Basic Concepts of Knowledge Management

By

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Introduction

This paper provides an introductory conceptual framework for knowledge management. It treats the concepts of Knowledge Management System, Knowledge Base, Knowledge, Knowledge Process, and Knowledge Management in the abstract. It then develops corresponding definitions at the slightly lower level of abstraction of human organizations. Two approaches to knowledge management are identified and characterized. The paper then concludes with a discussion of some issues suggested by the framework.

The Most Abstract Level

The Knowledge Management System (KMS)

The KMS is the on-going, persistent interaction among agents within a system that produces, maintains, and enhances the system's knowledge base. This definition is meant to apply to any intelligent, adaptive system composed of interacting agents. An agent is a purposive, self-directed object. Knowledge base will be defined in the next section.

In saying that a system produces knowledge we are saying that the system (a) gathers information and (b) compares conceptual formulations describing and evaluating its experience, with its goals, objectives, expectations or past formulations of descriptions, or evaluations. Further, this comparison is conducted with reference to ***validation criteria***. Through use of such criteria, intelligent systems distinguish competing descriptions and evaluations in terms of closeness to the truth, closeness to the legitimate, and closeness to the beautiful. [1]

In saying that a system maintains knowledge we are saying that a system continues to evaluate its knowledge base against new information by subjecting the knowledge base to continuous testing against its validation criteria. We are also saying that to maintain its knowledge, a more complex system must ensure both the continued dissemination of its currently validated knowledge base, and continued socialization of intelligent agents in the use and content of its

knowledge base.

Finally, in saying that a system enhances its knowledge base, we are saying that a system adds new propositions and new models to its knowledge base, and also simplifies and increases the explanatory and predictive power of its older propositions and models. That is, one of the functions of the KMS is to provide for the growth of knowledge.

Knowledge Base of a System and Knowledge

A system's knowledge base is: the set of remembered data; validated propositions and models (along with metadata related to their testing); refuted propositions and models (along with metadata related to their refutation); metamodels; and (perhaps, if the system produces such an artifact) software used for manipulating these, pertaining to the system and produced by it.

A knowledge management system, in this view, requires a knowledge base to begin operation. But it enhances its own knowledge base with the passage of time because it is a self-correcting system, and subjects its knowledge base to testing against experience.

This definition of knowledge base contrasts with a popular definition of knowledge as "justified, true belief." [2] The definition does agree with the necessity of justification as a necessary condition for knowledge; but it insists that justification be specific to the validation criteria used by a system to evaluate its descriptions and evaluations. The definition also agrees that knowledge is a particular kind of belief, provided that belief extends beyond cognition alone, to evaluation. [3]

The biggest discrepancy of the above definition with the popular one is in not requiring that justified beliefs be "true." Truth can be used as a regulating ideal by a system producing descriptive knowledge. "Right" can be used as a regulating ideal by a system producing evaluative or normative knowledge. But the system in question can never say for sure that a proposition or a model within its knowledge base is "true," or "right;" but only that it has survived refutation by experience better than its competitors, and therefore that the system "believes" it is true or right. So instead of knowledge as "true, justified belief," the position taken here is that knowledge equals justified belief that some conceptual formulation, fact, or evaluation, is true or right as the case may be.

Finally, the emphasis on a system's knowledge base, rather than its knowledge, recognizes that an identification of knowledge as individual conceptions, propositions, or models is inconsistent with the reality that acceptance of a piece of information into a system's body of knowledge is dependent on the background knowledge already within the knowledge base. This background knowledge is used to filter and interpret the information being evaluated. [4], [5], [6].

