THE KNOWLEDGE MANAGEMENT DOMAIN

A Knowledge Management Approach to Knowledge Management

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Abstract

In search of the ingredients to sustain a knowledge-based, learning organization, two General Motors Knowledge Management practitioners use knowledge management techniques to define the domain of knowledge management. This paper asserts that the Knowledge Management Domain is made up of at least 8 disciplines comprised of up to 50 specialties or dimensions. Each specialty or dimension has 2 thresholds, one for initiation and the another for sustainability. Between and on either side of the thresholds is a spectrum of metrics which measure the maturity of each specialty/dimension. The Domain and the spectra can be used to appraise the initiation readiness or the sustainability of a knowledge-based, learning organization. Additionally, the Domain and spectra can be used to create tactical and strategic KM initiatives. The authors have defined up to 7 core competencies for each specialty or dimension.

Acknowledgments

The authors would like to acknowledge and again thank Alex Morgan, Scientist, General Motors Corporation, for his comments and references on metaknowledge, taxonomies, ontologies, and semantic tags. Please refer to the Appendix, Attachment XVIII, pages 44-45.

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The Knowledge Management Domain

A Knowledge Management Approach to Knowledge Management

Introduction. Knowledge Management, KM, receives considerable press. Interestingly enough, an all-encompassing definition still eludes us. Each KM community has its own definition. For the IT community, KM is the development of tools that support communities of practice and databases that contain data, information or knowledge valued by a business. For the OD community, KM is about getting people to share their ideas and knowledge, establishing new behaviors and moving organizations closer to a learning centric organization.

For the Project Management community, KM is about managing knowledge initiatives, capturing and re-using procedural or process knowledge. The Artificial Intelligence (AI) and the Knowledge-based Engineering (KBE) communities understand knowledge management as developing *decision-making* or rule-based applications or wizards.

As automotive product engineers, KM revolves around capturing product knowledge as best practices. For us, knowledge management is assisting knowledge holders, or experts, with consciously surfacing their knowledge as well as the context and rationale supporting this knowledge. This knowledge is structured in a manner to ensure inclusive capture, fast retrieval, sharing and re-use by the entire enterprise. Of secondary importance are the mechanisms used to capture and deploy this knowledge.

Which perspective is valid? We believe all of the above perspectives and possibly others to be valid. In order to validate our hypothesis we decided to use the KM techniques we apply at GM to define the KM domain.

So what is KM? We believe that the definition of knowledge management needs to be more inclusive and holistic, rather than exclusive. Reviewing KM literature we found 7 KM framework models, 10 individual and 8 enterprise-learning models. The framework and learning models were often superimposed on one another. For our purposes, the models needed to be separated. Sorting through the models, tables and lists, as well as what we believed needed to be added, a pattern emerged. Unlike D. Holtshouse [Holtshouse, 1998, Slide 5] who identified 10 KM domains, we assert that KM *is* the domain. Additionally, the Knowledge Management Domain is made up of at least 8 disciplines comprised of up to 50 specialties or dimensions. Holtshouse's domains, as well as the elements of the other framework models, are captured as disciplines, specialties or dimensions in this paper. For reference, we have mapped the elements of the 6 KM framework models to the proposed disciplines, specialties or dimensions presented herein. Refer to Appendix, Attachment IA and IB, pp. 24-25.

Furthermore, a threshold of initiation and a threshold of sustainability has been defined for each specialty or dimension . Between, and on the other side of the 2 thresholds, is a spectrum of metrics *measuring* the maturity of that specialty/ dimension of KM. At this point we speculated, if not for each specialty or dimension, then for at least for each domain, core competencies can be defined. The metrics and competencies for each specialty or dimension can be found in the Appendix, Attachments II – V, pp. 26 –31, respectively.

The Knowledge Management Domain. There are eight major disciplines making up the Knowledge Management Domain. The disciplines are modeled in Figure 1 and listed below for reference:

1. Knowledge Arenas
2. Knowledge Capital
3. Knowledge-Based Learning Process
4. Enterprise-wide Infrastructure
5. Knowledge Arena Benchmarking
6. Knowledge Arena Content Management
7. Organizational Learning
8. Enterprise-wide Knowledge Socialization

Most organizations have these disciplines *in play* to varying degrees. Individually these disciplines are not generally viewed as Knowledge Management, and there in lies the challenge for Knowledge Managers and Engineers. At General Motors all eight disciplines do exist and collectively will eventually make up the backbone necessary to sustain a knowledge and learning-appreciative culture. Now that we have established a roadmap, let's start the journey through the knowledge domain and discover the essence of each discipline.

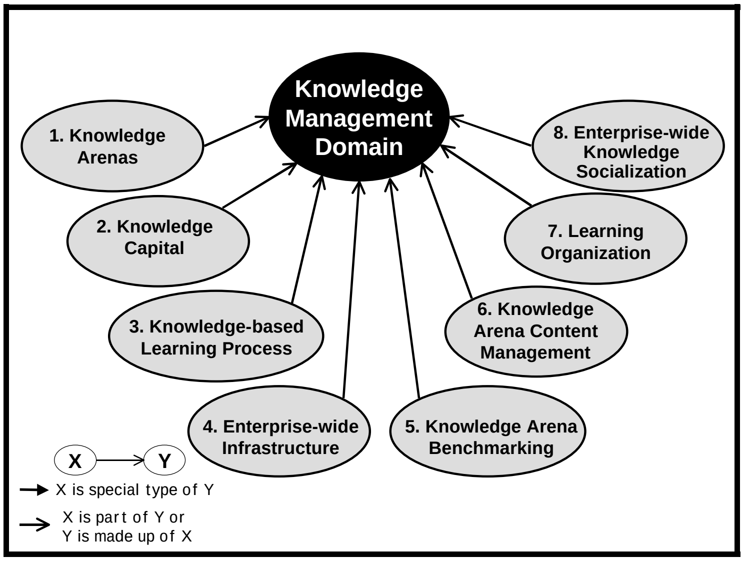

Figure 1- Knowledge Management Domain

1. Knowledge Arenas.

The first discipline embraces knowledge arenas or categories of knowledge content. Figure 2a models the Knowledge Arenas to show that there are 7 special types of Arenas. From left to right, we find primary and secondary product arenas, manufacturing and enterprise-wide business process arenas, the customer loyalty/value arena, the external-to-enterprise arena and Metaknowledge (knowledge about knowledge). Another way of representing knowledge arenas is a Venn diagram illustrated in Figure 2b. The Venn diagram reveals the intersection of the primary product and manufacturing process arenas as the secondary product arena.

