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Knowledge Management: A Framework for Analysis And Measurement

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Introduction

Knowledge Management (KM) is a field in ferment and disorder. In any such field a first order of business is developing a conceptual framework to serve as a map for problem definition, analysis, measurement, impact analysis, software applications development and research of various kinds. KM is no exception.

In this paper I offer such a conceptual framework. It provides basic KM-related concepts, a business process decision model, a knowledge life cycle model, a KM framework, and a detailed listing of descriptors and metrical concepts associated with the main categories of the conceptual framework. I begin with the basic concepts.

Complex Adaptive Systems

A Complex Adaptive System (CAS) is a goal-directed open system attempting to fit itself to its environment. It is "...composed of interacting" ... adaptive "agents described in terms of rules" [1, P. 10] applicable with respect to some specified class of environmental inputs. "These agents adapt by changing their rules as experience accumulates." The interaction of these purposive agents, though directed toward their own goals and purposes, results in emergent, self-organizing behavior at the global system level. This emergent behavior, in a sustainable CAS is itself adaptive.

Emergent behavior is behavior that cannot be modeled based on knowledge of the system's components. It is the ability of CASes to adapt, along with their emergent behavior that distinguishes them from simple adaptive systems and from Newtonian systems that lack adaptive capacity.

The Natural Knowledge Management System (NKMS*)*

The NKMS is a CAS. It is the on-going, conceptually distinct, persistent, adaptive interaction among intelligent agents (a) whose interaction properties are not determined by design, but instead emerge from the dynamics of the enterprise interaction process itself; and (b) that produces, maintains, and enhances the knowledge base produced by the interaction. An Enterprise NKMS includes mechanical and electrical organizational components produced by it, such as computers and computer networks, as well as human and organizational agents. An intelligent agent is a purposive, adaptive, self-directed object. Knowledge base will be defined in the next section.

In saying that a system produces knowledge we are saying that it (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.

In saying that a system maintains knowledge we are saying that it 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 content of the knowledge base.

Finally, in saying that a system enhances its knowledge base, we are saying that it 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.

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 (if the system produces such an artifact) software used for manipulating these, pertaining to the system and produced by it.

A knowledge management system requires a knowledge base to begin operation. And it enhances its own knowledge base with the passage of time because it is a self-correcting system, subject to testing against experience.

This definition of knowledge base contrasts with the popular definition of knowledge as "justified, true belief" [2, Pp. 19-23] in a number of ways:

- First, the definition agrees 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. Validation criteria and the "rules" governing their application will vary across organizations. Such variations will impact in important ways on the velocity and acceleration of innovation and on the quality of new knowledge produced by the system.

- Second, the definition is partly consistent with the idea that individual level knowledge is a particular kind of belief, provided that belief extends beyond cognition alone, to evaluation. But this consistency does not extend to the view that knowledge is *only* "belief" of a particular kind. And it does *not* imply that the knowledge base is composed of beliefs.

  Rather, following Popper, [3] [4] we recognize that there are "three worlds" we must keep in mind when analyzing knowledge. The first world is made of material things: things, oceans, quarks, neurons, brains, etc. The second world is made of psychological objects and emergent predispositional attributes of intelligent systems: minds, cognitions, beliefs, perceptions, intentions, evaluations, emotions, etc. The third world is made of abstractions created by second world objects acting upon first world objects.

  That is, agents, based on second world predispositions, make decisions and act to produce (first world) cultural products such as books, documents, and works of art, that are repositories of content. The content of these products is composed of third world abstractions such as theories, problems, arguments, and descriptions. These third world objects are not the same as the books or media we use to express or communicate them. Rather, they are ***what*** we express and communicate to our second world minds by using these first world objects.

  Second world objects act upon the first world to create third world abstractions. So mind impacts on and creates the third world. But as Popper emphasized, the third world is autonomous. Once third world objects exist, once they have been created, they, in turn, have an impact on our beliefs, on our minds, and eventually on our future actions.

  This brings us to knowledge. There are two kinds of knowledge.

  (1) Knowledge viewed as belief, is a second world predispositional object. We can talk of the predispositional knowledge of individuals, groups, teams, and organizations, as "justified" belief that is true as far as the agent holding the belief knows. Such knowledge is an immediate precursor of our decisions, and we use it to make them. Such knowledge is "subjective" in the sense that it is agent-specific, whether the agent is an individual, group, team, or organization. And at the

individual level, such knowledge is "personal," in the sense that other individuals do not have direct access to one's own knowledge in full detail and therefore cannot either "know it" as their own belief, or validate it. [5]

(2) Knowledge viewed as validated models, theories, arguments, descriptions, problem statements etc., is a third world, linguistic object. It is not psychological in nature or even sociological. We can talk about the truth, or nearness to the truth of such third world objects, and of knowledge defined as descriptions, models, theories, or arguments that are closer to the truth than competitors. This kind of knowledge is not an *immediate* precursor to decisions. Before it impacts decisions it impacts second world beliefs and these, in turn, impact decisions. This kind of knowledge, further, is "objective." It is objective in the sense that it is not agent specific and is shared among agents. It is also not "personal," because (a) all agents in the NKMS have access to it, and (b) it emerges from the interaction of a number of agents. Finally, it is objective because, since it is sharable, we can sensibly talk about community validation of this kind of knowledge.

Looking at the two kinds of knowledge, we can now see that the knowledge base of an NKMS is composed of the third world objects it validates, not the predispositional knowledge of its agents. It is that kind of world 3 knowledge that the system produces.

The knowledge of the individuals in a social organization is not produced by the system alone. The NKMS impacts upon that knowledge. But individuals participate in a variety of systems. And each of these systems interact with an individual to produce its world 2 knowledge (justified beliefs).

- Third, another discrepancy with the popular definition is in not requiring that knowledge be "true." Truth can be used as a regulating ideal by a system producing factual 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. So instead of knowledge as "true, justified belief," the position taken here is that knowledge equals some conceptual formulation, fact, or evaluation, that is closer to the truth or the right, as the case may be, compared to its competitors.

- Finally, the emphasis on a system's knowledge base in its totality, rather than its knowledge, recognizes that an identification of knowledge as specific 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. In a very real sense, a system's knowledge is *the analytical network of propositions and models constituting its knowledge base.*

Measurement, Knowledge Management Measurement and Metrics

"Measurement is the assignment of numerals to things according to any determinative, non-degenerate, rule." [6, P. 41] Determinative means the constant assignment of numerals given constant conditions. Non-degenerate means allowing for the possibility of assignment of different numerals under varying conditions.

Given this fairly broad definition it is common to distinguish classification, linear rank ordering, and metrical measurement. [7, Pp. 54-55] Metrical measurement is quantitative. It involves *assigning a real number* to any selected item in the domain of a concept. Classical examples of metrical concepts are temperature in degrees Celsius, and length in centimeters. The metrics in these concepts are "degrees Celsius," and "length in centimeters," respectively. To establish these metrics, the abstractions "temperature," and length," are related to observational events through rules. The rules determine the Celsius and centimeter metrical measurement scales. A quantitative concept, the rules associated with it, and the observational events, taken together, constitute a measurement model for a metrical scale concept. [8] It is the measurement model, as much as the quantitative concept and the associated observations, which establishes the metric.

In knowledge management measurement, we are trying to select and/or formulate those concepts useful in measuring and influencing knowledge management performance. Some concepts will prove useful because they directly relate to core notions about the goals of knowledge management, and in that sense, have *normative significance* as performance criteria. For example, providing for the growth of knowledge is one of the goals of knowledge management. The abstraction "growth of knowledge," is therefore a normative concept we may seek to metricize, and establish as a performance criterion for knowledge management.

Other concepts may at first not seem directly related to the goals of knowledge management. But, insofar as they represent causes of the core concepts, or possible side effects of the knowledge management process, we will still need to measure and perhaps to metricize them, in order to explain, predict, influence, or properly assess progress on the performance criteria. These other concepts provide *descriptive criteria* for knowledge management.

The two types of criteria: normative and descriptive, suggest two types of metrics for knowledge management: normative and descriptive metrics. Though at first

blush it seems that we should be less interested in descriptive than in normative metrics, this is not the case. Some descriptive metrics, in fact, are likely to make the NKMS "go round," and to be determinative of many of the normative metrics. These descriptive metrics then, provide a second set of knowledge performance metrics, a set whose members derive significance from their role in determining the course of the NKMS, not from their direct normative significance.

Organizational Knowledge Management System

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

An NKMS is itself an adaptive 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 NKMS 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 system 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 (criteria that do not effectively discriminate among formulations that organize experience and contribute to the growth of knowledge and those that do not) 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.

In addition to:

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

the organizational NKMS 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.

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. [9] Analytical properties are derived by aggregating them 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, and is itself characterized not only by its content, but also by classes of *global properties or attributes, "meta-information," 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: inequality of knowledge distribution, 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 describing knowledge, 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. [10] [11]

We can impose measurement models 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 according to their function. These categories 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.

Business Process Hierarchies, Decision Cycles, and Knowledge Processing

Much of the behavior of organizational systems is produced by business processes performed by individuals, teams, and groups within an organization. Figure One illustrates the idea that any business process (including knowledge and knowledge management processes) may be viewed as a network of linked activities governed by rule sets, or (world 2) knowledge, aimed at producing outcomes of value to those performing the activities. A linked sequence of activities performed by one or more agents sharing at least one objective is a ***task***. A linked, but not necessarily sequential set of tasks governed by rule sets, producing results of measurable value to the agent or agents performing the tasks, is a ***task pattern***. A cluster of task patterns, not necessarily performed sequentially, often performed iteratively, incrementally, and adaptively, is a ***task cluster***. Finally, a hierarchical network of interrelated, purposive, activities of intelligent agents that transforms inputs into valued outcomes, a cluster of task clusters, is a ***business process***.

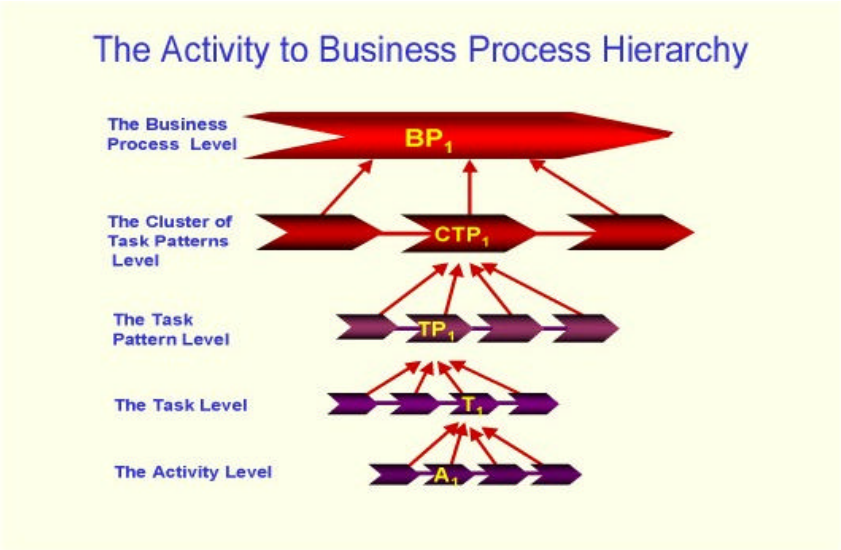


Figure One -- The Activity to Business Process Hierarchy

Any business process, task cluster, task pattern, or task must involve ***decision cycles,*** themselves composed of tasks and task patterns, through which agents execute their part in a business process or component. These decision cycles are focused on domain-centered tasks and task patterns in the NKMS, because such tasks and task patterns must be executed by agents (individuals, teams, and groups) in order to do work. It is through these domain-centered tasks that decision cycle tasks and task patterns affect the outcomes of task clusters and business processes.

The generic task patterns or ***phases*** of any decision/execution cycle are: Planning, Acting (including deciding), Monitoring, and Evaluating.

- **Planning** is a knowledge production and knowledge integration task pattern. It 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. It involves capturing and using data, information, and knowledge to produce a plan, an instance of world 3 planning knowledge.

- **Acting** means performing the specific domain business process (cluster, pattern, or task) or any of its components. Acting involves ***using the planning knowledge, along with other world 3 and world 2 knowledge*** to make and implement decisions.

- **Monitoring** means retrospectively tracking and describing the business process (cluster, pattern, or task) and its outcome. Monitoring involves gathering data and information, modeling processes, and using previous knowledge to produce new descriptive, impact-related, and predictive knowledge about the results of acting. Monitoring is another (world 3) knowledge production and knowledge integration task pattern.