In a very real sense, a system's knowledge is ***the analytical network of propositions and models constituting the knowledge base.*** It is therefore, just for convenience, that one may refer to a particular proposition or model as something a system "knows," because it knows that

"something," only if one assumes that numerous unspecified background propositions and models are also known by it. [7]

The Knowledge Management Process and Knowledge Management (KM)

The Knowledge Management Process (KMP) is an on-going persistent interaction among human-based agents who aim at integrating all of the various agents, components, and activities of the knowledge management system into a planned, directed process producing, maintaining and enhancing the knowledge base of the KMS. Knowledge Management is the human activity within the KMP aimed at creating and maintaining this integration, and its associated planned, directed process.

The Organizational Level

Organizational Knowledge Management System

An Organizational Knowledge Management System (OKMS) is the KMS of a formal organization. Since it is a type of KMS, it is also an on-going, persistent interaction among agents which produces, maintains, and enhances the system's (in this case the organization's) knowledge base. The agents in an OKMS may be individuals, formal or informal groups or any goal-directed purposive, intelligent and adaptive object whether human, machine, or system-based.

An OKMS is itself an agent. It exists within an environment including the organizational system itself, and the organization, in its turn, is in interaction with other organizations and with systems such as the climatological system which are not formal, human-based organizations.

The OKMS is greatly influenced by the power, influence, and authority structures existing in organizations, and in particular by the knowledge authority structure *produced by the knowledge management process itself*. These structures influence the creation and adoption of validation criteria employed by organizations to produce knowledge. They also influence the information selection and communications processes preceding validation. Finally, they can also directly influence the interpretation of the validation process so that untested or refuted information is nevertheless designated as knowledge by an organization.

There is tension between an organization's ability to adapt, and the impact of its power, authority and influence structures on the knowledge management system. The greatest amount of tension, is focused on the issue of knowledge validation criteria. If an organization establishes invalid validation criteria [8] due to the impact of its power, authority or influence configurations, it will succeed in creating a knowledge base that is valid only from its own organizational perspective. It will have learned only subjective knowledge, not objective knowledge. [9]

In addition to:

- a knowledge base of domain related knowledge,
- a knowledge authority structure, and
- knowledge validation criteria,

the OKMS produces a range of other effects or outputs. These include:

- a meta-knowledge base (a knowledge base about knowledge [for knowledge management], including knowledge validation criteria)
- knowledge diffusion to components of the organization,
- the effects of knowledge diffusion in organizational component knowledge bases,
- a knowledge-related technical infrastructure supporting retrieval, display, discovery, maintenance, communication, storage, knowledge base integration, etc.
- educated, trained, personnel who can use the organization's knowledge base, and
- educated, trained personnel who can perform knowledge management.

An important approach to KM is an approach attempting to specify the OKMS directly. Such a direct systems approach attempts to identify the most significant objects in the OKMS, their behavior, attributes, and methods. The approach moves from OKMS concept specification, to model specification, to KM metrics specification, and then repeats the cycle until a comprehensive and measurable model of the OKMS, including its KM aspects is in hand. This iterative approach is a classical General Systems Theory (GST) approach and has much to recommend it.

The Organizational Knowledge Base

An organizational knowledge base is the knowledge base of a formal organization. To clarify what this means beyond the more abstract notion of a system's knowledge base, we need some more specification.

First, organizations contain individuals, and groups, both formal and informal, as well as a formal authority structure. Every individual and group can be viewed as a purposive, self-directed agent in interaction with its members, with other groups, and with the organization as a whole. The members of every group can also be viewed as agents whose interaction forms the group.

Second, for every group and for the organization as a whole, we can distinguish analytical properties, structural properties, and global properties. [10] Analytical properties are derived by aggregating from data describing the members of a collective (a group or a system). Structural properties are derived by performing some operation on data describing relations of each member of a collective to some or all of the others. Lastly, global properties are based on information about the collective that is not derived from information about its members. Instead such properties are produced by the group or system process they characterize, and, in that sense, may be said to "emerge" from it, or from the series of interactions constituting it.

Third, an organization's knowledge base is composed of the elements identified above, characterized by classes of *global properties or attributes describing the knowledge elements*.