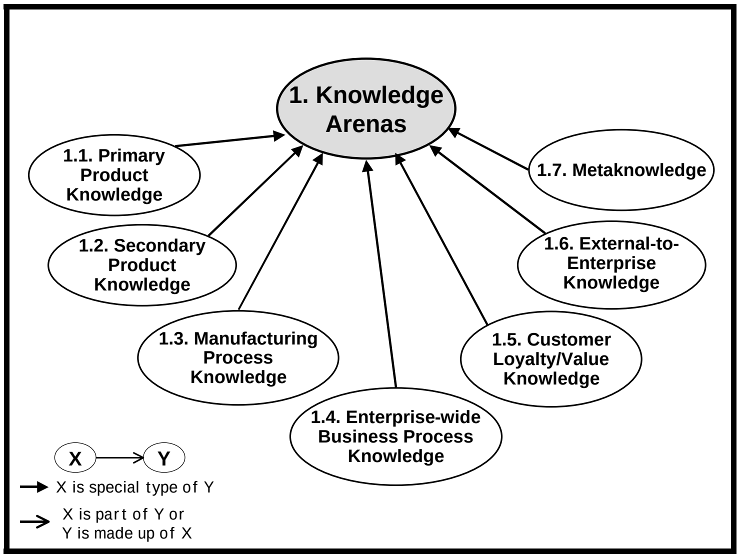

Figure 2a – Knowledge Arenas

Referring back to Figure 2a, the first arena shown is the **primary product** (1.1), which addresses knowledge about the enterprise's core business. As an example, General Motors' primary product is vehicles. Therefore the primary product knowledge arena encompasses vehicles, vehicle systems and components. The second arena, a less obvious arenas, is the **secondary product** (1.2) arena. Secondary products for the automotive industry are tooling, fixtures, camouflage, items designed and manufactured in order to produce the primary product. If secondary products are developed or manufactured by suppliers and/or partners, then they would manage this knowledge arena not the enterprise. Ideally, knowledge about the primary and secondary products should be independent of the development processes. Following this practice allows the primary and secondary product knowledge to be reused independent of the process, process changes, enterprise re-structuring, right-sizing, etc..

The third and fourth arenas, and the most frequently published, focus on either **manufacturing** (1.3) or **business processes** (1.4). The re-engineering and ISO Certification thrusts of the 1980's and 90's may account for the publishing popularity of these arenas. Examples of process knowledge are -- administrative procedures, methods to develop..., procedures to validate…, and fabricating sequences to manufacture a product. Process knowledge is generally *how-to* in nature. Documenting processes promotes stable operations, allows for continuous improvement and typically results in efficient operations.

The fifth arena focuses on **customer loyalty and values** (1.5) knowledge. This arena addresses knowledge of how the customer perceives specific businesses, as well as demographical data. Managing this customer data, information and knowledge is critical to business success. There is more to understanding a customer than demographics. Customer loyalty is driven more by customer values than demographics. For example, the *cultural-creative* group of nearly 50 million individuals spans multiple demographic segments. Businesses that know and display the same values as this group will have a tremendous advantage over organizations that focus only on education, income and age demographics. [Ray and Anderson, 2000, Section 1]

The Sixth arena is knowledge **external-to-enterprise** (1.6). This knowledge consists of industry and marketplace trends, patents, competitive benchmarking, legislation, global economics, etc. There is a strategic advantage in managing data, information and knowledge about what's going on external to an enterprise.

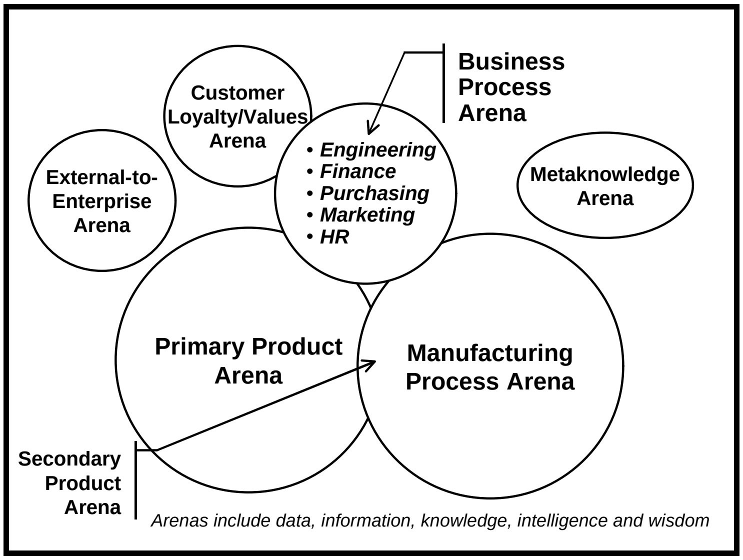

Table 2b – Knowledge Arena Venn Diagram

Finally, the least addressed, and possibly least understood, arena is **metaknowledge** (1.7), knowledge *about* knowledge. Much of what has been written on this topic, has come from the Artificial Intelligence community. Several types of metaknowledge are documented -- *declarative, procedural, semantic and episodic knowledge.* Additional comments provided by Alex Morgan, a General Motors Scientist, can be found in the Appendix, Attachment XVIII, Pages 44-45.

2. Knowledge Capital. The second discipline recognizes the potential sources for data, information, and knowledge. The sources are both tacit and explicit, as well as internal and external to an enterprise. Figure 3a illustrates 6 different sources, referred to as capital, within the Knowledge Capital Discipline. Lai and Chu identifies three types of knowledge sources -- Human, Organizational *(a.k.a. Structural)* and Customer. [Lai and Chu, 2002, pp. 26-27]

Karl-Erik Sveiby has a similar perspective. Sveiby explains organizations intangible assets are comprised of three *families* -- Individual Competency (*Human*), Internal (*Organizational*) and External (*Customer Capital*). [Sveiby, 2000, p.] Noteworthy, Lai and Chu's perspective is shown in parenthesis after Sveiby's perspective. We have added three additional sources of capital – Commercial Knowledge (Salable), Supplier/Partner and Public Domain. Lai, Chu and Sveiby combined the Supplier/Partner and Customer sources. These two sources are sufficiently unique and should be discussed and managed separately. From this point forward, we will refer to these knowledge sources as knowledge capital. The term *capital* is used to acknowledge true value to an organization and not intended to minimize the knowledge source as a mere physical asset.

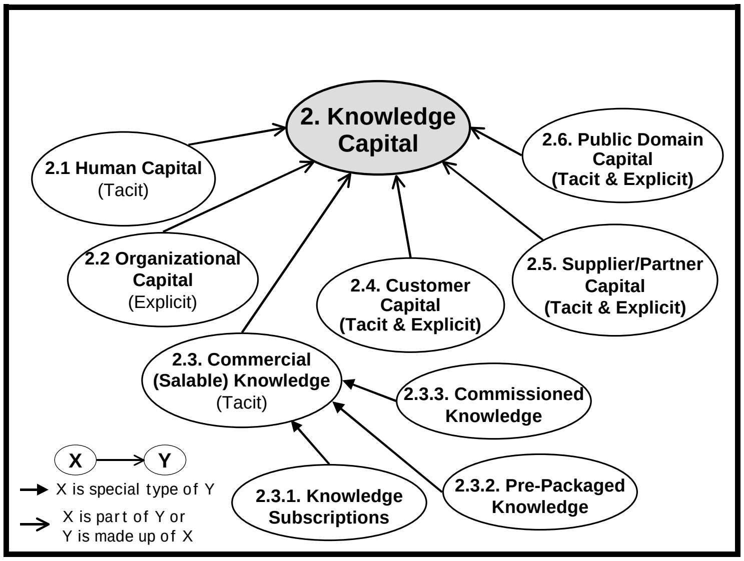

Figure 3a – Knowledge Capital Types

Human Capital (2.1) is tacit knowledge, ideas or understanding held by individuals at varying levels of competency to successfully accomplish individual's goals, solve problems and be creative. Over a lifetime, each individual accumulates experiences and learnings which are filtered by their own unique perception of the world. These experiences and learnings are key to invention, innovation and creativity. An enterprise accommodates these varying degrees of competencies or employee self-reliance with explicit knowledge. Which leads us to the next knowledge source.

