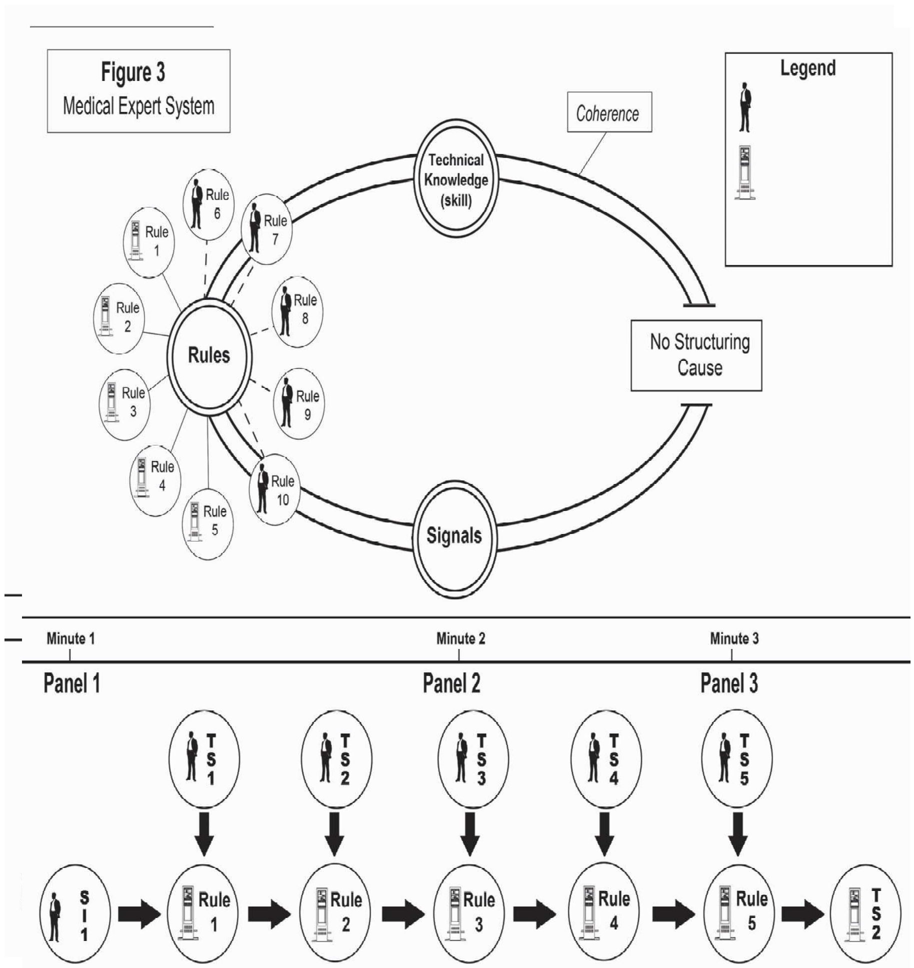

Figure 3: Moment Model

Additionally, knowledge micro analysis would support the definition of business process knowledge requirements and the conduct of knowledge requirement fulfillment analyses. These techniques were described by Randles, Miller, and Blades (2011), and their implementation should reveal that errors in the conduct of business processes often stem from a failure to satisfy knowledge requirements. Consequently, the objective of knowledge requirement fulfillment analysis is to detect potential knowledge gaps and reduce their chance of occurrence. Knowledge requirement fulfillment analysis would also be used to identify situations where the fulfillment of knowledge requirements is done by over qualified agents. These analyses will foster improvements in the firm's use of knowledge resources, as resources are better aligned to requirements. Finally, to support quality management, moment models would be used to calculate the cognitive force of different business scenarios. Over time, a library of maps (problem space, sub-state, business process, and response), moment models, and force assessments would be created, and these tools would support the management of risk, human resources, and quality.

The importance of explanations in the conduct of complex diagnoses was recognized through an analysis of video recordings of teleconsultations between primary care physicians and specialists. While these dialogues are just simple words when extracted from a video recording, when placed in the appropriate context, these explanations become powerful. However, there are also tacit aspects of the structuring cause that can be used to improve organization performance. For example, deep within the structuring cause stir emotions which might be important indicators. Unfortunately, these deep thoughts are often ignored. Instead, they should be managed.