The values of these attributes and the state of knowledge in an organization, is dependent upon the process that produces the values of knowledge attributes at any point in time; but it is not directly dependent on (or reducible to) the attributes (knowledge or otherwise) of the organization's members and/or the members' relations to one another.

Some of these attributes of organizational knowledge bases are observational in character. Some are abstractions measured through interpretations of observational attributes. But whether observational or abstract in nature the attributes of organizational knowledge bases are global properties of the organization system, distinct from the agents comprising the organization. Examples of global knowledge properties include: extent of integration of networks of propositions constituting the knowledge base, forecast success rates of various portions of the knowledge base, degree to which the knowledge base is relied on in corporate decision making, etc.

Fourth, Sources of observational (data) attributes measuring the organizational knowledge base, include the cultural products produced by an organization: its documents, both written and electronic, its art, its buildings, etc. Data attributes describing these cultural products provide observational indicators or measures of emergent abstract knowledge properties. [11] [12] We can impose measurement models [13] on these observational indicators to construct measures of these more abstract knowledge properties. In turn, we can relate these properties to one another in process models and dynamic models, and we can also relate them to concepts and properties we encounter in knowledge management such as knowledge creation, diffusion, maintenance, decline and so on.

Fifth, it is useful to distinguish different types of knowledge in the knowledge base. The categories to be used here include:

- planning knowledge (a network of propositions relating alternative decision options to predicted consequences and such consequences to the goals, objectives, and priorities expressed in a hierarchy of such goals and objectives);
- descriptive knowledge (a network of propositions specifying what exists or has existed exclusive of impact);
- knowledge about impact (a network of propositions specifying the extent of departure from an expected actual state given no purposive activity by an agent, caused by the purposive activity of that agent);
- predictive knowledge (a network of propositions specifying values of variables not yet available); and
- assessment knowledge (a network of propositions providing a value interpretation of descriptive, impact-related, or predictive knowledge, e.g. benefit/cost knowledge).

These categories apply to:

- the knowledge base,
- the meta-knowledge base,
- domain knowledge which will vary greatly with organizational specifics, and
- component subsystem-related knowledge, which also varies very greatly.

Examples of domains are sales, marketing, customer care, financial, knowledge management, products, services, and shipping. Examples of component subsystems are U.S. and International Sub-divisions of major corporations.

Organizational Knowledge Management Process

An Organizational Knowledge Management Process (OKMP) is a "business process," aimed at integrating the various organizational agents, components, and activities of the OKMS into a planned, directed process producing, maintaining and enhancing an organization's knowledge base. It differs from an OKMS, in that it is a human-managed process whose purpose is to control that system and its dynamics, while the OKMS itself exists whether or not humans explicitly try to manage it.

A Business Process is a sequence of interrelated activities that transforms inputs into positively or negatively valued outputs. Processes are value streams in that they are oriented toward producing, and do produce, value for the enterprise. An OKMP is one of a number of "business" processes that may be distinguished in organizations. An OKMP is a process directed by organizational goals and objectives. It is driven by a variety of knowledge management sub-processes, use cases, and tasks, whose collective purpose is to perform knowledge management and to control the knowledge management system and its outputs. The OKMP, in other words, is part of the OKMS, a process within it that exerts more or less control, as the case may be, over the more fundamental system and its knowledge base.

The sub-processes of an OKMP are: Planning, Acting, Monitoring, and Evaluating. **Planning** means setting goals, objectives, and priorities, making forecasts as part of prospective analysis, performing cost/benefit assessments as part of prospective analysis, and revising or reengineering a business process. **Acting** means performing the business process or any of its components. **Monitoring** means retrospectively tracking and describing the business process. **Evaluating** means retrospectively assessing the performance of the business process as a value stream.