The second type of knowledge capital is explicit in nature. **Organizational Capital** (2.2) refers to the structure, processes, systems, patents, experiences (vignettes), lessons and knowledge the enterprise values and documents. An enterprise leverages this capital through sharing or transferring amongst the employees and through re-use. [Lai and Chu, 2002, p. 27] Organizational Capital are the ideas or understandings, which an organization possesses that are used to take effective action to achieve the organization's goals. This knowledge is specific to the organization. [U of Texas, 1998, website]

Lai and Chu identify the third type of knowledge capital, **Customer Capital** (2.4), as the documented relationships between an organization and its customer, brand identification and the organization's reputation. [Lai and Chu, 2002, p. 27] Examples of documented organization-to-customer relationships are product and customer service policies and warranties. Customer Capital can also be feedback provided by customers to the organization on product improvements or features they would like to see in a product. As an example, software development companies commonly solicit expert user groups for software improvements. Customer Clinics are another method used by Marketing to capture customer product opinions and suggestions.

Commercial Knowledge (2.3) is sold and explicit in nature. This knowledge is available as a subscription, pre-packaged or commissioned through a broker. Subscribed knowledge has the advantage of being routinely updated and delivered. Pre-packaged knowledge is static and is typically a one-time purchase, like an encyclopedia. Commissioned knowledge is most often tailored to a specific need and is also typically a one-time purchase.

The fifth type of knowledge capital is **Supplier/Partner** (2.5) Capital. Traditionally suppliers or partners maintain their own knowledge independently as proprietary data, information and knowledge. In today's Supplier-integrated environment there must be a shared body of knowledge, which ensures the successful integration of the supplier's primary product into the enterprise's primary and even secondary products. An enterprise's supplier/partner capital may include a database of attributes like supplier certifications, delivery performance, compliance performance, pricing, etc.

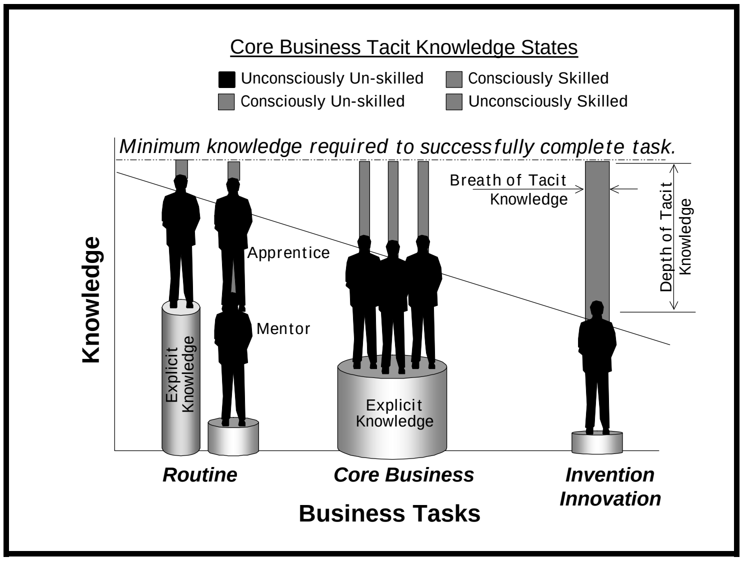

Figure 3b – Balancing Tacit and Explicit Knowledge

The final type of knowledge capital is **Public Domain** (2.6) Capital. This knowledge capital is available without restriction or cost to the general public. There is a wealth of knowledge that enters the public domain each year such as expired Patents and Copyrights. The Internet is a good source of data, information and knowledge, however all sources are not validated.

A Knowledge Manager must assist the organization with ensuring their knowledge capital is accurate, relevant, current and competitive. Additionally the Knowledge Manager must assist the organization with structuring all knowledge for fast retrieval, sharing and re-use.

Before leaving this section, let's explore an earlier comment (p. 8)…*an enterprise accommodates... varying degrees of competencies [tacit knowledge] or employee self-reliance with explicit knowledge.* An example of this accommodation is shown in Figure 3b for three different enterprise scenarios. The first scenario represents *routine* or process tasks. Process knowledge is procedural in nature requiring less primary product tacit knowledge for either the expert or novice. Being procedural, the *how-tos* are generally communicated through manuals, run-guides or on-the-job training like a mentor and apprentice. The second scenario addresses *core business* competency with the enterprise's primary products or services. This scenario requires a higher level of primary product tacit knowledge and skill. For example a mechanic requires more then just the repair manual to repair an automobile. The mechanic needs to draw upon understanding and know-how, in other words, acquired tacit knowledge.

The third scenario is *invention and innovation*, requiring mostly primary product tacit knowledge. Invention and innovation require an in-depth understanding of the primary product as well as a breadth of understanding of the principles involved. Within most enterprises all three scenarios exist. When an enterprise is unaware of the importance of balancing tacit and explicit knowledge, the enterprise is left vulnerable in several ways. First, when most of the core business knowledge is tacit, knowledge is often lost through employee attrition or related cost saving measures. Second, when the core business knowledge is primarily explicit, there may be very little employee *know-how* or depth of understanding. If the enterprise has minimal explicit knowledge, the enterprise will have no alternative but to deploy their experts to mentor and troubleshoot while sacrificing new product development, creating appropriate explicit knowledge or keeping abreast of technological advancements. Maintaining a balance between explicit and tacit knowledge is essential to the success of any enterprise.

3. Knowledge-based Learning Process. The third discipline answers the question -- Individuals learn, but how does an organization, an enterprise learn? For an enterprise to learn, it must operationalize one of several published knowledge-based, learning processes. Although beyond the scope of this paper to discuss each in detail, our research found 10 individual and 8 enterprise learning models. Typically the models are comprised of 4 phases. (Attachment XVII, p. 43, in the Appendix, shows models with 3, 5 and 7 phases as well.)

General Motors has derived their knowledge-based, enterprise learning process from the Deming Plan/Do/Check/Act and the Shewart Plan/Do/Study/Act models. The four phases of the GM model, shown in Figure 4a, are 1) Plan/Deploy, 2) Design/Build/Test, 3) Compile/Study and 4) Collaborate/Innovate/Capture. Unlike most of the other models, the GM model additionally defines the following deliverables for each phase — 1) Standard Work and Tools, 2) Raw Data and Issues, 3) Information and 4) Enterprise Knowledge.