- **Evaluating** means retrospectively assessing the performance of the business process as a value network [12]. Evaluating means using the results of monitoring, along with previous knowledge to assess the results of acting and to produce knowledge about the descriptive gaps between business outcomes and tactical objectives and about the normative (benefits and costs) impact of business outcomes. Evaluating is yet another decision cycle task pattern that produces and integrates world 3 knowledge in the business process.

There is a natural order to the four phases of any decision/execution cycle in a value network. Figure two illustrates the order of these phases, or task patterns of the decision cycle.

Three of these four phases require knowledge production and knowledge integration to solve problems that occur in each phase, and the fourth, the acting phase, uses the knowledge produced in the other three phases. So every decision cycle in every business process requires both knowledge processing (production and integration) and knowledge use. Knowledge use is not a separate task but rather is part of deciding and acting, and involves both world 3 and world 2 knowledge (where the decision maker interprets world 3 knowledge). But planning, monitoring, and evaluating are knowledge production task patterns of different types, each involving sequential patterns of knowledge production and knowledge integration.

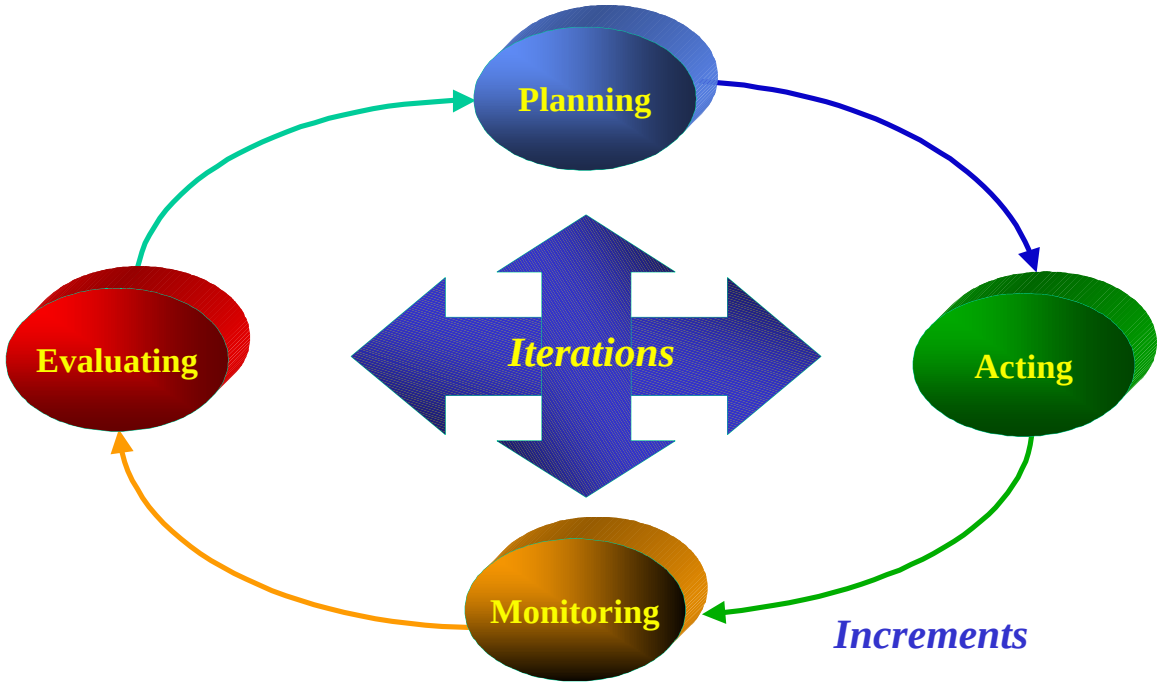


Figure Two -- Decision Cycle Phases and Their Interactions.

A Knowledge Life Cycle Model

So decision execution cycles performed by agents in executing tasks and task patterns in business processes are in large part sequentially ordered knowledge production and knowledge integration processes. Figure three provides an overview of a Knowledge Life Cycle (KLC) model begun in collaboration with Mark McElroy, Edward Swanstrom, Douglas Weidner, and Steve Cavaleri [13], during meetings sponsored by the Knowledge Management Consortium International (KMCI), and further developed more recently by Mark McElroy and myself [14]. Knowledge Production and Knowledge Integration, abstracted from the planning, monitoring, and evaluating phases of decision cycles, are core knowledge processes in the model.

Knowledge production is initiated in response to problems produced by decision cycles in business processes. It produces Validated Knowledge Claims (VKCs), Unvalidated Knowledge Claims (UKCs), and Invalidated Knowledge Claims (IKCs), and information about the status of these. All of the above are codified, explicit, world 3 objects. Organizational Knowledge (OK) is composed of all of the foregoing results of knowledge production. It is part of what is integrated into the enterprise by the knowledge Integration process.

The Knowledge Production process, in combination with previous agent predispositions, also produces *beliefs related to the world 3 knowledge claims*. These are world 2 objects, predisposing various organizational agents to action. In some instances they are predispositions that correspond to organizational knowledge, in other instances they are predispositions that reflect awareness of validated knowledge claims but contradict them, or supplement them, or bear some other conceptual relationship to them. At the individual level these beliefs are in part tacit, since all of them will have not been expressed by the individuals holding them. Where these beliefs have been validated by the individuals or other intelligent agents holding them, they constitute world 2 knowledge held by those agents. But they are not organizational knowledge. Rather they are outputs of the organizational NKMS to the individual agents.

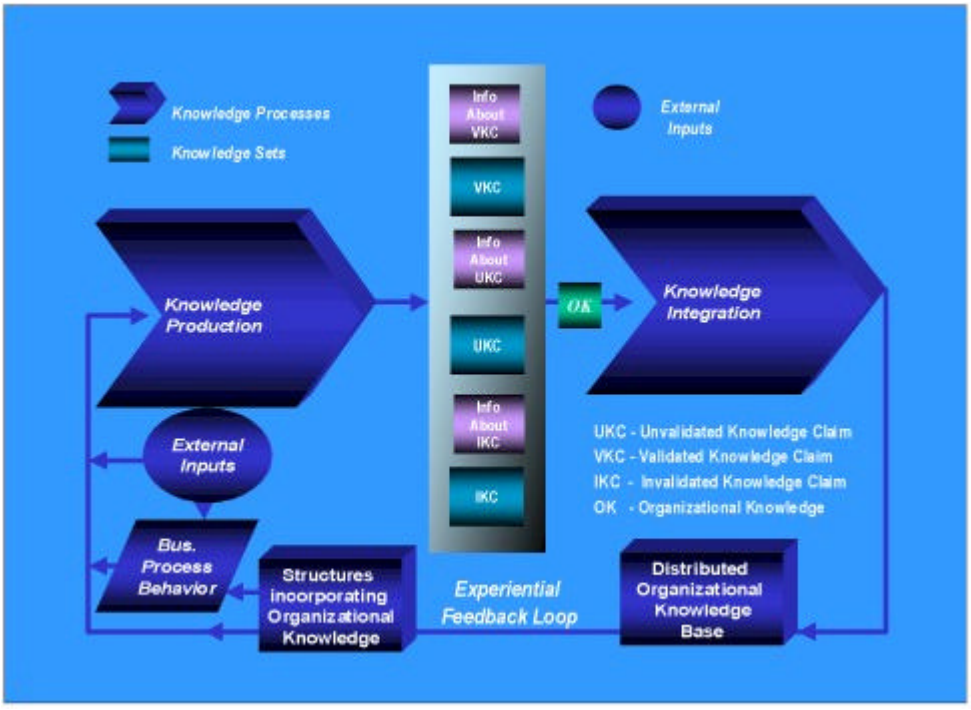


Figure Three -- The Knowledge Life Cycle Model (Overview)

The knowledge integration process takes organizational knowledge and by integrating it within the organization produces the Distributed Organizational Knowledge Base (DOKB). Integrating means communicating organizational

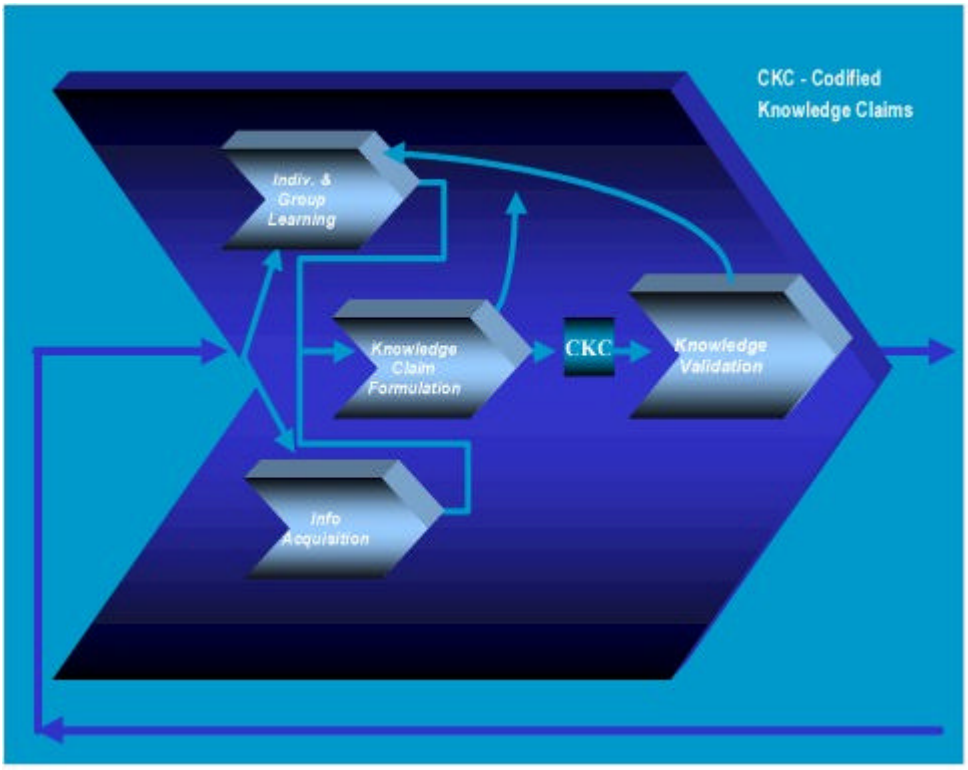
knowledge content to the organization's agents with the purpose of making them fully aware of existing organizational knowledge. This also requires making the knowledge available in knowledge stores that agents can use to search for and retrieve knowledge. The result of knowledge integration is that the content of codified organizational knowledge is available in both accessible and distributed knowledge stores and, in addition, is reflected in the predispositions of agents all across the enterprise. The DOKB is the combination of distributed third world and second world knowledge content.

The DOKB, in its turn, has a major impact on structures incorporating organizational knowledge such as normative business processes, plans, organizational culture, organizational strategy, policies, procedures, and information systems. Coupled with external sources these structures then feed back to impact behavioral business processes through the acting phase of decision cycles, which, in turn, generates new problems to be solved in the planning, monitoring, and evaluating phases -- that is, in the next round of knowledge processing. That is why it's called the Knowledge Life Cycle (KLC) model).

Drilling down into knowledge production (figure four), the KLC view is that information acquisition, and individual and group learning, in the service of problem-solving, impact on knowledge claim formulation, which, in turn, produces Codified Knowledge Claims (CKCs). These, in their turn, are tested in the knowledge validation task cluster, a critical examination of knowledge claims including, but not limited to, empirical testing, which then produces organizational knowledge.

The key task cluster that distinguishes knowledge production from information production is knowledge validation. It is the sub-process of criticism of competing knowledge claims, and of comparative testing and assessment of them, that transforms knowledge claims from mere information into tested information, some of which passes organizational tests and therefore becomes, from the organizational point of view, knowledge. Individual and group learning may involve knowledge production from the perspective of the individual or group, but from the perspective of the enterprise, what the individuals and groups learn is information, not knowledge. Similarly, information acquired may be knowledge from the perspective of the external parties it is acquired from, but not knowledge to the enterprise acquiring it, until it has been validated as such.

Figure Four also illustrates that knowledge validation has a feedback effect on individual and group learning. This occurs because individuals and groups participating in knowledge claim validation are affected by their participation in this process. They both produce world 3 organizational knowledge In the form of codified and validated knowledge claims and experience change in their own justified beliefs (generate world 2 knowledge) as an outcome of that participation.



Drilling down into knowledge integration (figure five), organizational knowledge is integrated across the enterprise by the broadcasting, searching/retrieving, teaching, and sharing task clusters. These generally work in parallel rather than sequentially. And not all are necessary to a specific instance of the KLC. All may be based in personal non-electronic or electronic interactions. Here is a glossary of the major terms used in the KLC Model.