Business Processes such as the OKMP, are used by human-based agents (individuals or groups) called Business System Actors who drive processes and sub-processes. **A** Business System Actor is a human-based agent performing a particular coherent cluster of activities in relation to a Business System or Process. [14] These structured sets of activities, or **roles** played by agents, distinguish Business System Actors from other agents including human-based agents in general. The actor concept is an abstraction from the basic notion of agent, and can apply to the role within an organization of either an individual, or a group.

A Business System Use Case is defined by Jacobson [15] as "A sequence of transactions in a system whose task is to yield a result of measurable value to an individual actor of the business system." A use case may also be composed of multiple transaction sequences or tasks. A behaviorally-related set of business use cases, in turn, constitutes a business process, and therefore extends over the four sub-processes. Figure One shows the relationships of business

processes, sub-processes, use cases, and tasks (transaction sequences) to one another.

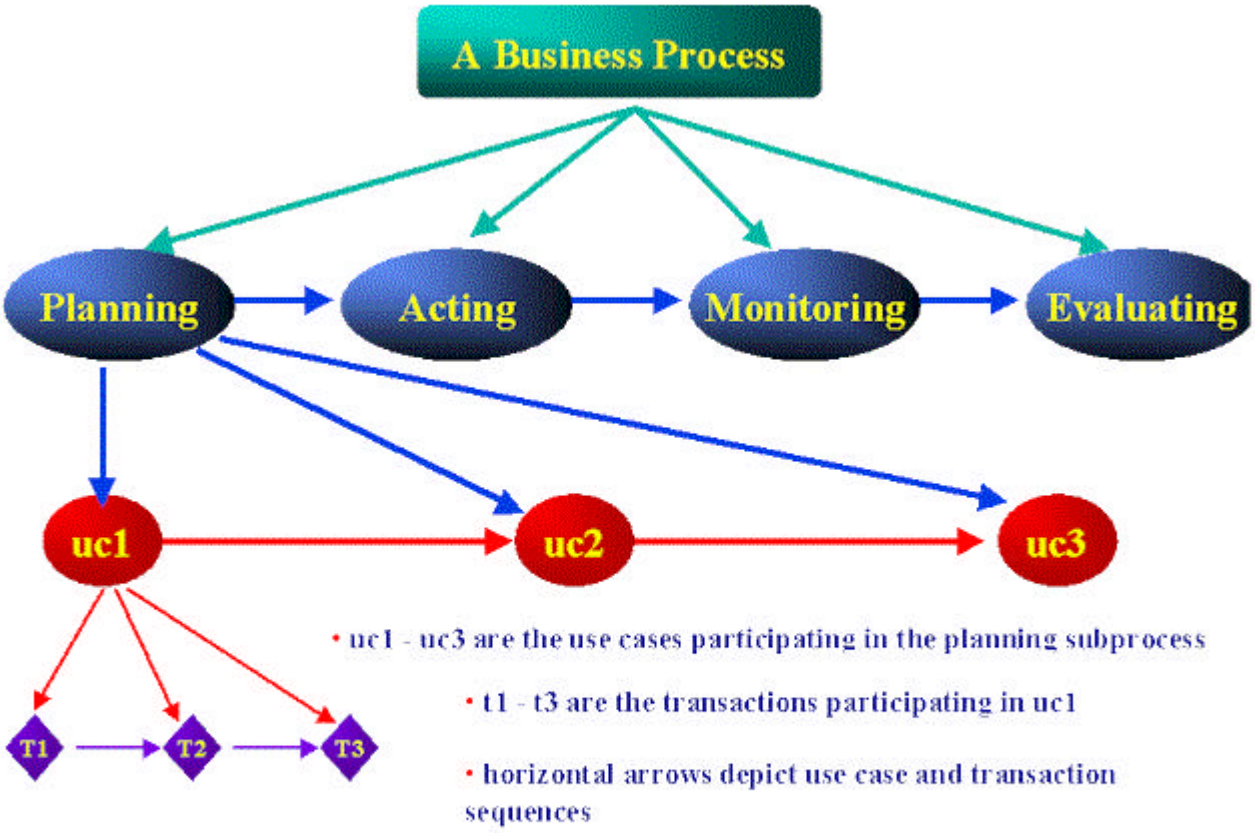

Figure One -- The Hierarchy of Business Processes, Subprocesses, Use Cases And Transaction Sequences