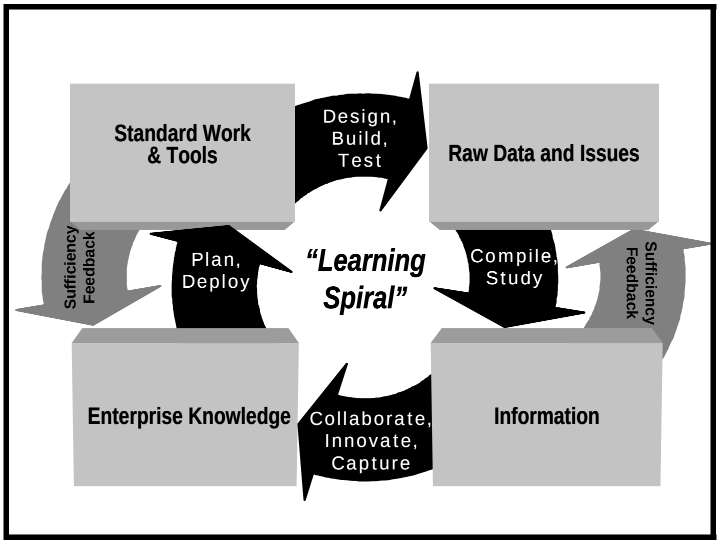

Figure 4a – General Motors Knowledge-based, Learning Model

In the GM, Deming and Shewart models, what is known is *applied*. What is not known is *learned.* With each product release what was *discovered* is captured during the product development process as results or issues in traditional databases. This data is then compiled, studied and promoted to information and stored in *information-bases*. Through synthesis, collaboration and innovation, the information is then promoted into knowledge and captured in a *knowledge base*. New knowledge derived from either product releases, product performance in customer hands or deliberately built from planned development activities, is added to the existing knowledge base. Although Figure 4a depicts a circular relationship between the 4 phases, the circle is actually a spiral, each learning cycle *spirals* the enterprise forward starting each new product release with what the entire enterprise knows to be true.

Without question a company must first know what it needs to know to be successful. Then…

> Any company that can figure out how to give its people the company's knowledge they need -- at the point and time needed -- can position itself to compete more effectively and succeed much faster…Many companies do not "know what they know." Such a situation can often lead to duplication of effort throughout the company…The enterprise that harnesses its intellectual capital can apply that asset to its business challenges and opportunities. In today's fast-paced society, a company's knowledge is quickly becoming its only sustainable competitive advantage. [U of Texas, 1998, website]

The knowledge-based, learning process is the means for an enterprise to learn and succeed. Every employee and decision maker should have fast, simple access to what is already known and advised of what knowledge is being built or developed.

The **Knowledge-based Learning Process** Discipline, the third discipline, is modeled in Figure 4b. As previously discussed, this discipline consists of 4 phases or dimensions. A more general description of the phases then previously described is…

3.1) Plan & Deploy Phase
3.2) Apply & Re-Use Phase
3.3) Compile & Study Phase
3.4) Collaborate, Innovate & Capture Phase

The application or re-use of knowledge can be either passive or active. Our definition of *passive* is that the actual use of the knowledge is left to the discretion of the knowledge user or worker. A passive knowledge application can be either be *pulled* (requested, searched or navigated to) by the user or *pushed* (filtered and delivered) to the user. If the knowledge application is automatic, without user discretion, the knowledge application is *active*.

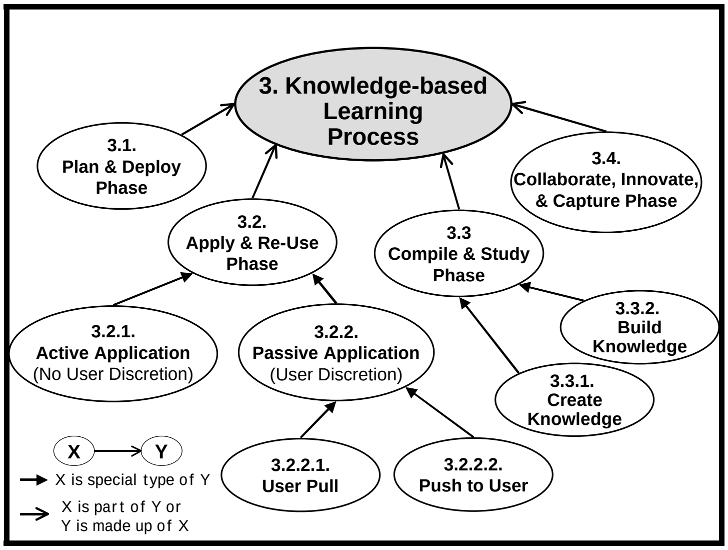

Figure 4b – Knowledge-based Learning Process Phases

4. Enterprise-wide Infrastructure. The fourth discipline, Enterprise-wide Infrastructure, encompasses 11 specialties. Infrastructure has been the primary focus for much of the Knowledge Management community and literature. Several of these specialties are sufficiently complex and far-reaching to be discussed as if the specialty alone is knowledge management. The following specialties are simultaneously required in order to maintain an enterprise-wide infrastructure…

4.1 Reward and incentives systems for knowledge sharing and re-use,
4.2 Knowledge Leadership,
4.3 Knowledge relevant measurements (metrics),
4.4 Communications addressing knowledge initiatives (which includes *story telling* or vignettes),
4.5 Allocation of resources focused on a knowledge-based learning process,
4.6 IT infrastructure to support a knowledge-based learning process,
4.7 Knowledge Management and primary product core competencies,
4.8 Budget for knowledge initiatives,
4.9 Knowledge capture and collaboration facilities,
4.10 Knowledge capture, storing, retrieving and application hardware and software,
4.11 Knowledge Asset Ledger.

Consider the first 4 specialties (4.1 – 4.4). To reinforce the desired behavior of knowledge sharing and re-use, employees, including management, must be fairly and consistently rewarded. There must be a continual and prevalent emphasis from management of the significance of knowledge to the organization. For an enterprise to sustain any initiative there must be a fearless and relentless champion. Relevant knowledge metrics must be defined and used to measure the organization's success in meeting its objectives. Every avenue, especially *story telling*, should be used to clearly and concisely communicate knowledge objectives and successes throughout the enterprise.

An enterprise will need to allocate resources to KM. Reviewing Figure 5, you will find that the **Allocation of Resource Specialty** (4.5) is made up of 7 different roles. Only 1 of the 7 roles is actually a new position or career, the Knowledge Manager. Within GM Engineering, we refer to this role as Knowledge Asset Manager to emphasize that knowledge is and should be managed as an asset. The other 6 roles generally exist within an enterprise under a different name. Table I lists the roles using both knowledge and traditional names, aligning each to the appropriate Knowledge-base Learning Process Phase.

Why use new, knowledge resource names? Why not just use the traditional role names? One of the responsibilities of a knowledge manager is to assist employees and management in moving to a conscious awareness of managing (sharing and re-using) knowledge. Knowledge Management is more than a Knowledge Manager rationalizing the value of knowledge, or a knowledge-based software developer writing a knowledge application. Managing Knowledge is a conscious awareness of what knowledge the enterprise needs to know to be successful, then ensuring that this knowledge is easily available to each decision maker and employee.