According to the knowledge combustion and vehicle analogy, action is controlled by two sets of cognitive processes that precede two emotions (risk and confidence). Risk is based on an assessment of an action's consequences and an action threshold is established by the structuring cause. Like risk, confidence is an emotion determined deep within the structuring cause through an assessment of knowledge requirements and abilities. Just before an action is performed the action threshold and the actor's confidence are compared. Only if confidence surpasses the action threshold, will an action be performed voluntarily. Hence, the deepest, most tacit of Dretske's three knowledge types - the structuring cause - has the final say concerning risky intelligent actions. It seems imperative that this mechanism be better understood and managed in order to better support the agents of the firm in delicate situations.

Tact is the mapping level after governance and requires doing the appropriate thing in a delicate situation. A competent risk analysis is required so that risk and action can be balanced, and SccoB mapping operations would be supported by the firm's risk managers so that explanations to motivate action are balanced by an explanation of its risks. As HTKB technologies are implemented, the risk of the proposed actions would be analyzed and explained by the firm's risk managers and an action threshold would be established. In return for the support of the firm's risk managers, SccoB mapping operations would communicate the aforementioned risk assessments using HTKB technologies. This would move the firm beyond governance to the tact mapping level with its maps and explanations also serving as a risk management tool.

People do not just utter propositions; they perform illocutionary acts such as stating, requesting, and commanding. Every speech act consists of the illocutionary force F applied to a proposition P, and this is known as the F(P) hypothesis (Covington, 1998). The Bach and Harnish classification system would be used to classify the explanations provided by specialists. This classification system makes many distinctions and is better for enumerating the whole range of human speech (Covington, 1998). Using rules of illocution to classify words, the hypothesis testing knowledge blend would vary the wording of explanations to control their illocutionary force. For example, the illocutionary force of a message could be increased in an urgent situation or decreased in a situation requiring caution.

Our video analysis revealed that during diagnostic teleconsultations the specialists had to gain the trust of the remote physicians and patients. The importance of elocution (how something is said) was demonstrated by a deep-voiced neurologist who gained the immediate respect of a disoriented elderly patient. Elocutionary forces are controlled by the way the message is said (elocution). Using rules of elocution, the HTKB would control voice production in the provision of directions and explanations, customizing the manner of elocution for specific diagnosticians.

As was previously stated, deep within the structuring cause stir emotions that are often ignored, and it is the intent of the SccoB process to gather, depersonalize, aggregate, and report these signals about critical events on a timely basis. A program entitled – thank you for asking – would be implemented. A query schedule would be created and selected agents of the firm would be queried by one of their coworkers about their feelings regarding critical issues. Furthermore, information such as agents' assessments regarding their confidence in performing specific business tasks would be collected and analyzed to refine the firm's task assignments and training programs. By better balancing two emotions concerning risk and confidence, the firm would move to greater tact and to doing the appropriate thing in delicate situations more often.

CLOSING REMARKS

Organizations must recognize that artifacts of the structuring cause are valuable resources. Their use should gain a firm significant competitive advantage. This seems such an important point that an alternate title was strongly considered for this paper. This alternate title was as follows: *milking the structuring cause - a valuable knowledge cow*.

By increasing organization congruence, the underlying SccoB processes serve as a strategic management tool, and it is hoped that HTKB technologies and the tools of knowledge micro analysis will increase the adoption of knowledge management by knowledge intensive organizations. Developing the aforementioned tools of knowledge micro analysis is the focus of our current research. It is early in the emergence of the science of knowledge management. It is only beginning to transition from an information systems perspective, which is one of its foundation sciences, to a knowledge perspective. We suggest that knowledge management be viewed as a quality, risk, human resource, and project management tool that fosters organization knowledge creation, learning, and agility as well as improving the allocation of knowledge resources. While there is much work to be done, we are excited about the 21st century and the science of knowledge management.

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