A use case is intended to accomplish some tactical objective of an actor, or to aid in accomplishing a tactical objective. The use case concept focuses attention on the actor's viewpoint about what the system is supposed to give back in response to the actor's actions. That is, it is supposed to give back a response or output, and that output, or other effects or consequences of the use case, will have value relative to a hierarchy of tactical and strategic objectives and goals. Figure Two illustrates the connection between a use case and a hierarchy of goals and objectives, by way of the effects of the use case.

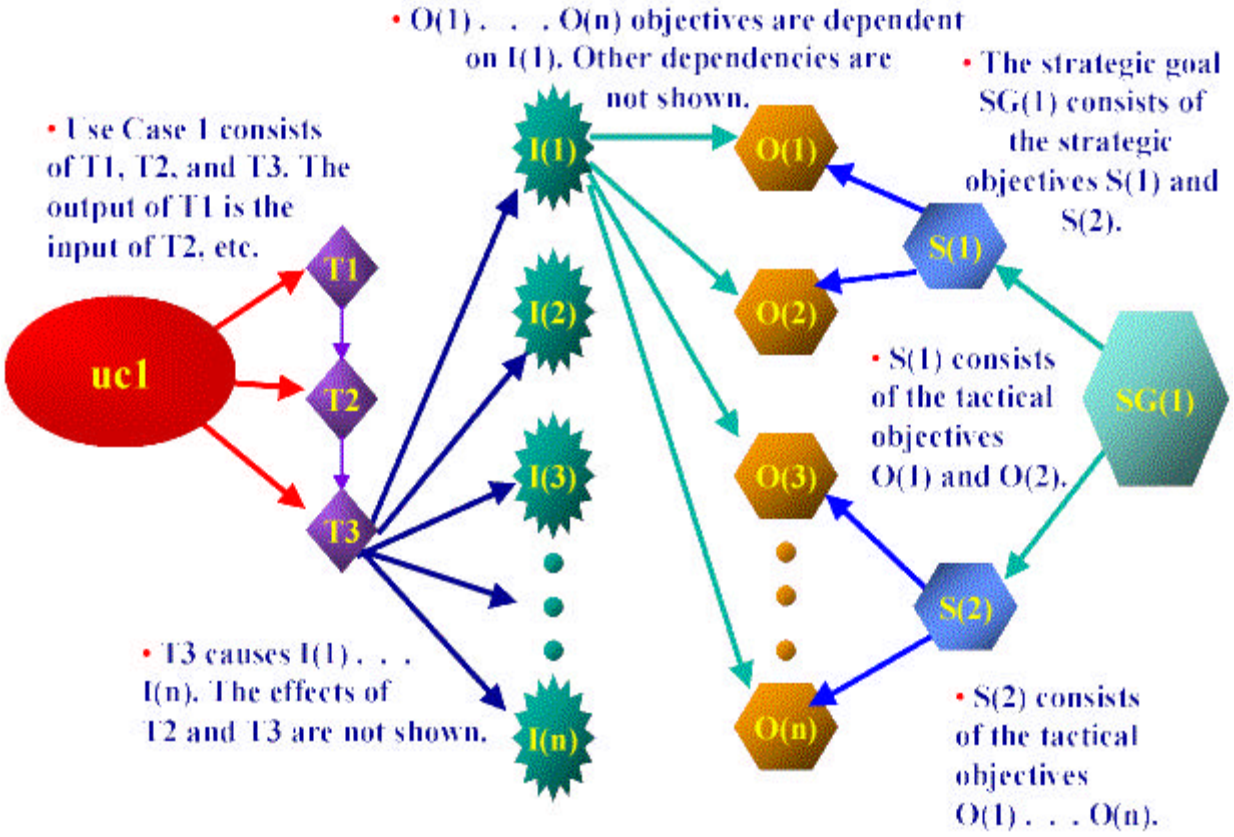

Figure Two -- Connecting a Use Case to Goals and Objectives

Business Process Use Cases, KM and KM Metrics

A good way to look at the human activity called knowledge management is through the concept of the Use Case. In a use case a human-based agent, within the KMS, called an actor, participates in the KMP to get an outcome from the KMS that has value for the actor. The OKMP can be represented as a set of Business Process Use Cases each classified within one of the four business sub-process categories. *A way of decomposing knowledge management activity then, is in terms of the use cases that constitute it.*

The set of all use cases aimed at creating and maintaining the integrated, planned, directed process producing, enhancing and maintaining the OKMS knowledge base, is an alternative characterization of knowledge management. The set of these use cases represents all of the organizational knowledge management activity of the actors making use of the OKMS through the OKMP. In other words, the set of use cases is what we mean by knowledge management in an organization.

Identification and specification of each of these use cases leads to an initial specification of concepts (conceptual objects) supporting that use case. The task sequence constituting the use case motivates interactions, or collaborations among the conceptual objects. And the attributes of these objects are affected by the interactions defining the course of the use case.

The focus of description and evaluation in the OKMS then, should be on the attributes of the object interactions or task sequences, and also on the attributes of the conceptual objects supporting the OKMP use cases. As well, this must also be the focus of Knowledge Management Metrics (KM Metrics) development, because (a) quantitative measurement in the context of the OKMS, is nothing more than the act of performing quantitative

description and evaluation of the conceptual objects and attributes of the OKMS, and (b) we must develop metrics to make this possible.