Management and employees must realize that managing knowledge is just business, but not as usual. Managing knowledge is just business with a conscious, deliberate plan to structure, share and re-use what an enterprise knows. Humans possess a great deal of tacit knowledge – we know more than we can say and share. The organizational challenge is to remove the barriers and train people to tap into this knowledge in order to create stronger, more innovative companies. [Iske and Boekhoff, 2001]

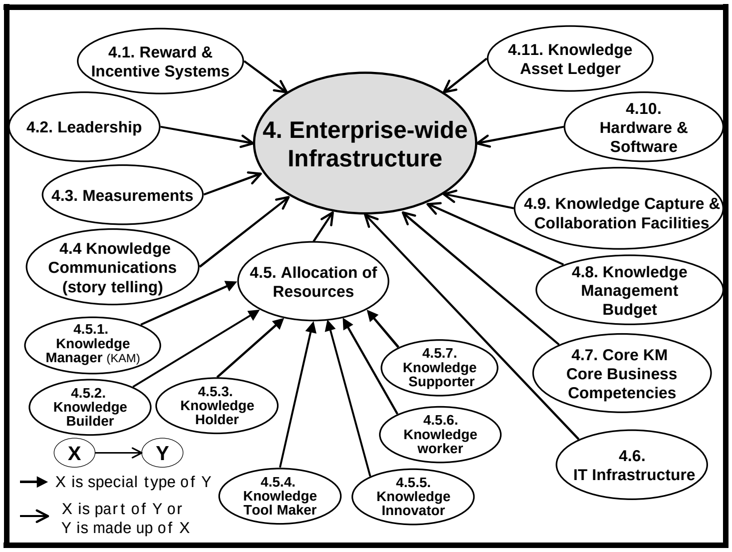

Figure 5 – Enterprise-wide Infrastructure

The next 4 specialties (4.6 and 4.8 – 4.10) address other necessities like IT infrastructure, budget, facilities, hardware and software. Managing knowledge, specifically structuring knowledge for fast retrieval, sharing and re-use is not universally understood. Enterprises will need to provide **training and education** (4.7) opportunities for their employees. The final specialty is in its infancy. Since knowledge is an asset, an enterprise should have a *knowledge asset ledger* (4.11). The value of knowledge is not established by the cost of development, validation or even storage and retrieval. The value of knowledge is established each time the knowledge is effectively applied, and not before.

Knowledge aware organizations…

- value each other's knowledge. Apply and re-use each other's knowledge,
- structure each other's knowledge in a manner that supports, fast retrieval, sharing and re-use by everyone,
- allocate resources to improve the fidelity of what is known or to build what is not known and
- provide an enterprise-wide knowledge infrastructure.

Knowledge Role	Traditional role	Alignment to Knowledge-based, Learning Process Phase(s)
Knowledge Manager	Relatively New Position	All 4 Phases
Knowledge Builder	Researcher, Design for Six Sigma Engineer, Statistician, or Data *Miner*	Compile and Study Phase
Knowledge Holder	Expert (Primary Product and Mfg Processes)	Collaborate, Innovate & Capture and Apply & Re-use
Knowledge Tool Maker	Knowledge-based Engineer, Knowledge-based and Artificial Intelligence Software Developers	Plan & Deploy (Tools support the deployment)
Knowledge Worker	Employee working directly on the primary product of the enterprise.	Apply & Re-use
Knowledge Supporter	Employee working, indirectly on the primary product of the enterprise, to provide supporting data and information.	Compile & Study
Knowledge Innovator	Inventor, Product Development Scientist or Engineer	Collaborate, Innovate & Capture

Table I – Knowledge-to-Traditional Resource Alignment

5. Knowledge Arena Benchmarking. The fifth discipline within the knowledge management domain acknowledges the benefit and critical role of benchmarking. **Benchmarking** (5.0) is the process of acquiring and classifying data and information as well as promoting that information to *intelligence* through *inference*. Refer to Appendix, Attachment VI, p. 32, for delineation between data, information, intelligence and knowledge. In any type of business, having access to maturing technologies, competitive product assessments, proposed legislation and regulations is imperative. In order for an entire enterprise to leverage benchmark results, the enterprise must first employ a common taxonomy for classification. Second, the benchmarking must reflect the content and context of the enterprise's knowledge base.

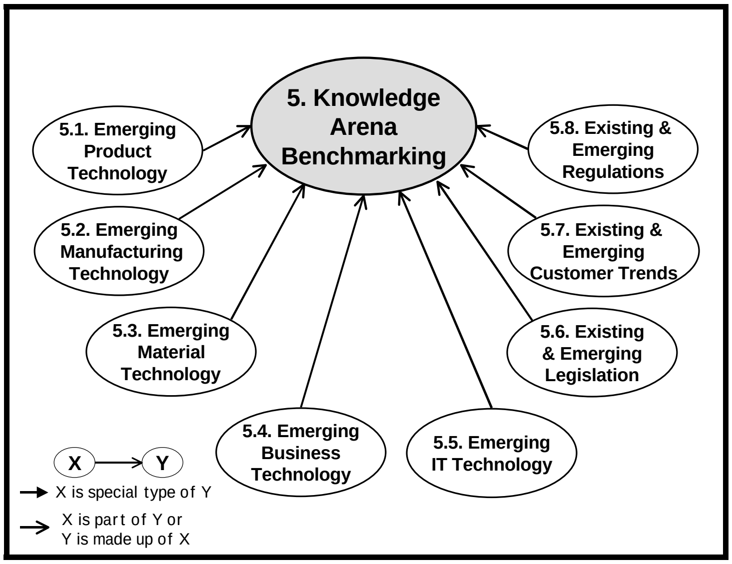

Figure 6 – Knowledge Arena Benchmarking

Benchmarking is the first line of defense to maintain relevant and competitive knowledge for any of the 7 knowledge arenas. The following dimensions, modeled in Figure 6, comprise the Knowledge Arena Benchmarking Discipline…

5.1 Emerging Product Technology,
5.2 Emerging Manufacturing Technology,
5.3 Emerging Material Technology,
5.4 Emerging Business Technology,
5.5 Emerging IT Technology,
5.6 Existing and Emerging Legislation,
5.7 Existing and Emerging Customer Trends, and
5.8 Existing and Emerging Regulations

Benchmarking adds a supporting context to an enterprises' explicit knowledge through real examples or data. This context should enhance the comprehension and understanding of the knowledge or content as described in the next Discipline 6.

6. Knowledge Arena Content Management. The essence of KM is captured in the sixth discipline – managing explicit knowledge or content management. This discipline is made up of 6 dimensions, which are listed below and modeled in Figure 7…

6.1 Classifications (labels or tags),
6.2 Knowledge Modeling (relationships and attributes),
6.3 Topics (subjects),
6.4 Granularity (size or quantity),
6.5 Domain Views (knowledge landscape) and
6.6 Structure (inclusive content).

Classifications (6.1) or taxonomy are labels used to group or categorize, in this case, explicit knowledge. One of the most important levers in sharing and re-using knowledge is a steady state, non-changing taxonomy. If an enterprise can establish a common taxonomy for each knowledge holder to label their content, then anyone in the enterprise can quickly retrieve groups of related data, information and knowledge using these labels. Generally taxonomies are hierarchical in nature. The content is categorized over multiple levels in only one arbitrary arrangement.

The next dimension moves beyond a simple hierarchy to modeling multi-dimensional relationships and attributes. This science is referred to as ontology. This specialty is **knowledge modeling** (6.2). The authors have applied this modeling technique to the knowledge management domain as shown in Figures 1 through 9. The models delineate between *a-special-type-of* and *a-part-of* or *made-up-of* relationships. For example in Figure 7, Knowledge Arena Content Management is *made up of* Classifications, Knowledge Modeling, etc. Referring to Figure 5, we find that Knowledge Holder Allocation (4.5.3) is a *special type of* Knowledge Resource Allocation (4.5). A subject matter expert might be able to infer these relationships from a hierarchical arrangement, but a knowledge model explicitly captures and delineates the relationships.