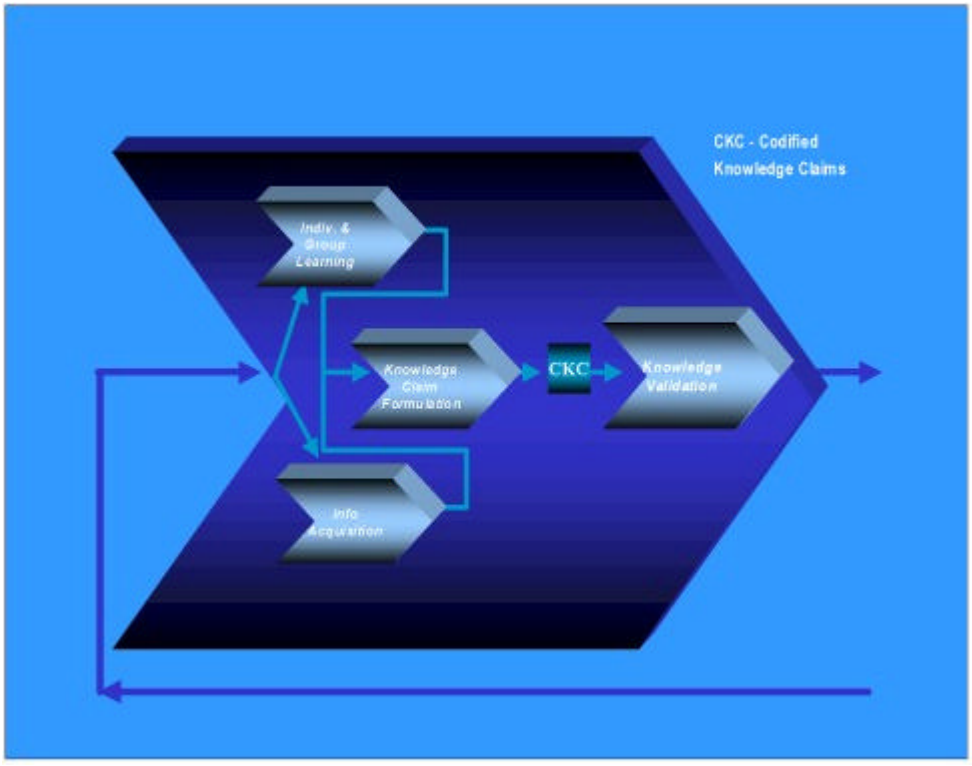


Figure Four -- The Components of Knowledge Production

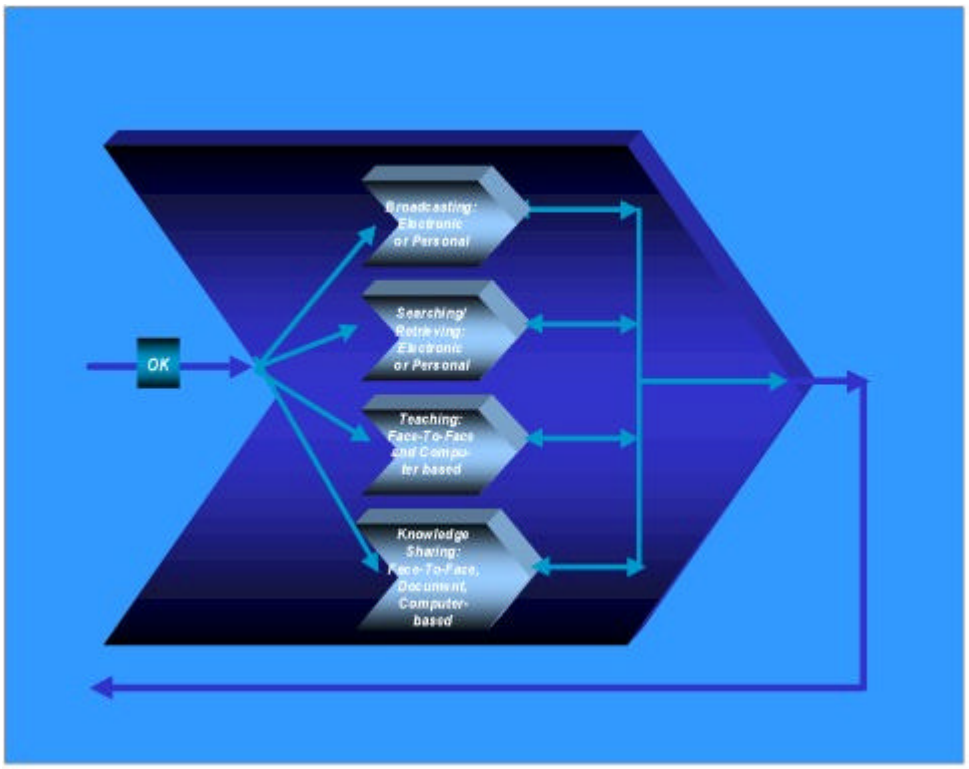


Figure Five -- The Components of Knowledge Integration

Sidebar One: KLC Glossary

Codified Knowledge Claims - Information that has been codified, but which has not yet been subjected to organizational validation.

Distributed Organizational Knowledge Base - an abstract construct representing the outcome of knowledge integration. The DOKB is found everywhere in the enterprise, not merely in electronic repositories. It is distributed over all of the agents and all of the repositories in the enterprise.

Experiential Feedback Loops - Processes by which information concerning the outcomes of organizational learning activities are fed back into the Knowledge Production phase of an organization's knowledge life cycle as a useful reference for future action.

Individual and Group Learning (I & G) - A task cluster involving human interaction, information acquisition, individual and group learning, knowledge claim formulation, and validation by which new individual and/or group knowledge is created. This task cluster is recursive in the sense that I & G is itself a KLC at the level of system interaction just below the global level, while I & G at this second level is itself a KLC at the level below, and so on until individual learning is reached.

Information About Invalidated Knowledge Claims - Information that attests to the existence of invalidated knowledge claims and the circumstances under which such knowledge was invalidated.

Information About Unvalidated Knowledge Claims - Information that attest to the existence of unvalidated knowledge claims, and the circumstances under which such knowledge was tested and neither validated nor invalidated.

Information About Validated Knowledge Claims - Information that attests to the existence of validated knowledge claims and the circumstances under which such knowledge was validated.

Information Acquisition - A process by which an organization either deliberately or serendipitously acquires knowledge

claims or information produced by others external to the organization.

Invalidated Knowledge - A collection of codified invalidated knowledge claims.

Invalidated Knowledge Claims - Codified knowledge claims that have not satisfied an organization's validation criteria. Falsehoods.

Knowledge Claim - A codified expression of potential knowledge which may be held as validated knowledge at an individual and/or group level, but which has not yet been subjected to a validation process at an organizational level. Information. Knowledge claims are components of hierarchical networks of rules, that if validated would become the basis for organizational or agent behavior.

Knowledge Claim Formulation - A process involving human interaction by which new organizational knowledge claims are formulated. The experience of participating in knowledge claim formulation feeds back to individual and group learning and produces world 2 individual and group level knowledge.

Knowledge Integration - The process by which an organization introduces new validated knowledge claims to its operating environment and retires old ones. Knowledge Integration includes all knowledge transmission, teaching, knowledge sharing, and other social activity that communicates either an understanding of previously produced organizational knowledge to knowledge workers, or the knowledge that certain sets of knowledge claims have been tested, and that they and information about their validity strength is available in the organizational knowledge base, or some degree of understanding between these alternatives. Knowledge integration processes, therefore, may also include the transmission and integration of information.

Knowledge Production - A process by which new organizational knowledge is created. Synonymous with "organizational learning."

Knowledge (Claim) Validation Process - A process by which knowledge claims are subjected to competitive testing against organizational criteria to determine their value and veracity.

Organizational Knowledge - A complex network of codified knowledge and knowledge sets held by an organization, consisting of validated declarative and procedural rules (validated knowledge claims).

Organizational Learning - A process involving human interaction, knowledge claim formulation, and validation by which new organizational knowledge is created.

(Business) Structures Incorporating Organizational Knowledge - Outcomes of organizational system interaction. The organization behaves through these structures including business processes, strategic plans, authority structures, information systems, policies and procedures, etc. Knowledge structures exist within these business structures and are the particular configurations of knowledge found in them.

Unvalidated Knowledge Claims - Codified knowledge claims that have not satisfied an organization's validation criteria, but which were not invalidated either. Knowledge claims requiring further study.

Validated Knowledge Claims - Codified knowledge claims that have satisfied an organization's validation criteria. Truth from the viewpoint of the organization.

Knowledge production and knowledge integration, their sub-processes, task clusters, etc., like other value networks, are partly composed of decision cycles through which agents execute their roles in these value networks. This means that planning, acting, monitoring and evaluating also apply to knowledge processes and to activity in the KLC. That is, higher level KLC processes are executed by agents performing KLC decision cycles, and engaging in planning, monitoring, and evaluating. The knowledge producing and knowledge integrating activities initiated by KLC decision cycles are KM-level knowledge producing and knowledge integrating task clusters, because they address problems in knowledge processing about how to plan, how to monitor, or how to evaluate. These problems are solved by producing and integrating KM - level knowledge.

Tacit Knowledge, Explicit Knowledge, and the KLC

A widely recognized distinction in knowledge management circles is Polanyi's distinction [15][16] between tacit, personal knowledge and explicit, codified knowledge. The distinction's importance is emphasized in Nonaka and Takeuchi's [17] account of the "Knowledge Creating Company." They assume that knowledge is created through the interaction between tacit and explicit knowledge, and they postulate four different modes of knowledge conversion:

- from tacit to tacit (called socialization);
- from tacit to explicit (externalization);
- from explicit to explicit (combination); and
- from explicit to tacit (internalization).

Before discussing these modes of conversion, notice that the tacit vs. explicit distinction corresponds closely to Popper's subjective vs. objective knowledge distinction. That is, Popper's objective knowledge (world 3) is obviously all explicit and codified, On the other hand, his world 2 "beliefs" are obviously personal and "tacit" in the sense that (by definition) they are objects that are unobservable abstractions or "hidden variables." They are hypothetical constructs whose characteristics must be inferred using measurement instruments and models.

Note, also, that all explicit statements are not about world 3 objects and all personal, tacit knowledge is not about world 2. Thus, if I say that I know that the "many-worlds" interpretation of quantum theory is true, this explicit statement is about my *belief* that the many-worlds interpretation Is true. It is an explicit statement about a world 2 object. It converts my tacit knowledge (belief) into an explicit knowledge claim about my belief. It is not a direct statement about the (world 3) many-worlds model. It also doesn't convert my tacit knowledge to explicit knowledge in the sense that I have fully and faithfully transformed my personal beliefs into an explicit, codified form. That cannot be done because my belief is a psychological phenomenon, not a linguistic formulation, and the epistemic gap between internal predispositions and external linguistic formulations is irreducible.

On the other hand, I can also hold subjective knowledge (beliefs) about either subjective states or about world 1 or world 3 objects. My procedural knowledge about how to make lamb stew is about world 1, for example. So subjective knowledge is in no way restricted to knowledge about world 2 objects. Now let us consider the four modes of conversion.

- *Tacit to tacit* conversions are not instances of knowledge creation from the organizational point of view. They are knowledge transfers of unexpressed, unarticulated procedural knowledge (world 2 mental process models) from one agent to another through sharing of experience. The knowledge is not organizational because it is not transferable throughout the organization, and therefore cannot be generally validated.

  Tacit to explicit conversions also do not create organizational knowledge. If the conversion only involves measurement of tacit knowledge, no "creation" is involved, but only inference of existing subjective knowledge from a measurement. The inferred personal knowledge can then be considered a knowledge claim in the KLC. Before it becomes organizational knowledge it needs to be validated.

If the "conversion" involves collaborative organizational development of metaphors, analogies, and models, then this does involve "creation" of knowledge claims that were not implicit in the original tacit knowledge; but this creation is only of a knowledge claim. It still must be validated before it becomes organizational knowledge.

Tacit to explicit "conversions" are a very important aspect of knowledge production in organizations. They are one of the primary sources of knowledge claim formulation. The importance of the issue of tacit knowledge in KM relates primarily to this conversion, and to the perceived reluctance of employees to share their knowledge and participate in such conversions, and also to the perceived inability of the enterprise to "manage" this conversion process.

- *Explicit to explicit conversion* is the combination mode of knowledge creation in which already explicit pieces of knowledge are combined to produce new explicit knowledge. It is doubtful however, that this form of knowledge creation exists in just this form. Explicit pieces of knowledge are often combined by individuals to create new knowledge claims. But this combination involves the intervention of individuals who must perform the combination by first understanding (converting into tacit knowledge) one piece of knowledge and then another and visualizing what a combination of the two would produce. The sequence is not from explicit to explicit. Instead, it is from explicit to tacit and then from tacit to explicit.