An alternative to the direct GST approach to KM is the business process/sub-process/use case approach. This approach recognizes the existence of the OKMS and the place of the OKMP and KM within it, and its ultimate objective is also to specify and model the OKMS. But it attempts to approach system specification directly from the viewpoint of a conceptual segmentation of the OKMP and KM, so that aspects of the OKMS may be incrementally modeled and brought under control. This process-driven approach also has much to recommend it.

Some Issues and Implications

Is The Agent Part of the OKMS Or Outside It? [16]

In a mechanical or an information system the process governing its use may be viewed as external to the system. The actor is outside the information system, and a use case is the actor's way of relating to the system and getting something out of it. To describe the system and account for its behavior, we need not know anything about the actor except that it is the means of exercising the use case that initiates the process resulting in the system's response. The actor is outside of the information system in the sense that we are not interested in its impact on the actor, and we can largely neglect this impact in controlling the information system's behavior.

In the OKMS though, its business processes and the human agents participating in these processes, are both impacted by the system and also impact upon it. The impact of the system on an agent affects the agent's future behavior in the system. In turn, the impact of the agent on the system affects the system's future behavior, and even how it behaves toward the agent. In short, the agent is both an observer in the OKMP/OKMS, and also a participant in it.

Since the agent participates in many systems aside from the OKMS, the OKMS does not determine the agent's behavior. But it does impact on the agent's behavior, and effect the nature of its future participation in the OKMS.

Does the Knowledge Base of An OKMS Include the Knowledge in the Minds of Its Human Agents: That Is: Is "Wetware" Part of the OKMS?

From the viewpoint of the above conceptual development, "wetware" is part of each agent and, like the agent, shares the duality of being both a participant and also only partially determined

by the OKMS. Enterprises are currently much concerned with "wetware" and with ensuring that it can be captured and used by enterprises. Some even view such "wetware" as belonging to the enterprise and as part of its knowledge resources.

From our perspective though, the "wetware" of the human agents participating within the OKMS, is determined by the variety of systems the agent participates in, and the OKMS only impacts on the knowledge of its individual human agents. So clearly, "wetware" does not "belong" to the OKMS, even though how much of it can be integrated with an enterprise is a natural concern of Knowledge Managers.