The third dimension is simply **Topics** (6.3), or general subjects the enterprise intends to capture. All of the topics should be from a preventive perspective, not corrective like lessons learned typically are. For enterprises whose primary product is physical in nature, the topics fall into 8 categories…

a. Performance decomposition or allocation (Performance),
b. Performance balancing (Performance-to-Performance),
c. Feature-to-Performance relationships,
d. Feature-to-Feature-to-Performance (Interfaces),
e. Feature decomposition,
f. Overviews or Summaries
g. Design Guidelines and
h. Application Guidelines.

The first of a quintet (a-e) of topics addresses either the decomposition of an aggregate performance (an overall performance made up of several performances) or the allocation of a performance across more than one system or subsystem within a physical product. The next topic (b) explains a means to balance competing performances. The third topic (c) is *gold* and captures the relationship between product features and desired product performances. Knowing what features create a desired performance provides first-time design capability. Every feature has a function, some are desired, and some are not. The fourth topic (d) addresses interfaces or feature-to-feature relationships that in turn control desired physical product performances. The final topic (e) of this quintet is decomposing or breaking down a physical product into its various features.

The sixth topic (f), Overviews, become necessary to summarize or to *over-view* an area of interest requiring one or more of the quintet topics. Guidelines (g) are *knowledge shorthand* for experts. Characteristically, guidelines are bulleted lists of generalities or mental ticklers to remind an expert what not to overlook. Guidelines are to be encouraged and often are the first step in drafting more explicit and inclusive knowledge. The last topic (h) listed is Application Guidelines that describe how to select one design over another for a specific application.

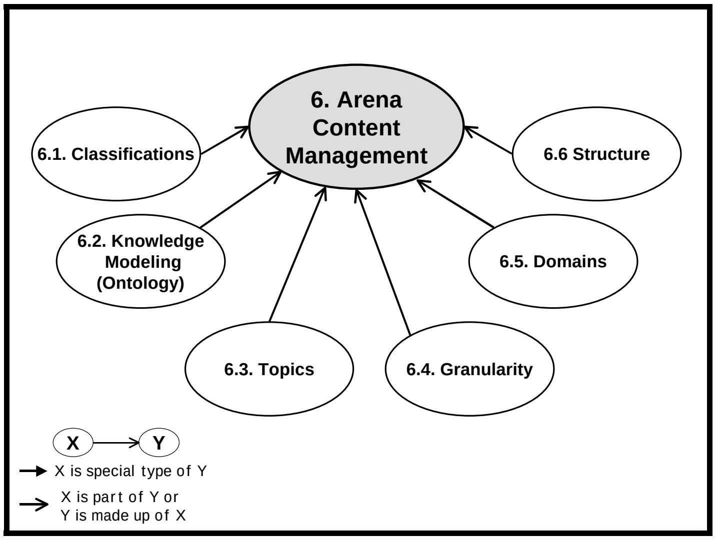

Figure 7 – Arena Content Management

You may ask why not just write one all encompassing document? The answer leads us to the next specialty, **knowledge granularity** (6.4). At General Motors, we refer to our knowledge topics as knowledge nuggets. The word nugget infers *gold nuggets* or real assets. Other organizations refer to their focused topics as *knowledge atoms* or golf ball-size knowledge. One of the advantages of knowledge nuggets, especially if storing in a knowledge base, is re-usability. A nugget of knowledge, which is common to multiple topics, can be captured once and referenced (pointed to) a hundred times. Another advantage of knowledge nuggets is the author's reward of accomplishment. Converting tacit knowledge into relevant, easily understood and readily applied explicit knowledge can be grueling. Breaking this task up into small topics allows the opportunity to complete 2 or 3 topics over the course of a couple of weeks rather than one large effort taking months. Smaller topics often prove to be less controversial and more readily approved by a group of peers. Providing a clear and concise context for a knowledge nugget generally is easier. Most importantly, the Knowledge User or Worker does not necessarily need to read everything that is written about an area of interest, rather can search or navigate quickly to the relevant nugget.

Domains (6.5) are the fifth dimension of Content Management. A domain is a sphere of activity, a sphere of concern or function — an expert's field of practice. A domain view is the landscape of the domain, a grouping of knowledge nuggets.

A domain view may be physical, performance or process centric. More than one view may be appropriate, tailored for different perspectives or occasions. We could create a Domain View of Knowledge Management by combining Figures 1 through 9. The simplest form of a domain view is a list of knowledge nuggets. Increasing complex domain views progress from a list to an outline or hierarchical list, then to graphical view (org chart-like) possibly including decisions paths and finally an object-like, multi-dimensional model. There are at least 5 reasons to construct a domain view…

a. Raises the author/user's conscious awareness of their domain,
b. Identifies the total number of knowledge nuggets to be captured,
c. Identifies common or redundant nuggets,
d. Identifies knowledge voids where knowledge does not exist, and
e. Provides a means to navigate, find or retrieve knowledge nuggets.

The final dimension of Content Management is **knowledge structure** (6.6). The objective of structuring knowledge is to ensure inclusive capture, fast retrieval, sharing and re-use. The structure the authors are currently using is domain independent. The structure is tailored to the 8 knowledge topics previously discussed in this section and is currently being used at GM to capture *virtual* product best practice documents.

Sections	Rationale
1. Title and Abstract	What (Clear and concise)
2. Description	What (Detail)
3. Conditions	When
4. Formulas	Rule
5. Consequences	Why
6. Sources	Who
7. Classifications and Key Words	Retrieval Labels
8. Examples	Where
9. Supporting Data	What (secondary)
10. Approvals	Who

Table II – Knowledge Structure

The knowledge structure consists of 10 sections listed in Table II. The title, abstract and description are increasingly more detailed presentations of the knowledge. The conditions define the context of the knowledge. Where appropriate the knowledge may additional be represented as a rule or formula. The impact on the organization for deciding not to use the knowledge is captured as consequences. The authors, technical reviewers and references are included as sources. Labels and keywords used for retrieval are grouped as classifications. Whenever possible, examples of where the knowledge has been applied is captured. The supporting data structure is a miscellaneous category. The final section identifies the approver. Depending on the topic, all 10 sections may not be required . See Appendix, Attachment VII, p. 33, for section requirements by topic.

7. Learning Organization.

Goodes states…

> "KM is at least as much about changing culture as it is about improving systems; the key is recognizing that both move in tandem. Culture change without system change leads to frustration and backsliding. System change without culture change will kill both profits and morale". [Goodes, 2003, p. 14]

A predominant domain in and of itself, Senge's Learning Organization is essential to the Knowledge Management Domain. For the purposes of this paper, we refer to the learning organization domain as a discipline and the 5 disciplines as specialties. Several aspects of a learning organization are crucial to sustaining a knowledge-based, learning organization.

> First "…people at all levels, individually, and collectively, are continually increasing their capacity to produce results they really care about".

> Second, learning organizations are "…characterized by its clear and consistent 1) openness to experience, 2) encouragement of responsible risk taking and 3) willingness to acknowledge failures and learn from them..." [Lapides, 1990, p.1]

The third aspect is the continual sharing of information and knowledge between employees at all levels. The fourth aspect is the basic meaning of a learning organization defined by Senge as…

> " an organization that is continually expanding its capacity to create its future." [Senge, 1990, p. 14]

The Learning Organization is modeled in Figure 8. The model reveals this discipline to be made up of 6 specialties. The first 5 specialties are attributed to Peter Senge and the sixth specialty is attributed to Gary Salton.