  What if the combination is performed by computer? In that case, the combination is purely deductive in character. The explicit to explicit conversion is only possible because (a) it is carried out through application of deductive principles alone or (b) it is carried out through such an application where tacit knowledge was previously built into the programming process through the creative process of formulating rules for combining knowledge through conjecture, inductive inference, abduction or other methods employing human intuition.

- Explicit to tacit conversions are called internalization by Nonaka and Takeuchi. They refer to the process of individuals' learning explicit knowledge and "internalizing" it in their belief systems. It is through internalization that world 3 objects have an impact on organizational decision making. Knowledge integration is the process that produces internalization and sets the stage for knowledge use in business processes. But internalization does not itself create organizational knowledge. Instead it is the process that transfers organizational knowledge to the individual.

Nonaka and Takeuchi's four modes of conversion are all encompassed by the KLC model and are perhaps better interpreted in its terms and in terms of

Popper's distinction between World 2 beliefs and World 3 "objective knowledge." The movement from individual and group learning to knowledge claim formulation encompasses externalization. World 3 objects (concepts, models, analogies) are created from World 2 beliefs. But externalization doesn't extend all the way to validation. Consequently, objective knowledge is not produced from externalization.

Externalization, and therefore knowledge claim formulation, focuses on the major issue in KM related to tacit knowledge: that of sharing it with the enterprise. Enterprises worry about world 2 tacit knowledge, produced in part through work in the enterprise (through internalization), being lost to it, because such individual knowledge has never been converted to world 3 codified knowledge claims. They want to implement processes that will incent knowledge workers to routinely produce such conversions. From the point of view of the KLC this is a matter of managing the knowledge claim formulation task cluster so that it supplies such incentives.

Explicit to explicit conversion, if we view it according to the revised sequence of explicit to tacit to explicit, is located within the knowledge claim formulation and the individual and group learning task clusters. Combination doesn't involve any validation. It does involve movements back and forth between (World 2) individual and group learning and (World 3) knowledge claim formulation.

Tacit to tacit conversion is located solely within the (World 2) individual learning area. No knowledge claims are made or validated. No external information is required. No organizational knowledge is produced. No organizational knowledge is integrated. Nevertheless, increasing the amount and effectiveness of such conversions may improve performance in an enterprise. Therefore, it may be desirable to manage the individual and group learning task cluster in the KLC to support tacit to tacit conversions.

Finally, internalization is one of the anticipated impacts of knowledge integration on the DOKB. Internalization does not mean replicating World 3 knowledge as World 2 individual beliefs, instead it means individual learning of the World 3 knowledge, an active process involving interpretation of World 3 and adaptation of it to the agent's "cognitive map."

In sum, the KLC model, incorporates all of the knowledge conversion modes of Nonaka and Takeuchi, while emphasizing Popper's distinction between World 2 and World 3 objects. It also provides a much broader framework than the four modes of knowledge conversion for tracking the interaction of World 2 and World 3 knowledge, a framework that can encompass all of their results and relate them to a much broader range of processes and concepts.

The KLC, Knowledge Processes and Knowledge Management

What is the relationship between managing the KLC or its knowledge processes and Knowledge Management itself? To answer this question, we need to decide whether managing knowledge refers to managing knowledge processes, managing the outcomes of these processes, or managing both.

It has recently been stated [18, P. 87] that *"It's not knowledge management, stupid, it's knowledge PROCESS management."* But this is surely too simple. While KM is a process that manages the knowledge processes of the KLC, since those processes produce knowledge outcomes including the knowledge base, it is also true that KM indirectly manages knowledge outcomes. Or, to put the situation another way, knowledge management is most directly knowledge process management, and only indirectly knowledge base management. The knowledge processes in question are given in the KLC. So knowledge management is both process and outcome management.

The Nature of Knowledge Management

There are many available definitions of knowledge management [19], but few specifications that bring the definitions a step closer to analysis and measurement. I define KM as human activity that is part of the Knowledge Management Process (KMP) of an agent or collective. This reduces KM to the definition of KMP. And the KMP, in turn, is an ongoing, persistent, purposeful network of interactions among human-based agents through which the participating agents aim at managing (handling, directing, governing, controlling, coordinating, planning, organizing) other agents, components, and activities participating in the basic knowledge processes (knowledge production and knowledge integration) into a planned, directed, unified whole, producing, maintaining, enhancing, acquiring, and transmitting the enterprise's knowledge base. This definition is another way of stating the idea that KM is management of the KLC and its outcomes. But the idea of KM still needs further specification.

Let's note first that the KMP is a business process. I break down the KMP [20] into three task clusters: interpersonal behavior, knowledge processing behavior, and decision making behavior. Interpersonal behavior may be further categorized into the following task clusters (there are two levels of task clusters in this hierarchy):

- Figurehead or ceremonial KM activity (focuses on performing formal KM acts such as signing contracts, attending public functions on behalf of the enterprise's KM process, and representing the KM process to dignitaries visiting the enterprise);
- Leadership (includes hiring, training, motivating, monitoring, and evaluating staff. It also includes persuading non-KM agents within the enterprise of the validity of KM process activities); and
- Building external relationships -- another political activity designed to build status and to cultivate external sources of support for KM.

KM Knowledge processing behavior includes:

- KM knowledge production (different in that it is here that the rules for knowledge production that are used at the level of knowledge processes are specified);
- KM Knowledge Integration (affected by KM knowledge production, and also affects knowledge production activities by stimulating new ones).

Decision making behavior includes:

- Changing knowledge process rules (involves making the decision to change such rules and causing both the new rules and the mandate to use them to be implemented);
- Crisis Handling (e.g., meeting CEO requests for new competitive intelligence in an area of high strategic interest for an enterprise, and directing rapid development of a KM support infrastructure in response to requests from high level executives);
- Allocating Resources (KM support infrastructures, training, professional conferences, salaries for KM staff, funds for new KM programs, etc.);
- Negotiating agreements (with representatives of business processes over levels of effort for KM, the shape of KM programs, the ROI expected of KM activities, etc.).

In brief, the nature of knowledge management is that it is a complex process composed of the above task clusters broken down into task patterns, executed by agents through decision cycles composed of planning, acting, monitoring, and evaluating activities. Further specification of KM, therefore, involves breaking down these task clusters.

Further Specification of Knowledge Processing and Knowledge Management Descriptors and Metrics

The KLC begins with problems generated in evaluating business results. The specifics of an instance of the KLC vary with the domain of the problem and with the type of knowledge that will solve it. Nevertheless, there are generic abstract KLC and KM-related concepts, in addition to the ones already presented, which can be applied generally to KLCs and KM activities. In this section I develop the KM conceptual framework further by breaking down the high-level task clusters and laying out these generic concepts, and also presenting lists of descriptors and possible metrical concepts (metrics) for various aspects of the conceptual framework. This further specification of the framework provides a foundation for further detailed analyses and measurement.

Information Acquisition

Information Acquisition is a network of task patterns and tasks by which an organization either deliberately or serendipitously acquires knowledge claims or information produced by others external to the organization. That is, it refers *only* to the process of information flow across the boundary of the learning organization, team, group, or individual. It also refers to information flow relevant to the process of producing knowledge for solving specific problems generated by business processes.

Information acquisition occurs through interpersonal methods, electronic methods and through combinations of the two. From the viewpoint of the organization, information:

- may be gathered through explicit search activities,
- may be received as a result of solicited communications (subscriptions, request for alerts, etc.)
- may be received as a result of unsolicited communications

Information may be acquired from any of the following external sources:

- Interpersonal peer communications
- Interpersonal expert communications
- e-mail messages
- web documents
- web-accessed databases
- Media (CDs, Tapes, etc.)
- Printed Documents

However information is acquired and from whatever external source, the efficiency and effectiveness of the KLC is related to the cycle time of acquiring information, to the relevance of the information that is acquired, and to the scope of that information. That is:

- the cycle time must be fast enough to provide information to other task clusters in the KLC that require the information;
- the information must be relevant to the problems KLC agents are trying to solve in their decision cycles; and
- The information available externally must be broad enough in scope to meet the diversity of problems presented to the decision makers.

The process and outcome descriptors below are intended to address the scope, relevance, and cycle time issues

Descriptors of information acquisition are classified into process descriptors and information descriptors.

- Process descriptors
    - Information acquisition cycle time
    - Information acquisition velocity
    - Information acquisition acceleration
    - Intensity of collaborative activity in information acquisition
    - Methods of interpersonal searching and intelligence gathering
        - Attending conferences
        - Telephone conversations
        - Meetings
        - Reading books and documents
    - Methods of electronic searching and intelligence gathering
        - KDD/data mining
        - Content analysis
        - Cognitive mapping of content
        - Text Mining
        - Web-enabled searching/retrieving
        - Web-enabled application-specific searching/retrieving
        - Web-enabled file sharing
        - Portal-enabled searching/accessing/retrieving
        - Agent-based scanning
    - Information acquisition infrastructure
        - Internet facilities -- both physical and software
        - Fax
        - Document and book subscriptions
        - Intelligence service subscriptions
        - Telephone facilities
        - Training programs
        - Electronic broadcast reception facilities
        - Conference programs
- Information descriptors
    - Media
        - hard copy
        - microfiche
        - tape
        - removable electronic media
        - fixed disk

- optical
- silicon

- Type of Information

  - Structured Data
  - conceptual models
  - data models
  - object models
  - planning models
  - analytical models
  - Measurement models
  - Predictive models
  - Impact models
  - Assessment models
  - electronic repositories
  - application software
  - validation criteria
  - methods
  - methodologies
  - formal languages
  - semi-formal languages
  - HTML documents
  - XML tags and documents
  - SGML tags and documents
  - meta-information
  - planning information
  - descriptive information
    - Factual information
    - Measurements of abstractions
  - information about impact and cause and effect
  - predictive information
  - assessment information
  - Distributed/centralized architecture of acquired information base
  - Degree of integration/coherence of acquired information base within or between information types or domains
  - Scope of the acquired information base within and across information types or domains
  - Level of measurement of attributes in acquired information base within and across domains
  - Quantification of attributes in the acquired information base
  - Types of models used in the acquired information base (conceptual analytic, data models, measurement models, impact models, predictive models, assessment models, object models, structural models);

- Types of formal languages used in the acquired information base (set theory, mathematics, fuzzy logic, etc.);
- Types of semi-formal languages used in the acquired information base (object modeling language, information modeling language, etc.);
- Types of methods (features, benefits, specifications);
- Types of methodologies (features, benefits, specifications);
- Software applications (features, benefits, specifications, performance, interface);
- Priority of information components in terms of relevance.

- Descriptors of change in processes
  - Change in information acquisition cycle time
  - Change in information acquisition velocity
  - Change in information acquisition acceleration
  - Change in intensity of collaborative activity in information acquisition
  - Change in priority of information components in terms of relevance.

Further descriptors can be arrived at by cross-classifying many of the above.

Individual and Group Learning

This task cluster is recursive in the sense that I & G is itself a KLC at the level of system interaction just below the global level, while I & G at the second level is itself a KLC at the level below, and so on until individual learning is reached. KLCs, therefore, occur at the group and individual levels of analysis as well as at the organizational level of analysis. They produce knowledge claims that have been validated from the perspective of the individual or the group as the case may be, but from the perspective of the organization they are unvalidated information.

Process descriptors for individual and group learning are the same as those given for all of the other task clusters of the KLC combined. Outcome descriptors are also those of all other task clusters combined. Specific lists are provided under the other KLC categories.

Knowledge Claim Formulation

Knowledge claim formulation is a task cluster involving human interaction by which new organizational knowledge claims are formulated and codified.

From the viewpoint of the organization, knowledge claims may be formulated through:

- Deriving them from previously existing mental models
- Gathering data and information and describing the results of that process by asserting a factual claim
- Performing a measurement
- Thinking up a conjecture
- Using Intuition
- Developing new models of various kinds
  - Mathematical
  - Statistical
  - Computer
  - Verbal
  - Visual
- Interacting with others in a collaborative environment
- Analyzing textual content
- Text Mining
- Data Mining
- Using knowledge claim-eliciting collaborative techniques such as Delphi, Knowledge Café, Nominal group and Analytical Hierarchy Process Techniques
- Using knowledge claim eliciting software applications other than textual content analysis text and data mining
- Reformulating an invalidated model
- Meditation and
- Many other activities.