Is Organizational Knowledge the Sum of the Knowledge In the Minds of Organizational Agents?

Some in KM believe that knowledge itself, is only resident in the human mind, so that the knowledge base of an organization is the sum of the knowledge in all the human minds in an organization. This view is contrary to our own. For us the organizational knowledge base is primarily a global, emergent outcome of the interaction among agents, both human and otherwise. Part of this knowledge base may be our aggregations of the knowledge base properties of individual human agents, and our structural analyses and measurements of the relationships among individuals with respect to the properties of their knowledge bases. But the knowledge base of the OKMS, though it certainly may be influenced by knowledge in "wetware," and may certainly incorporate such knowledge if it is transferred to the OKMS through the interaction of its human agents with it, is a global product of this very interaction. Therefore it is distinct from the sum of knowledge of individual participants in the OKMS.

What's the Difference Between Data, Information, Knowledge, and Wisdom?

To begin with, organizational data, information, knowledge, and wisdom, all that emerge from the social process of an organization, and are not private. In defining them,we are not trying to formulate definitions that will elucidate the nature of personal data, information, knowledge, or wisdom. Instead, to use a word that used to be more popular in discourse than it is at present, we are trying to specify intersubjective constructs and to provide metrics for them.

A datum is the value of an observable, measurable or calculable attribute. Data is more than one such attribute value. Is a datum (or is data) information? Yes, information is provided by a datum, or by data, but only because data is always specified in some conceptual context. At a minimum, the context must include the class to which the attribute belongs, the object which is a member of that class, some ideas about object operations or behavior, and relationships to other objects and classes.

Data alone and in the abstract therefore, does not provide information. Rather, information, in general terms, is data plus conceptual commitments and interpretations. Information is data extracted, filtered or formatted in some way (but keep in mind that data is always extracted filtered, or formatted in some way).

Knowledge is a subset of information. But it is a subset that has been extracted, filtered, or formatted in a very special way. More specifically, the information we call knowledge is information that has been subjected to, and passed tests of validation. Common sense knowledge is information that has been validated by common sense experience. Scientific knowledge is information (hypotheses and theories) validated by the rules and tests applied to it by some scientific community. Organizational knowledge in terms of this framework is information validated by the rules and tests of the organization seeking knowledge. The quality of its knowledge then, will be largely dependent on the tendency of its validation rules and tests to produce knowledge that improves organizational performance (the organization's version of objective knowledge).

Wisdom, lastly, has a more active component than data, information, or knowledge. It is the application of knowledge expressed in principles to arrive at prudent, sagacious decisions about conflictful situations. [17]

From the viewpoint of the definition given of organizational knowledge, we now ask what an organization is doing when it validates information to produce knowledge, it seems reasonable to propose that the validation process is an essential aspect of the broader organizational learning process, and that validation is a form of learning. So, though knowledge is a product and not a process derived from learning, knowledge validation (validation of information to admit it into the knowledge base) is certainly closely tied to learning, and depending on the definition of organizational learning, may be viewed as derived from it.

Should the Use Case Concept Be Applied To Specify the OKMP?

While the use case concept is widely used in connection with Object Technology, its very use in software development may suggest that it not be applied to the problem of the more abstract analytical task of specifying the OKMP. After all we do not want to reduce KM to software development, and we do not anticipate that KM will ever be fully automated. [18]

But if one is going to take a process approach to KM at all, it is convenient to develop a systematic framework for talking about a hierarchical decomposition of the OKMP. Here, process, sub-process, use case, and tasks, have been distinguished to name various levels of this process hierarchy. The fact that this usage is close to that in software development circles means that communicating with groups interested in the software side of KM will be easier, and is enough justification to use the vocabulary and conceptual framework of use cases.

What is the set of Use Cases Constituting the OKMP?