Personal Mastery (7.1) is being a life long learner, internalizing values and goals and balancing personal and work life. As a life long learner each individual is continually aware that the root of their personal mastery is their values and conviction to live up to those values. Masters understand and leverage structural conflict -- the creative tension pulling them towards their vision and the emotional conflict holding them back and anchored by 5 perceived *demons*. The 5 demons are listed in the Appendix, Attachment IX, p.35. Further more, Masters discard the 3 traditional ineffective structural coping strategies of…

a. Increasing the creative tension with fear of failure or reprisal
b. Increasing the creative tension through shear willpower, or
c. Reducing both emotional and creative tension by eroding your vision

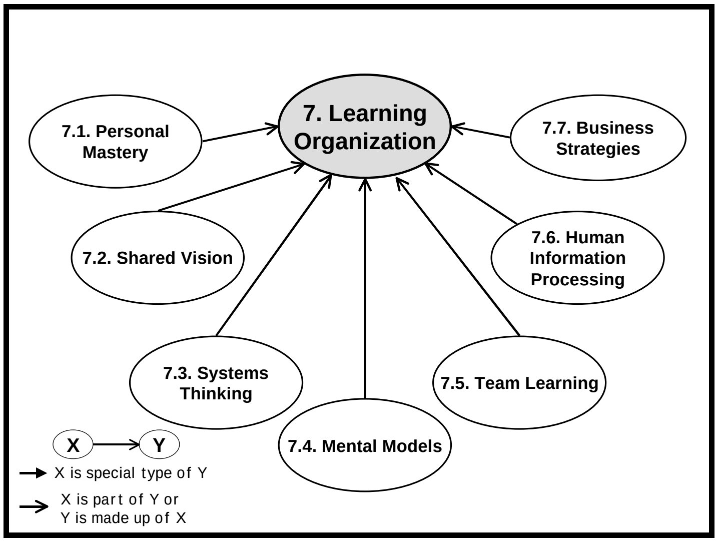

Figure 8 – Learning Organizational Discipline Model

…for 3 effective mastery approaches...

a. Reduce emotional tension by re-evaluating mental models of powerless or unworthiness, challenge the 5 *demons*,
b. Increase the creative tension by limiting the uncertainty of the vision through scenarios and role playing, and
c. Review the truth of the current reality altering mental models to create a state dissatisfaction.

The 3 ineffective coping strategies and the 3 mastery approaches are overlaid in Robert Fritz's original Structural Conflict Model. Refer to the Appendix, Attachment VIII, p. 34. The antidotes to the 5 *demons* are included in the Appendix, Attachment IX, p. 35.

A **Shared Vision** (7.2) is not a vision statement published by management. A shared vision has shared meaning amongst management and employees achieved through dialog. Shared meaning creates a collective sense of what is important and why. This collective sense ensures effective employee empowerment. A shared vision is a unification of individual visions not a mandate. Enrollment and commitment to a shared vision is by individual choice.

> Visions that are truly shared take time to emerge. They grow as a by-product of interactions [through dialog] of individual visions. Experience suggests that visions that are genuinely shared require ongoing conversation where individuals not only feel free to express their dreams, but learn how to listen to each other's dreams. Out of this listening, new insights into what is possible gradually emerge. [Senge, 1990, pp. 217-18]

Systems Thinking (7.3) looks beyond events and does not react to them. System thinking sees the structure behind the pattern of events. System thinkers suppress the traditional perception of sequential patterns looking for the *dynamic complexity* of the situation rather than just focusing on the *detail complexity*. Dynamic complexity is the phenomenon of a given action having different short-term and long-term effects. This phenomenon is obscure and confound due to 1) the length of time between action and the long-term, often unintended consequence, and 2) our training to observe immediate cause and effect relationships. Systems thinkers consider the possibility of longer-term consequences because of the complexity and detail of short-term consequences, hence the term detail complexity. [Senge, 1990, pp. 72]

Referring to Attachment X, Appendix, p. 36, illustrates Carl Jung's [Jung, NA, pp. 9-55] mental model of systems – the Iceberg Model. This model, like an iceberg, suggests that events observed are only on the surface. System thinkers *submerge* into a system to learn and leverage what is unseen and not easily observable like:

1) the patterns of behavior – past events, trends and corrective actions taken;
2) the underlying structures – roles, procedures, practices and interrelationships; and
3) the mental models – beliefs about the system and each other.

In order to *surface* the iceberg, system thinkers need to be proficient with modeling *links and loops* that comprise all structures. There are several other system model archetypes that have been modeled and which are readily available but beyond the scope of this paper. [Kim, 1994, pp. 2-27] Systems thinking is about 1) looking beyond events, 2) reflecting on structure, 3) identifying loops, links, patterns, interactions and 4) being aware that beliefs and structure produce behavior.

Mental Models (7.4) are individually held internal pictures of a world which should be shared not imposed on each other. Often the spoken word and espoused theories do not align with what is really believed and practiced. [Senge, 1994, p.175] Beliefs control our actions and behavior. To change behavior for the long term, beliefs must be modified. Individual beliefs and mental models can be discovered through dialogue and inquiry. To facilitate dialogue between one or more individuals, individual assumptions, certainty and judgments must be suspended. Any inquiry must come from a true sense of not knowing while demonstrating respect for the diversity and different perspectives. Individual beliefs may be advocated with an appropriate balance of inquiry. Be reminded to first improve your own mental models, then contribute to others' mental models best demonstrates leadership. [Senge, 1990, p. 240-244]

Team Learning (7.5) is one of several essential ingredients to sustain a team or community of practice.

> "Team Learning is vital because teams [communities of practice], not individuals, are the fundamental learning unit in modern organizations...unless teams can learn, the organization cannot learn." [Senge, 1994, p. 10]

Team Learning is significantly different then team building. Team building may develop individual skills like…"creating courteous behaviors, improving communications, becoming better able to perform everyday work tasks together, or even building strong relationships." [Senge, 1994, p.355] Team learning is far more enduring …"transforming conversational and collective thinking skills, so that groups of people can reliably develop intelligence and ability greater than the sum of individual members' talents." [Senge, 1994, p.6] Team learning is a collective phenomenon. Each team member is aware of their partners' aspirations, assumptions, capabilities and uniqueness. Each team member experiences a… "sense of occupying a collective sensibility, in which the thoughts, emotions, and resulting actions belong not to one individual, but to all of [us]..." [Senge, 1994, p. 358] Team learning is 1) intelligence and ability greater than the sum of individuals, 2) a collective sensibility, 3) thinking together through dialogue, inquiry and reflection and 4) a shared understanding.

There are 5 reasons for establishing teams …

1. Teams can handle formidable challenges that an individual could not,
2. Teams leverage cross-functional skills,
3. Teams provide access to different perspectives,
4. Teams can improve efficiency through multi-tasking, and
5. Under the correct environment, teams will produce synergy, where the outcome is greater than the sum of the parts.