That is, knowledge claim formulation can result from diverse activities. Sometimes these activities are relatively mundane. Often they are creative activities. Always they involve an interaction between world 2 knowledge of those formulating knowledge claims and the world 3 knowledge claims they are producing or have produced in the past. In other words, knowledge claim formulation activities involve an interaction between the subjective and the objective, between individual and group learning and knowledge claim formulation.

In the end knowledge claim formulation at the organizational level is an emergent process. This does not mean that knowledge claims are not formulated by human agents. They are. But they are formulated by human agents interacting in teams, groups, communities of practice and projects. Viewed at any point in time the act of formulating a knowledge claim is another decision made by an individual. But viewed from a group perspective the patterning of knowledge claim formulation is a *cas* phenomenon, and the pattern of knowledge claims produced is an emergent global property of the organizational NKMS.

Which activities are most effective for knowledge claim formulation depends on the specific problem situation being addressed by a specific KLC motivated by that problem. There is no general answer to the question of which of the above

are most effective in leading to knowledge claims that are likely to be validated. But as more formal approaches to managing the KLC are implemented it may be possible to develop knowledge on the relative effectiveness of different methods of knowledge claim formulation. Relevant outcomes for success or effectiveness include:

- cycle time,
- production of knowledge claims that tend to survive validation,
- production of knowledge claims that are relevant to the problem motivating the KLC, and
- production of knowledge claims of sufficient scope to handle problems motivating the KLC.

Knowledge claims may be formulated from interacting with any of the following internal organizational sources:

- Interpersonal peer communications
- Interpersonal expert communications
- Meetings
- e-mail messages
- web documents
- web-accessed databases
- Non-web accessed databases
- Web-enabled collaborative applications
- Media (CDs, Tapes, etc.)
- Printed Documents

Descriptors of knowledge claim formulation are classified into process descriptors and knowledge claim descriptors. Descriptors were selected because they either relate directly to cycle time, survivability and relevance or because they may be causally relevant to producing success in these terms.

- Process descriptors
  - KCF cycle time
  - KCF velocity
  - KCF acceleration
  - Intensity of collaborative activity in KCF
  - Intensity of cooperative behavior in formulating KCs
  - Intensity of conflict behavior in formulating KCs
  - Extent of withdrawal from interaction with other agents as an outcome of collaborative activity
  - Extent of inequality of access to previous knowledge claims
  - Extent of inequality of access to methods and sources supporting KCF

- Volume of documents transmitted among all agents making knowledge claims
- Ratio of messages received by an Agent to messages sent by that agent related to knowledge claim formulation

- Use and Frequency of use of methods of interpersonal searching, intelligence gathering, and knowledge claim formulation

  - Delphi Technique
  - Knowledge Café,
  - Nominal Group Technique
  - Focus Groups
  - Joint Application Design
  - Personal Networking
  - Project Meetings
  - Company Meetings
  - Self-organizing teams
  - Communities of Practice
  - Credit assignment processes

- Use and frequency of use of methods of electronic searching, intelligence gathering, and knowledge claim formulation

  - KDD/data mining
  - Content analysis
  - Cognitive mapping/semantic networking of content
  - Text Mining
  - Database Querying
  - Modeling
    - Mathematical
    - Statistical
    - Computer
    - Verbal
    - Visual
    - Data
    - Object
  - Web-enabled searching/retrieving
  - Web-enabled application-specific searching/retrieving
  - Web-enabled file sharing
  - Web-enabled collaboration
    - Project management
    - Problem-solving teams
  - Portal-enabled searching/accessing/retrieving
  - Agent-based scanning

- Web-enabled knowledge claim eliciting software applications other than textual content analysis, text and data mining
  - Analytic Hierarchy applications
  - Balanced Scorecard applications
  - Solution Specification applications
  - "Thinking outside the box" applications
  - credit assignment applications
- Business Intelligence and OLAP reporting and analysis
- Work Flow analysis and modeling

- KCF infrastructure

  - Intranet facilities -- both physical and software
  - Databases
  - Content and textbases
  - Document Management Systems
  - Collaborative Systems
  - DSS/Data Warehousing/BI/OLAP
  - ERP Systems
  - Computer Hardware
  - Network Infrastructure
  - Fax
  - Documents and books
  - Telephone facilities
  - Training programs
  - Electronic broadcast reception facilities
  - Conference programs

- KCF Outcome descriptors

  - Media

    - hard copy
    - microfiche
    - tape
    - removable electronic media
    - fixed disk
    - optical
    - silicon

  - Type of Knowledge Claim

    - Structured database knowledge claims
    - Descriptive factual statement
    - conceptual models
    - data models

- object models
- computer models
- planning models
- analytical models
- Measurement models
- Predictive models
- Impact models
- Assessment models
- application software
- validation criteria
- methods
- methodologies
- formal language utility
- semi-formal language utility
- meta-knowledge claims
- planning knowledge claims
- descriptive knowledge claims
  - Factual knowledge claims
  - Measurements of abstractions
- Knowledge claims about impact and cause and effect
- predictive knowledge claims
- assessment knowledge claims
- Distributed/centralized architecture of knowledge claim base
- Degree of integration/coherence of knowledge claim base within or between knowledge claim types or domains
- Scope of the knowledge claim base within and across information types or domains
- Degree of relevance of knowledge claims produced to problems motivating the KLC
- Level of measurement of attributes in knowledge claim base within and across domains
- Quantification of attributes in the knowledge claim base
- Types of models used in the knowledge claim base (conceptual analytic, data models, measurement models, impact models, predictive models, assessment models, object models, structural models);
- Types of formal languages used in the knowledge claim base (set theory, mathematics, fuzzy logic, XML, HTML, SGML, etc.);
- Types of semi-formal languages used in the knowledge claim base (Unified Modeling Language (UML), knowledge claim modeling language, KQML, etc.);
- Types of methods (features, benefits, specifications);
- Types of methodologies (features, benefits, specifications);
- Software applications (features, benefits, specifications, performance, interface);

- Other Outcome descriptors

    - Priority of knowledge claim components;
    - Extent of inequality among agents in knowledge claim formulation
    - Types of rewards provided for participation in knowledge claim formulation
    - Extent of satisfaction with rewards for knowledge claim formulation
    - Performance metric on establishing organizational knowledge claim base

- Descriptors of growth and change in knowledge claim outcomes

    - Growth/decline of various types of knowledge claims,
    - Changes in knowledge claim base architecture centralization,
    - Growth/decline in integration/coherence of knowledge claim base,
    - Increase/decrease in scope of the knowledge claim base,
    - Changes in levels of measurement of attributes in knowledge claim base,
    - Increase/decrease in quantification of attributes in knowledge claim base,
    - Increase/decrease in logical consistency of attributes in knowledge claim base,
    - Change in types of models used in knowledge claim base,
    - Development in formal languages used,
    - Development in semi-formal languages used,
    - Changes in types of methods (reduction in costs, increase/decrease in capabilities);
    - Change in types of methodologies (reduction in costs, increase in scope, increase/decrease in capabilities);
    - Increase/decrease in IT-assisted support for decision making provided by software applications;
    - Change in degree of inequality of knowledge claim formulation
    - Change in KCF cycle time
    - Change in KCF velocity
    - Change in KCF acceleration
    - Change in intensity of collaborative activity in KCF
    - Change in intensity of cooperative behavior in formulating KCs
    - Change in intensity of conflict behavior in formulating KCs
    - Change in extent of withdrawal from interaction with other agents as an outcome of collaborative activity
    - Change in extent of inequality of access to previous knowledge claims

- Change in extent of inequality of access to methods and sources supporting KCF
- Change in degree of relevance of knowledge claims produced to problems motivating the KLC
- Change in volume of documents transmitted among all agents making knowledge claims
- Change in ratio of messages received by an Agent to messages sent by that agent related to KCF
- Change in types of rewards provided for participation in knowledge claim formulation
- Change in extent of satisfaction with rewards for knowledge claim formulation
- Change in performance metric on formulation of new knowledge claims.

Further descriptors can be arrived at by cross-classifying many of the above.

Knowledge Claim Validation

Knowledge claim validation is a task cluster in which knowledge claims are subjected to competitive testing against organizational criteria to determine the value and veracity of knowledge claims. It is the critical task cluster in distinguishing knowledge processing from information processing.

The validation and testing process in real organizations is not a cut-and-dried process in which fixed knowledge claim rivals take prescribed tests and are evaluated against static criteria. Instead knowledge claim validation in organizations is a dynamic vortex in which many competing knowledge claims are considered simultaneously against criteria that are often being re-weighted, reformulated in various ways, and even introduced to or expelled from the decision cycle of validation.

Validated, invalidated, and unvalidated knowledge claims emerge from this vortex of conflict in a manner that is not predictable from any simple model. An organization may develop and try to apply fixed formulae to be used by agents for knowledge claim comparison and validation, so that we can sensibly describe a normative knowledge claim validation cluster. But the actual knowledge validation process will vary from this normative pattern and will present to the analyst and modeler a *cas* pattern of emergence.

Key success criteria in knowledge claim validation are:

- cycle time,
- production of validated knowledge claims that are relevant to the problem motivating the KLC, and

- production of validated knowledge claims of sufficient scope to handle problems motivating the KLC.

Knowledge claims may be validated from interacting with any of the following internal organizational sources:

- Interpersonal peer communications
- Interpersonal expert communications
- Meetings
- e-mail messages
- web documents
- web-accessed databases
- Non-web accessed databases
- Web-enabled collaborative applications
- Media (CDs, Tapes, etc.)
- Printed Documents

Descriptors of knowledge claim validation are classified into process descriptors and knowledge claim descriptors.

- Process descriptors

    - KCV cycle time
    - KCV velocity
    - KCV acceleration
    - Intensity of collaborative activity in KCV
    - Intensity of cooperative behavior in KCVs
    - Intensity of conflict behavior in KCVs
    - Extent of withdrawal from interaction with other agents as an outcome of collaborative KCV activity
    - Extent of inequality of access to previous knowledge claims
    - Extent of inequality of access to sources and methods supporting KCV
    - Volume of documents transmitted among all agents validating knowledge claims
    - Ratio of messages received by an Agent to messages sent by that agent related to KCV

    - Use and Frequency of use of methods of interpersonal knowledge claim validation

        - Delphi Technique
        - Knowledge Café,
        - Nominal Group Technique
        - Focus Groups
        - Personal Networking

- Project Meetings
- Company Meetings
- Self-organizing teams
- Communities of Practice
- Credit assignment processes

- Use and frequency of use of methods of electronic support for knowledge claim validation
  - Text Mining
  - Database Querying
  - Modeling
    - KCV Assessment Modeling
  - Web-enabled searching/retrieving of knowledge claims
  - Web-enabled collaboration
    - Problem-solving teams
  - Portal-enabled, server-based automated arbitration of agent mapped knowledge claims
  - Portal-enabled credit assignment for participating in knowledge claim validation
  - Business Intelligence and OLAP reporting and analysis

- KCV infrastructure

  - Intranet facilities -- both physical and software
  - Databases
  - Content and textbases
  - Document Management Systems
  - Collaborative Systems
  - DSS/Data Warehousing/BI/OLAP
  - ERP Systems
  - Computer Hardware
  - Network Infrastructure
  - Fax
  - Documents and books
  - Telephone facilities
  - Training programs
  - Electronic broadcast reception facilities
  - Conference programs

- KCV Outcome descriptors

  - Media

    - hard copy
    - microfiche
    - tape

- removable electronic media
- fixed disk
- optical
- silicon

- Type of Validated Knowledge Claim

  - Structured database knowledge claims
  - Descriptive factual statements
  - conceptual models
  - data models
  - object models
  - planning models
  - analytical models
  - Measurement models
  - Predictive models
  - Impact models
  - Computer models
  - Assessment models
  - application software
  - validation criteria
  - methods
  - methodologies
  - formal language utility
  - semi-formal language utility
  - meta-knowledge claims
  - planning knowledge claims
  - descriptive knowledge claims
    - Factual knowledge claims
    - Measurements of abstractions
  - Knowledge claims about impact and cause and effect
  - predictive knowledge claims
  - assessment knowledge claims
  - Distributed/centralized architecture of knowledge claim base
  - Degree of integration/coherence of validated knowledge claim base within or between knowledge claim types or domains
  - Scope of the knowledge claim base within and across information types or domains
  - Level of measurement of attributes in validated knowledge claim base within and across domains
  - Quantification of attributes in the validated knowledge claim base
  - Types of models used in the validated knowledge claim base (conceptual analytic, data models, measurement models, impact models, predictive models, assessment models, object models, structural models);