The answer to this question will be addressed in a forthcoming White Paper.

Is A Direct GST or An OKMP-Based Approach to KM Development the Correct One?

There is no single correct approach to KM development. Both the direct GST and OKMP approaches contemplate the development of system models, and merit vigorous pursuit.

I prefer to follow the OKMP approach because it approaches the OKMS through the lens of specific use case constructs that identify areas of KM concern or problems. It is a partial, incremental, approach to systems development. It stays close to areas of concrete concern to Knowledge Managers.

In contrast, a direct GST approach, even though it may be implemented iteratively, seems to attempt to do too much at once. To avoid the "big bang" development problem, it then becomes necessary to abstract too much in developing key measures and metrics, and in modeling KM. The resulting models and metrics may run the risk of not addressing the "nuts and bolts" of KM and how they are related to value.

References

[1] I'm referring to the view that validation criteria can be applied in arriving at ethical and aesthetic knowledge, as in arriving at factual knowledge. See Nicholas Rescher's Objectivity: The Obligations of Impersonal Reason (Notre Dame, IN: University of Notre Dame Press, 1997), Chs. 9-11, and E. W. Hall, Our Knowledge of Fact and Value (Chapel Hill, NC: University of North Carolina Press, 1961).

[2] Another viewpoint on the traditional view is given by Allan H. Goldman, Empirical Knowledge (Berkeley, CA: University of California, 1991), Pp. 19-23.

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[7] Ibid.

[8] Criteria that do not effectively discriminate among formulations that organize experience and contribute to the growth of knowledge and those that do not.

[9] Reshcher, Objectivity . . ., op. cit. Also see Karl Popper, Objective Knowledge: An

Evolutionary Approach (Oxford, UK: The Clarendon Press, 1972)

[10] These distinctions were originally formulated by Paul F. Lazarsfeld and Herbert Menzel, "On the Relation Between Individual and Collective Properties," in Amitai Etzioni (ed.), Complex Organizations (New York: Holt, Rinehart and Winston, 1961).

[11] Kenneth W. Terhune, "From National Character to National Behavior: A Reformulation," Journal of Conflict Resolution, 14 (1970), 203-263.

[12] Joseph M. Firestone, "The Development of Social Indicators from Content Analysis of Social Documents, " Policy Sciences, 3 (1972), 249-263.

[13] Joseph M. Firestone, "Remarks on Concept Formation: Theory Building and Theory Testing," Philosophy of Science, 38 (Dec. 1971), 570-604

[14] This business system actor concept is different from Ivar Jacobson's, who defines it as one who "defines one or a set of roles that someone or something in the environment can play in relation to the business. In contrast, our agent/actor is a component of the OKMS. See Ivar Jacobson, Maria Ericsson and Agneta Jacobson., The Object Advantage: Business Process Reengineering with Object Technology (Reading, MA: Addison-Wesley, 1995), P. 339

[15] Ibid., P. 343

[16] My thanks to Jack Ring of Kennen Technology, Inc. for raising this issue in a critique of a draft working paper I prepared for the KM Metrics Task Force of the Knowledge Management Consortium. You can find the KMC at http://www.km.org.

[17] I read Gene Bellinger's views on data, information, knowledge, and wisdom at http://www.radix.net/~crbnblu/musings/kmgmt/kmgmt.htm, before writing my own differing account of these four concepts. His views are certainly worth keeping in mind when considering mine.

[18] My thanks to Ed Swanstrom of Agilis Corp. and Executive Director of the KMC, for pointing out this issue with use cases. Jack Ring has many more problems with the use case approach, but to address those here is beyond our present scope.

Biography

Joseph M. Firestone is an independent Information Technology consultant working in the areas of Decision Support (especially Data Marts and Data Mining), Business Process Reengineering and Database Marketing. He formulated and is developing the idea of Market Systems Reengineering (MSR). In addition, he is developing an integrated data mining approach

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