- Types of formal languages used in the validated knowledge claim base (set theory, mathematics, fuzzy logic, XML, HTML, SGML, etc.);
- Types of semi-formal languages used in the validated knowledge claim base (Unified Modeling Language (UML), knowledge claim modeling language, KQML, etc.);
- Types of methods (features, benefits, specifications);
- Types of methodologies (features, benefits, specifications);
- Software applications (features, benefits, specifications, performance, interface);

- Other Outcome descriptors

  - Type of validation information describing validated knowledge claims
    - Extent of logical consistency:
    - Extent of empirical fit;
    - Extent of simplicity;
    - Extent of projectibility;
    - Extent of commensurability;
    - Extent of continuity
    - Coherence of measurement modeling;
    - Extent of systematic fruitfulness;
    - Extent of heuristic quality;
    - Extent of completeness of the comparison set
    - Other attributes
    - Cognitive maps of validation information
    - History of knowledge claim validation events
  - Priority of validated knowledge claim components
  - Types of rewards provided for participation in knowledge claim validation
  - Extent of satisfaction with rewards for knowledge claim validation
  - Performance metric on establishing organizational validated knowledge claim base

- Descriptors of growth and change in validated knowledge claim outcomes

  - Growth/decline of various types of validated knowledge claims,
  - Changes in validated knowledge claim base architecture centralization,
  - Growth/decline in integration/coherence of validated knowledge claim base,
  - Increase/decrease in scope of the validated knowledge claim base,

- Changes in levels of measurement of attributes in validated knowledge claim base,
- Increase/decrease in quantification of attributes in validated knowledge claim base,
- Increase/decrease in logical consistency of attributes in validated knowledge claim base,
- Change in types of models used in validated knowledge claim base,
- Development in formal languages used,
- Development in semi-formal languages used,
- Changes in types of methods (reduction in costs, increase/decrease in capabilities);
- Change in types of methodologies (reduction in costs, increase in scope, increase/decrease in capabilities);
- Increase/decrease in IT-assisted support for decision making provided by software applications;
- Increase/decrease in type of validation of various components of the knowledge base
  - logical consistency:
  - empirical fit;
  - simplicity;
  - projectibility;
  - commensurability;
  - continuity
  - coherent measurement modeling;
  - systematic fruitfulness;
  - heuristic quality;
  - completeness of the comparison set, etc.
- Increase/decrease in extent of validation within each type;
- Increase/decrease in composite extent of validation of various components.
- Change in degree of inequality of KCV
- Change in KCV cycle time
- Change in KCV velocity
- Change in KCV acceleration
- Change in intensity of collaborative activity in KCV
- Change in intensity of cooperative behavior in KCV
- Change in intensity of conflict behavior in KCV
- Change in extent of withdrawal from interaction with other agents as an outcome of collaborative activity
- Change in extent of inequality of access to previous knowledge claims
- Extent of inequality of access to sources and methods supporting KCV
- Change in volume of documents transmitted among all agents validating knowledge claims

- Change in ratio of messages received by an Agent to messages sent by that agent related to KCV
- Change in types of rewards provided for participation in knowledge claim validation
- Change in extent of satisfaction with rewards for knowledge claim validation
- Change in performance metric on knowledge claim validation.

Further descriptors can be arrived at by cross-classifying many of the above.

Knowledge, Information, and Data Broadcasting

Broadcasting means one agent sending data, information, or knowledge to another agent on the initiative of the first agent. It is one way of transmitting or disseminating validated knowledge claims throughout an organization. Key success factors are cycle time and relevance of validated knowledge claims being broadcasted.

- Process descriptors
  - Broadcasting cycle time
  - Broadcasting velocity
  - Broadcasting acceleration
  - Intensity of collaborative activity in broadcasting
  - Intensity of cooperative behavior in broadcasting
  - Intensity of conflict behavior in broadcasting
  - Extent of withdrawal from interaction with other agents as an outcome of collaborative broadcasting activity
  - Extent of inequality of access to previous broadcasts
  - Volume of documents transmitted to agents in broadcasting
  - Ratio of messages received by an Agent to messages sent by that agent related to broadcasting
  - Use and Frequency of use of methods of interpersonal broadcasting
    - Delphi Technique
    - Knowledge Café,
    - Nominal Group Technique
    - Focus Groups
    - Personal Networking
    - Project Meetings
    - Company Meetings
    - Self-organizing teams
    - Communities of Practice

- Use and frequency of use of methods of electronic support for broadcasting
  - Portal-enabled, agent-based broadcasting of alerts
  - E-mail alerts and messages
  - Telephone alerts
  - Fax alerts

- Broadcasting infrastructure

  - Intranet facilities -- both physical and software
  - Collaborative Systems
  - Computer Hardware
  - Network Infrastructure
  - Fax
  - Telephone facilities
  - Electronic broadcast reception facilities

- Broadcasting outcome descriptors

  - Content of validated knowledge claims as outlined earlier
  - Extent of distribution of validated knowledge claims
  - Extent of acceptance and support for above claims
  - Extent of distribution of validated knowledge claims among targets of these claims
  - Extent of acceptance and support for above claims
  - Degree of knowledge worker satisfaction with broadcasting vehicles and process,
  - Degree of knowledge manager satisfaction with broadcasting vehicles and process,
  - Degree of satisfaction with broadcasting vehicles and process by knowledge authority structure,
  - Degree of satisfaction with broadcasting vehicles and process by organizational authority structure,
  - Degree of satisfaction with broadcasting vehicles and process by subsystem,
  - Degree of fulfillment of broadcasting objectives by knowledge assignment,
  - Degree of fulfillment of broadcasting objectives by knowledge assignment segment,
  - Degree of fulfillment of broadcasting objectives by knowledge authority structure segment,
  - Degree of fulfillment of broadcasting objectives by organizational authority segment,
  - Degree of fulfillment of broadcasting objectives by subsystem segment.
  - Performance metric on broadcasting the knowledge base

- Descriptors of growth and change in broadcasting outcomes

    - Change in degree of inequality of access to broadcasting
    - Change in broadcasting cycle time
    - Change in broadcasting velocity
    - Change in broadcasting acceleration
    - Change in intensity of collaborative activity in broadcasting
    - Change in intensity of cooperative behavior in broadcasting
    - Change in intensity of conflict behavior in broadcasting
    - Change in extent of withdrawal from interaction with other agents as an outcome of collaborative activity in broadcasting
    - Change in extent of inequality of access to previous validated knowledge claims
    - Change in volume of documents transmitted among all agents broadcasting knowledge claims
    - Change in ratio of messages received by an agent to messages sent by that agent related to broadcasting

Searching/Retrieving

Searching/retrieving is the sequence of tasks an agent performs to find and access validated knowledge claims in an organization. Sometimes searching and retrieving is interpersonal (going to a friend) or manual (going to a library). Sometimes it is electronic (as in searching for and retrieving documents or querying structured data to retrieve records that fulfill the query criterion). Success factors are cycle time and relevance of retrieved knowledge to queries.

Process and outcome descriptors follow.

- Process descriptors

    - Searching/retrieving cycle time
    - Searching/retrieving velocity
    - Searching/retrieving acceleration
    - Intensity of collaborative activity in searching/retrieving
    - Intensity of cooperative behavior in searching/retrieving
    - Intensity of conflict behavior in searching/retrieving
    - Extent of withdrawal from interaction with other agents as an outcome of collaborative searching/retrieving activity
    - Extent of inequality of access to previous searching/retrieving
    - Volume of documents transmitted to agents in searching/ retrieving
    - Ratio of messages received by an Agent to messages sent by that agent related to searching/retrieving

- Use and Frequency of use of methods of interpersonal searching/retrieving

  - Delphi Technique
  - Knowledge Café,
  - Nominal Group Technique
  - Focus Groups
  - Personal Networking
  - Project Meetings
  - Company Meetings
  - Self-organizing teams
  - Communities of Practice
  - Gathering and reading documents

- Use and frequency of use of methods of electronic support for searching/retrieving
  - Portal-enabled, agent-based document and document segment searching and retrieving
  - E-mail searching
  - Database querying and retrieving
  - Content analysis and retrieval
  - Cognitive mapping of content
  - Web-enabled searching/retrieving
  - Web-enabled application-specific searching/retrieving
  - Web-enabled file sharing and retrieving

- Searching/retrieving infrastructure

  - Intranet facilities -- both physical and software
  - Fax
  - Document subscriptions
  - Telephone facilities
  - Electronic broadcast reception facilities

- Searching/retrieving outcome descriptors

  - Content of validated knowledge claims as outlined earlier
  - Extent of distribution of validated knowledge claims
  - Extent of acceptance and support for above claims
  - Extent of distribution of validated knowledge claims among targets of these claims
  - Extent of acceptance and support for above claims
  - Degree of knowledge worker satisfaction with searching/retrieving vehicles and process,
  - Degree of knowledge manager satisfaction with searching/retrieving vehicles and process,

- Degree of satisfaction with searching/retrieving vehicles and process by knowledge authority structure,
- Degree of satisfaction with searching/retrieving vehicles and process by organizational authority structure,
- Degree of satisfaction with searching/retrieving vehicles and process by subsystem,
- Degree of fulfillment of searching/retrieving objectives by knowledge assignment,
- Degree of fulfillment of searching/retrieving objectives by knowledge assignment segment,
- Degree of fulfillment of searching/retrieving objectives by knowledge authority structure segment,
- Degree of fulfillment of searching/retrieving objectives by organizational authority segment,
- Degree of fulfillment of searching/retrieving objectives by subsystem segment.
- Performance metric on searching/retrieving the knowledge base.

- Descriptors of growth and change in searching/retrieving

  - Change in degree of inequality of searching/retrieving
  - Change in searching/retrieving cycle time
  - Change in searching/retrieving velocity
  - Change in searching/retrieving acceleration
  - Change in intensity of collaborative activity in searching/ retrieving
  - Change in intensity of cooperative behavior in searching/ retrieving
  - Change in intensity of conflict behavior in searching/retrieving
  - Change in extent of withdrawal from interaction with other agents as an outcome of collaborative activity in searching/retrieving
  - Change in extent of inequality of access to previous validated knowledge claims
  - Change in volume of documents transmitted among all agents searching/retrieving knowledge claims
  - Change in ratio of messages received by an agent to messages sent by that agent related to searching/retrieving

Teaching

Teaching is a non-peer, often hierarchical, interaction in which one agent tries to communicate with another in such a way that the second agent is motivated to understand the conceptual network being communicated by the first person. Success factors are cycle time and success in conveying understanding.

- Process descriptors
    - Teaching cycle time
    - Teaching velocity
    - Teaching acceleration
    - Intensity of collaborative activity in teaching
    - Intensity of cooperative behavior in teaching
    - Intensity of conflict behavior in teaching
    - Extent of withdrawal from interaction with other agents as an outcome of collaborative teaching activity
    - Extent of inequality of access to previous teaching
    - Volume of documents transmitted to agents in teaching
    - Ratio of messages received by an Agent to messages sent by that agent related to teaching
    - Use and Frequency of use of methods of interpersonal teaching
        - Lecture classes
        - Discussion classes
        - Seminars
        - Tutorials
        - Team teaching
        - Self-organizing classes
    - Use and frequency of use of methods of electronic support for teaching
        - Web-enabled training (eLearning)
        - Web-enabled application-specific training
    - Teaching infrastructure
        - Intranet facilities -- both physical and software
        - eLearning facilities
        - classrooms
        - Fax
        - Document subscriptions
        - Books
        - Telephone facilities
        - Electronic broadcast reception facilities
- Teaching outcome descriptors
    - Content of validated knowledge claims as outlined earlier
    - Extent of distribution of validated knowledge claims
    - Extent of acceptance and support for above claims

- Extent of distribution of validated knowledge claims among targets of these claims
- Extent of acceptance and support for above claims
- Production/existence of training vehicles,
- Degree of knowledge worker satisfaction with training vehicles and process,
- Degree of knowledge manager satisfaction with training vehicles and process,
- Degree of satisfaction with training vehicles and process by knowledge authority structure,
- Degree of satisfaction with training vehicles and process by organizational authority structure,
- Degree of satisfaction with training vehicles and process by subsystem,
- Degree of fulfillment of training objectives by knowledge assignment,
- Degree of fulfillment of training objectives by knowledge assignment segment,
- Degree of fulfillment of training objectives by knowledge authority structure segment,
- Degree of fulfillment of training objectives by organizational authority segment,
- Degree of fulfillment of training objectives by subsystem segment.

- Descriptors of growth and change in teaching

  - Change in degree of inequality of teaching
  - Change in teaching cycle time
  - Change in teaching velocity
  - Change in teaching acceleration
  - Change in intensity of collaborative activity in teaching
  - Change in intensity of cooperative behavior in teaching
  - Change in intensity of conflict behavior in teaching
  - Change in extent of withdrawal from interaction with other agents as an outcome of collaborative activity in teaching
  - Change in extent of inequality of access to previously validated knowledge claims
  - Change in volume of documents transmitted among all agents teaching knowledge claims
  - Change in ratio of messages received by an agent to messages sent by that agent related to teaching
  - Performance metric on training personnel to manage and use the knowledge base.

Sharing

Knowledge sharing is the activity of making knowledge available (a) through a knowledge store accessible to individuals and groups in an enterprise, or (b) through spoken communication. Some knowledge stores are off-line and store documents or electronic media. Some are contained in on-line computer databases. Some are contained in virtual databases in computer memory.

When knowledge is shared through the spoken word, knowledge sharing needs to be carefully distinguished from broadcasting and teaching. In broadcasting, knowledge is sent without specific elicitation. In teaching, an agent plays the role of instructor to another in a non-peer interaction. But in face-to-face knowledge sharing peers communicate organizational knowledge they hold in a conversational context. Cycle time and success in conveying understanding are critical success factors.

- Process descriptors
    - Sharing cycle time
    - Sharing velocity
    - Sharing acceleration
    - Intensity of collaborative activity in sharing
    - Intensity of cooperative behavior in sharing
    - Intensity of conflict behavior in sharing
    - Extent of withdrawal from interaction with other agents as an outcome of collaborative sharing activity
    - Extent of inequality of access to previous sharing
    - Volume of documents transmitted to agents in sharing
    - Ratio of messages received by an Agent to messages sent by that agent related to sharing
    - Use and Frequency of use of methods of interpersonal sharing
        - Delphi Technique
        - Knowledge Café,
        - Nominal Group Technique
        - Focus Groups
        - Personal Networking
        - Project Meetings
        - Company Meetings
        - Self-organizing teams
        - Communities of Practice
        - Credit assignment processes
    - Use and frequency of use of methods of electronic support for sharing
        - Web-enabled sharing

- Web-enabled application-specific sharing
- Portal-enabled collaboration
- Portal-enabled agent-based sharing
- Portal-enabled credit assignment applications for sharing

- Sharing infrastructure

  - Intranet facilities -- both physical and software
  - classrooms
  - Fax
  - Documents
  - Telephone facilities
  - Electronic broadcast reception facilities

- Sharing outcome descriptors

  - Content of validated knowledge claims as outlined earlier
  - Extent of distribution of validated knowledge claims
  - Extent of acceptance and support for above claims
  - Extent of distribution of validated knowledge claims among targets of these claims
  - Extent of acceptance and support for above claims
  - Degree of knowledge worker satisfaction with sharing vehicles and process,
  - Degree of knowledge manager satisfaction with sharing vehicles and process,
  - Degree of satisfaction with sharing vehicles and process by knowledge authority structure,
  - Degree of satisfaction with sharing vehicles and process by organizational authority structure,
  - Degree of satisfaction with sharing vehicles and process by subsystem,
  - Degree of fulfillment of sharing objectives by knowledge assignment,
  - Degree of fulfillment of sharing objectives by knowledge assignment segment,
  - Degree of fulfillment of sharing objectives by knowledge authority structure segment,
  - Degree of fulfillment of sharing objectives by organizational authority segment,
  - Degree of fulfillment of sharing objectives by subsystem segment.
  - Types of rewards provided for participation in knowledge sharing
  - Extent of satisfaction with rewards for knowledge sharing
  - Performance metric on sharing the knowledge base

- Descriptors of growth and change in sharing

    - Change in degree of inequality of sharing
    - Change in sharing cycle time
    - Change in sharing velocity
    - Change in sharing acceleration
    - Change in intensity of collaborative activity in sharing
    - Change in intensity of cooperative behavior in sharing
    - Change in intensity of conflict behavior in sharing
    - Change in extent of withdrawal from interaction with other agents as an outcome of collaborative activity in sharing
    - Change in extent of inequality of access to previous validated knowledge claims
    - Change in volume of documents transmitted among all agents sharing knowledge claims
    - Change in ratio of messages received by an agent to messages sent by that agent related to sharing
    - Change in types of rewards provided for participation in knowledge sharing
    - Change in extent of satisfaction with rewards for knowledge sharing

Symbolically Representing the KM Function

Symbolic representation is an aspect of all managerial activity. Managers have authority. Part of what maintains that authority is the symbolism used and manipulated by them to express the legitimacy of their authority and to claim it. Here are various process descriptors that may be used to describe representing.

- Process descriptors

    - Representing cycle time
    - Representing velocity
    - Representing acceleration
    - Intensity of collaborative activity in representing
    - Intensity of cooperative behavior in representing
    - Intensity of conflict behavior in representing
    - Extent of withdrawal from interaction with other agents as an outcome of collaborative representing activity
    - Extent of inequality of access to previous representing
    - Volume of documents transmitted to agents in representing
    - Ratio of messages received by an Agent to messages sent by that agent related to representing

- Use and frequency of use of methods of interpersonal representing
  - Personal Networking
  - Meetings
  - Public appearances
- Use and frequency of use of methods of electronic support for representing
  - Web-enabled representing
- Representing infrastructure
  - Intranet facilities -- both physical and software
  - Conference and presentation rooms
  - Fax
  - Documents
  - Telephone facilities

- Representing outcome descriptors
  - Degree of knowledge worker satisfaction with symbolic representation,
  - Degree of knowledge manager satisfaction with symbolic representation,
  - Degree of satisfaction with symbolic representation by knowledge authority structure,
  - Degree of satisfaction with symbolic representation by organizational authority structure,
  - Degree of satisfaction with symbolic representation by subsystem,
  - Performance metric on symbolic representation,

- Descriptors of growth and change in symbolic representation
  - Change in symbolic representation cycle time
  - Change in symbolic representation velocity
  - Change in symbolic representation acceleration

Leading

Leading includes hiring, training, motivating, monitoring, and evaluating staff. It also includes persuading non-KM agents within the enterprise of the validity of KM process activities

- Process descriptors

- Leading cycle time
- Leading velocity
- Leading acceleration
- Intensity of collaborative activity in leading
- Intensity of cooperative behavior in leading
- Intensity of conflict behavior in leading
- Extent of withdrawal from interaction with other agents as an outcome of collaborative leading activity
- Extent of inequality of access to leadership
- Volume of documents transmitted to agents in leading
- Ratio of messages received by an Agent to messages sent by that agent related to leading

- Use and Frequency of use of interpersonal methods of leading

  - Consensus building
  - Persuading
  - Compelling
  - Incenting
  - Informing
  - Obligating
  - Hiring
  - Evaluating
  - Delegating
  - Meeting
  - Memoranda

- Use and frequency of use of methods of electronic support for leading
  - Web-enabled meeting
  - E-mails
  - Portal-enabled collaboration

- Leading infrastructure

  - Intranet facilities -- both physical and software
  - Offices
  - Conference rooms
  - Fax
  - Telephone facilities

- Leading outcome descriptors

  - Degree of knowledge worker satisfaction with leading,
  - Degree of knowledge manager satisfaction with leading,

- Degree of satisfaction with leading by knowledge authority structure,
- Degree of satisfaction with leading by organizational authority structure,
- Degree of satisfaction with leading by subsystem,
- Degree of fulfillment of leading objectives by knowledge assignment,
- Degree of fulfillment of leading objectives by knowledge assignment segment,
- Degree of fulfillment of leading objectives by knowledge authority structure segment,
- Degree of fulfillment of leading objectives by organizational authority segment,
- Degree of fulfillment of leading objectives by subsystem segment.
- Responsibility segmentation,
- Depth of authority/assignment structure created,
- Scope of authority/assignment structure within and across knowledge management domains,
- Growth in scope of authority structure.
- Degree of hierarchy in KM leadership process
- Performance metric on leading KM activities

- Descriptors of growth and change in leading

  - Change in leading cycle time
  - Change in leading velocity
  - Change in leading acceleration
  - Change in intensity of collaborative activity in leading
  - Change in intensity of cooperative behavior in leading
  - Change in intensity of conflict behavior in leading
  - Change in extent of withdrawal from interaction with other agents as an outcome of collaborative activity in leading
  - Change in extent of inequality of access to KM leaders
  - Change in ratio of messages received by an agent to messages sent by that agent related to leading
  - Change in degree of hierarchy in KM leadership process

Building External Relationships (ER)

Building external relationships means performing those activities intended to produce friendships, alliances, and "partnerships" with decision makers external to one's own company. These relationships are essential to knowledge managers for acquiring sources of information. They are also essential for providing "role models" for knowledge managers.

- Process descriptors
    - Building ER cycle time
    - Building ER velocity
    - Building ER acceleration
    - Intensity of collaborative activity in Building ER
    - Intensity of cooperative behavior in Building ER
    - Intensity of conflict behavior in Building ER
    - Extent of withdrawal from interaction with other agents as an outcome of collaboration in Building ER
    - Use and frequency of use of interpersonal methods of building ER
        - Personal Networking
        - Public appearances
        - Conferences
        - Tours
        - Meetings
        - Telephone conversations
    - Use and frequency of use of methods of electronic support for building ER
        - Web-enabled building ER
        - E-mail communications
        - External-facing portal-enabled collaborative environments
    - Building ER infrastructure
        - Internet facilities -- both physical and software
        - Conference and presentation rooms
        - Fax
        - Documents
        - Telephone facilities
- Outcome descriptors
    - Degree of knowledge worker satisfaction with external relationship building,
    - Degree of knowledge manager satisfaction with external relationship building,
    - Degree of satisfaction with external relationship building by knowledge authority structure,
    - Degree of satisfaction with external relationship building by organizational authority structure,

- Degree of satisfaction with external relationship building by subsystem,
- Performance metric on external relationship building,

- Descriptors of growth and change in building external relationships

  - Change in external relationship building cycle time
  - Change in external relationship building velocity
  - Change in external relationship building acceleration
  - Change in intensity of collaborative activity in external relationship building
  - Change in intensity of cooperative behavior in external relationship building
  - Change in intensity of conflict behavior in external relationship building
  - Change in extent of withdrawal from interaction with other agents as an outcome of collaborative activity in external relationship building

KM knowledge production

KM knowledge production is analogous to knowledge production at the level of knowledge processing. The difference is that the objective is to produce knowledge about how to manage knowledge processing and its outcomes. In particular, KM knowledge production focuses on producing the rules that govern knowledge processing. Refer to Knowledge Production above for details of process and outcome descriptors.

KM knowledge integration

This category is analogous to knowledge integration at the level of knowledge processing. The difference is that the objective is to integrate knowledge about how to manage knowledge processing and its outcomes. Refer to Knowledge Integration for details of process and outcome descriptors.

Changing knowledge processing rules

The task clusters of information acquisition, individual and group learning, knowledge claim formulation, knowledge claim validation, broadcasting, searching/retrieving, teaching, and sharing are all composed of rule governed tasks. Knowledge workers execute these tasks and knowledge managers produce the process rules. Knowledge managers also change the rules once they produce new knowledge about them.

- Process Descriptors

- Changing knowledge processing rules cycle time
- Changing knowledge processing rules velocity
- Changing knowledge processing rules acceleration
- Intensity of collaborative activity in changing knowledge processing rules
- Intensity of cooperative behavior in changing knowledge processing rules
- Intensity of conflict behavior in changing knowledge processing rules
- Extent of withdrawal from interaction with other agents as an outcome of collaborative changing knowledge processing rules activity
- Extent of inequality of access to previous changing knowledge processing rules
- Volume of documents transmitted to agents in changing knowledge processing rules
- Ratio of messages received by an Agent to messages sent by that agent related to changing knowledge processing rules

- Use and Frequency of use of interpersonal methods of changing knowledge processing rules

    - Personal Networking
    - Meetings
    - Briefings
    - Conferences
    - Telephone conversations

- Use and frequency of use of methods of electronic support for changing knowledge processing rules

    - Web-enabled changing knowledge processing rules
    - E-mail communications
    - Portal-enabled collaborative environments

    - Infrastructure for changing knowledge processing rules

        - Intranet facilities -- both physical and software
        - classrooms
        - Fax
        - Documents
        - Telephone facilities
        - Electronic broadcast reception facilities

- Outcome descriptors

- Extent of distribution of validated rules knowledge claims
- Extent of acceptance and support for above claims
- Extent of distribution of validated rules knowledge claims among targets of these claims
- Extent of acceptance and support for above claims
- Degree of knowledge worker satisfaction with rule changes
- Degree of knowledge manager satisfaction with rule changes
- Degree of satisfaction with rule changes by knowledge authority structure,
- Degree of satisfaction with rule changes by organizational authority structure,
- Degree of satisfaction with rule changes by subsystem,
- Degree of fulfillment of rule change objectives by knowledge assignment,
- Degree of fulfillment of rule change objectives by knowledge assignment segment,
- Degree of fulfillment of rule change objectives by knowledge authority structure segment,
- Degree of fulfillment of rule change objectives by organizational authority segment,
- Degree of fulfillment of rule change objectives by subsystem segment
- Performance metric on changing knowledge processing rules.

- Descriptors of growth and change in changing knowledge processing rules

  - Change in degree of inequality of changing knowledge processing rules
  - Change in changing knowledge processing rules cycle time
  - Change in changing knowledge processing rules velocity
  - Change in changing knowledge processing rules acceleration
  - Change in intensity of collaborative activity in changing knowledge processing rules
  - Change in intensity of cooperative behavior in changing knowledge processing rules
  - Change in intensity of conflict behavior in changing knowledge processing rules
  - Change in extent of withdrawal from interaction with other agents as an outcome of collaborative activity in changing knowledge processing rules
  - Change in extent of inequality of access to previously validated knowledge claims
  - Change in volume of documents transmitted among all agents changing knowledge processing rules knowledge claims

- Change in ratio of messages received by an agent to messages sent by that agent related to changing knowledge processing rules
- Above descriptors for each knowledge processing task cluster

Crisis handling

Crisis Handling involves such things as meeting CEO requests for new competitive intelligence in an area of high strategic interest for an enterprise, and directing rapid development of a KM support infrastructure in response to requests from high level executives. Here are the process and outcome descriptors

- Process Descriptors
  - Crisis handling cycle time
  - Crisis handling velocity
  - Crisis handling acceleration
  - Intensity of collaborative activity in crisis handling
  - Intensity of cooperative behavior in crisis handling
  - Intensity of conflict behavior in crisis handling
  - Extent of withdrawal from interaction with other agents as an outcome of collaborative crisis handling activity
  - Extent of inequality of access to previous crisis handling
  - Volume of documents transmitted to agents in crisis handling
  - Ratio of messages received by an Agent to messages sent by that agent related to crisis handling
  - Use and Frequency of use of interpersonal methods of crisis handling
    - Personal Networking
    - Meetings
    - Briefings
    - Conferences
    - Telephone conversations
  - Use and frequency of use of methods of electronic support for crisis handling
    - Web-enabled crisis handling
    - E-mail communications
    - Portal-enabled collaborative environments
  - Infrastructure for crisis handling

- Intranet facilities -- both physical and software
- Fax
- Documents
- Telephone facilities
- Electronic broadcast reception facilities

- Outcome descriptors

  - Extent of distribution of validated crisis handling knowledge claims
  - Extent of acceptance and support for above claims
  - Extent of distribution of validated crisis handling knowledge claims among targets of these claims
  - Extent of acceptance and support for above claims
  - Degree of knowledge worker satisfaction with crisis handling
  - Degree of knowledge manager satisfaction with crisis handling
  - Degree of satisfaction with crisis handling by knowledge authority structure,
  - Degree of satisfaction with crisis handling by organizational authority structure,
  - Degree of satisfaction with crisis handling by subsystem,
  - Degree of fulfillment of crisis handling objectives by knowledge assignment,
  - Degree of fulfillment of crisis handling objectives by knowledge assignment segment,
  - Degree of fulfillment of crisis handling objectives by knowledge authority structure segment,
  - Degree of fulfillment of crisis handling objectives by organizational authority segment,
  - Degree of fulfillment of crisis handling objectives by subsystem segment
  - Performance metric on crisis handling activities

- Descriptors of growth and change in crisis handling

  - Change in degree of inequality of crisis handling
  - Change in crisis handling cycle time
  - Change in crisis handling velocity
  - Change in crisis handling acceleration
  - Change in intensity of collaborative activity in crisis handling
  - Change in intensity of cooperative behavior in crisis handling
  - Change in intensity of conflict behavior in crisis handling
  - Change in extent of withdrawal from interaction with other agents as an outcome of collaborative activity in crisis handling
  - Change in extent of inequality of access to previously validated knowledge claims

- Change in volume of documents transmitted among all agents crisis handling
- Change in ratio of messages received by an agent to messages sent by that agent related to crisis handling
- Above descriptors for each knowledge processing task cluster

Allocating Resources

Allocating resources includes allocations for KM support infrastructures, training, professional conferences, salaries for KM staff, funds for new KM programs, etc.

- Process Descriptors
  - Allocating resources cycle time
  - Allocating resources velocity
  - Allocating resources acceleration
  - Intensity of collaborative activity in allocating resources
  - Intensity of cooperative behavior in allocating resources
  - Intensity of conflict behavior in allocating resources
  - Extent of withdrawal from interaction with other agents as an outcome of collaborative activity in allocating resources
  - Extent of inequality of access to previously allocated resources
  - Volume of documents transmitted to agents in allocating resources
  - Ratio of messages received by an Agent to messages sent by that agent related to allocating resources

  - Use and frequency of use of interpersonal methods of allocating resources
    - Personal Networking
    - Meetings
    - Briefings
    - Conferences
    - Telephone conversations

  - Use and frequency of use of methods of electronic support for allocating resources
    - Web-enabled resource allocation
    - E-mail communications
    - Portal-enabled collaborative environments

  - Infrastructure for allocating resources
    - Intranet facilities -- both physical and software
    - Computational facilities

- Fax
- Documents
- Telephone facilities

- Outcome descriptors

  - Extent of distribution of validated allocating resources knowledge claims
  - Extent of acceptance and support for above claims
  - Extent of distribution of validated allocating resources knowledge claims among targets of these claims
  - Extent of acceptance and support for above claims
  - Degree of knowledge worker satisfaction with allocating resources
  - Degree of knowledge manager satisfaction with allocating resources
  - Degree of satisfaction with allocating resources by knowledge authority structure,
  - Degree of satisfaction with allocating resources by organizational authority structure,
  - Degree of satisfaction with allocating resources by subsystem,
  - Degree of fulfillment of allocating resources objectives by knowledge assignment,
  - Degree of fulfillment of allocating resources objectives by knowledge assignment segment,
  - Degree of fulfillment of allocating resources objectives by knowledge authority structure segment,
  - Degree of fulfillment of allocating resources objectives by organizational authority segment,
  - Degree of fulfillment of allocating resources objectives by subsystem segment
  - Performance metric on resource allocation activities

- Descriptors of growth and change in allocating resources

  - Change in degree of inequality of allocating resources
  - Change in allocating resources cycle time
  - Change in allocating resources velocity
  - Change in allocating resources acceleration
  - Change in intensity of collaborative activity in allocating resources
  - Change in intensity of cooperative behavior in allocating resources
  - Change in intensity of conflict behavior in allocating resources

- Change in extent of withdrawal from interaction with other agents as an outcome of collaborative activity in allocating resources
- Change in extent of inequality of access to previously validated knowledge claims
- Change in volume of documents transmitted among all agents allocating resources
- Change in ratio of messages received by an agent to messages sent by that agent related to allocating resources
- Above descriptors for each knowledge processing task cluster

Negotiating Agreements

Negotiating agreements with representatives of business processes over levels of effort for KM, the shape of KM programs, the ROI expected of KM activities, etc., is an essential knowledge management function.

- Process Descriptors
  - Negotiating agreements cycle time
  - Negotiating agreements velocity
  - Negotiating agreements acceleration
  - Intensity of collaborative activity in negotiating agreements
  - Intensity of cooperative behavior in negotiating agreements
  - Intensity of conflict behavior in negotiating agreements
  - Extent of withdrawal from interaction with other agents as an outcome of collaborative activity in negotiating agreements
  - Volume of documents transmitted to agents in negotiating agreements
  - Ratio of messages received by an Agent to messages sent by that agent related to negotiating agreements
  - Use and frequency of use of interpersonal methods of negotiating agreements
    - Personal Networking
    - Meetings
    - Briefings
    - Conferences
    - Telephone conversations
  - Use and frequency of use of methods of electronic support for negotiating agreements
    - Web-enabled negotiating
    - E-mail communications

- Portal-enabled collaborative environments

- Infrastructure for negotiating agreements

  - Intranet facilities -- both physical and software
  - Computational facilities
  - Fax
  - Documents
  - Telephone facilities

- Outcome descriptors

  - Extent of distribution of validated negotiating agreements knowledge claims
  - Extent of acceptance and support for above claims
  - Extent of distribution of validated negotiating agreements knowledge claims among targets of these claims
  - Extent of acceptance and support for above claims
  - Degree of knowledge worker satisfaction with negotiating agreements
  - Degree of knowledge manager satisfaction with negotiating agreements
  - Degree of satisfaction with negotiating agreements by knowledge authority structure,
  - Degree of satisfaction with negotiating agreements by organizational authority structure,
  - Degree of satisfaction with negotiating agreements by subsystem,
  - Degree of fulfillment of negotiating agreements objectives by knowledge assignment,
  - Degree of fulfillment of negotiating agreements objectives by knowledge assignment segment,
  - Degree of fulfillment of negotiating agreements objectives by knowledge authority structure segment,
  - Degree of fulfillment of negotiating agreements objectives by organizational authority segment,
  - Degree of fulfillment of negotiating agreements objectives by subsystem segment
  - Performance metric on negotiating activities.

- Descriptors of growth and change in negotiating agreements

  - Change in degree of inequality of negotiating agreements
  - Change in negotiating agreements cycle time
  - Change in negotiating agreements velocity
  - Change in negotiating agreements acceleration

- Change in intensity of collaborative activity in negotiating agreements
- Change in intensity of cooperative behavior in negotiating agreements
- Change in intensity of conflict behavior in negotiating agreements
- Change in extent of withdrawal from interaction with other agents as an outcome of collaborative activity in negotiating agreements
- Change in extent of inequality of access to previously negotiated agreements
- Change in volume of documents transmitted among all agents negotiating agreements
- Change in ratio of messages received by an agent to messages sent by that agent related to allocating resources
- Above descriptors for each knowledge processing task cluster

Summary and Conclusion

This paper presented a conceptual framework providing basic KM-related concepts, a business process decision model, a knowledge life cycle model, a KM framework, and a detailed listing of descriptors and metrical concepts associated with the main categories of the conceptual framework. Previous work performed on the KLC model and on a general conceptualization of KM provided a place to start, but without a detailed framework such as that provided here, further progress in applying the KLC and KM frameworks would be difficult at best. With it all kinds of applications are within reach. The framework, for example, could be used:

- To set up System Dynamics or *cas* (swarm) simulations of KM impact on the knowledge life cycle, and the organizational system;
- As a guide to developing measurement models and measures of KM impact on the KLC
- Along with indicators external to the KLC, to measure the impact of KM on business processes and their outcomes. Examples of such indicators include change in: Manufacturing Production Cycle Times; Customer Service Cycle Time; Intensity of collaboration in enterprise business processes; and Changes in ROI, Profitability, Market Share, Customer Retention, and Employee Retention.
- As a guide to analysis of any of the processes and task clusters in the KLC or KM components of the framework.

In short, the framework opens the way to further development of KM as a discipline. It provides a map that students of KM can use to conceptualize problems and puzzles that, if solved, can produce progress in the discipline.

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Biography

Joseph M. Firestone, Ph.D. is Vice-President and Chief Scientist of Executive Information Systems (EIS), Inc. Joe has varied experience in consulting, management, information technology, decision support, and social systems analysis. Currently, he focuses on product, methodology, architecture, and solutions development in Enterprise Information and knowledge Portals, where he performs Knowledge and knowledge management audits, training, and facilitative systems planning, requirements capture, analysis, and design. Joe was the first to define and specify the Enterprise Knowledge Portal Concept. He is widely published in the areas of Decision Support (especially Enterprise Information and Knowledge Portals, Data Warehouses/Data Marts, and Data Mining), and Knowledge Management, and has recently completed a full-length industry report entitled "Approaching Enterprise Information Portals."

Joe is a founding member of the Knowledge Management Consortium International (KMCI), a member of its: Executive Committee, Board of Directors, Metaprise Project, and Governing Council of the KMCI Institute. He is also the Editor of the new journal "Knowledge and Innovation: Journal of the KMCI," and Chairperson of the KMCI's Artificial Knowledge Management Systems Special Interest Group, Joe is a frequent speaker at national conferences on KM and Portals. He is also developer of the web site www.dkms.com, one of the most widely visited web sites in the Portal and KM fields. DKMS.com has now reached a visitation rate of 95,000 visits annually.