Human Information Processing is another essential ingredient in sustaining a team or community of practice. Human Information Processing (7.6), a specialty within the Organizational Engineering Domain, is considered as a core competency in this paper. The human information-processing model encompasses how people acquire, process and apply information while conducting their lives. The mathematics underlying the model suggests the relative ease individuals will likely incur when working together, including the vulnerabilities and misunderstandings inherent in team relationships. The model may also predict the most likely outcome of their interactions if not influenced by external intervention. [Salton, 1996, pp. 7-17]

Organizational Engineering theory is based on human information processing, a sociological phenomenon, not the psychology of understanding, measuring and predicting human behavior. [Salton, 1996, p. 8] Attachment XI, found in the Appendix, p. 37, compares this sociological instrument or questionnaire used to predict an individual's information preference to the popular Myers-Briggs psychological instrument.

Organizational Engineering technology provides a means to select and align team members to effectively address a common purpose. Team effectiveness is *immediate* because people do not have to change. Organizational engineering addresses how we prefer to process information. We have to make decisions. We recognize the cost of continuously deciding how to decide. Therefore, we adopt and apply a preferred decision strategy. For example consider the decision for -- What should you wear today? You might use any of the 4 strategies listed below…

1. Grab the first thing I see,
2. Analyze the day I expect to have,
3. Select a creative or innovative outfit or
4. Follow pre-defined dress code.

Did you decide on a strategy first, then select what to wear, or did you just select what to wear? Most likely you just selected what to wear without thinking about the strategy that you have already adopted.

Typically an individual will adopt a primary and secondary strategic posture. An individual's primary and secondary strategic postures can be mapped into one of four strategic patterns or decisions strategies. Your preferred decision strategy defines the...

1. The amount of input information you require,
2. The kind of input information you prefer,
3. The method you use to process information and
4. The action you will typically take.

Understanding and leveraging the similarities and differences in each other's decision strategies improve our interpersonal communications and team performance. [Salton, 1996, pp. 7-17]

The seventh dimension of this discipline is **Business Strategy** (7.7). The business strategy of an organization has a great deal to do with how well an organization is able to implement the goals of Knowledge Management. The authors have focused in on the following 3 business strategies and 2 transitional states as being the most prevalent. The strategies and transitions are:

- Command & Control
- In transition from Command and Control to Quality Enhancement
- Quality Enhancement (Sharing)
- In transition from Quality Enhancement to Innovative
- Innovative (Innovating)

Investigating the different types of business strategies we discovered the most successful KM implementation has occurred in an appreciative environments where...

1. Discovering the best of,
2. Understanding what creates the best of,
3. Amplifying the people and processes who best
   exemplify the best of, [Adamson, Handford (2002) p.487]

…is the organization's default behavior. Appreciative environments are more likely to occur where Quality Enhancement or Innovative strategies have been implemented.

According to W. Richard Scott, organizations take on basically three major forms, the Rational (Command and Control), Natural (Quality Enhancement) and the Open System (Innovative). For an implemented Rational strategy, organizations develop in order to achieve goals beyond the reach of individuals. "Organizations are a cooperation among men that is conscious, deliberate, and purposeful. (Barnard 1938:4)." [Scott (1998) p.4] Organizations applying the business strategy of Command and Control have specific goals and a formalized structure by which to govern the behaviors of the organization. [Scott (1998) p.33]

The Natural strategy primarily appears in the transitional state of Command Control to Quality Enhancement. The focus is mainly on behavior and the complex inter-actions. For the Natural, the emphasis is more on the organizational structure than on the prescribed rules, job descriptions and the associated regularities in behavior. [Scott (1998) p.59] Gene Mage points out "within a culture of excellence an organization embraces shared expectations for high performance. Everybody holds themselves and others accountable for doing things the right way." The Command and Control/Quality Enhancement business strategy transition is a blend that still exhibits many command and control behaviors with the addition of quality assurance and quality management beginning to emerge.

To shift an organization to a true Quality Enhancement strategy, "…the organization focuses on sustainability which is defined as the ability of an organization to adapt to change in the business environment, to capture contemporary best practice methods and to achieve and maintain superior competitive performance." [Zairi, Liburd (2001) pp.452-461] Total Quality Management, TQM, becomes the prevalent practice and knowledge management techniques can be applied to improve the organization's performance.

The final business strategy is known as the Open or Innovative strategy. This strategy stresses the interdependence between several organized parts. Implemented Open strategies are capable of self-maintenance. While there are few examples of this type of environment, innovation driven companies have the ability to reuse and innovate on explicit knowledge and realize that the innovation of a product is only the first step in a long process. Generally these firms have long time horizons and plan for the long haul. J. Nemec Jr. points out "to enhance its returns a corporation must rely on its ability to exploit its innovations." [Coffinet, Nemec (1992)] When an organization decides to implement a business strategy of innovation, the organization must be mindful of their social structure, their knowledge-base richness and the competitiveness of their benchmarking intelligence. Their intention is always to leap frog, not just to incrementally innovate.

To move from a Command and Control strategy to an innovation strategy requires a great deal of leadership commitment and the organization's understanding of the fundamental cultural changes that will need to occur. The fundamental cultural change is moving from controlling each other to appreciating each other's diversity of perspective and experience while sharing. "A successful Knowledge Manager becomes a facilitator who helps to determine what conditions made excellence possible and how this could encourage those conditions within the organizational culture." [Adamson, Handford (2002) p. 486]

8. Enterprise-wide Knowledge Socialization. Organizational knowledge socialization occurs continually, and should begin again each time an employee or manager transitions into a different role. There are four dimensions for this discipline – knowledge socialization objectives, phases, strategies and inclusiveness or involvement. Refer to Figure 9. The process of *learning the ropes,* socialization, will reduce ambiguity about knowledge roles and ensure that both the employee and enterprise continue to be successful.

We have adopted Gordon's **socialization objectives** (8.1) for the first dimension. [Gordon, 1991, pp.103-4] The knowledge socialization objectives are to convey the…

a. Basic knowledge-based goals,
b. Preferred means to attain goals,
c. Basic knowledge-roles and responsibilities,
d. Effective knowledge-role performance behavior,
e. Rules or principles to maintain the enterprise's identity and integrity,
f. Meaning of Enterprise Symbols and Rituals, and
g. Meaning of Enterprise events.

Gordon has identified 3 **socialization phases** (8.2), the second dimension, to socialization within an enterprise – anticipation, breaking-in and settling phases. [Gordon, 1991, p.202] Transitioning from one phase to the next occurs when the following accomplishments have occurred respectively…

1. Realistic expectations are acknowledged (ends the Anticipating Phase),
2. Familiarization and initiation have been experienced (completes the Breaking-in Phase), and continually
3. Balancing life interests, enterprise demands and knowledge resolution process, (ends the Settling-in Phase).

The third dimension is knowledge socialization **strategies** (8.3). Gordon has defined 7 strategies that could be employed to socialize new and transferred employees or managers/executives. [Gordon, 1991, pp. 104-5] The strategies are summarized in the Appendix, Attachment XII, p. 38.

The final dimension addresses the **inclusiveness of the knowledge socialization** (8.4) . Without any hesitation, socialization is a continuous process that must occur each time a new employee or manager/executive enters the enterprises or is or transferred within the enterprises. With appropriate strategies and a continuous socialization process any enterprise will be able to sustain a knowledge-based, learning organization.

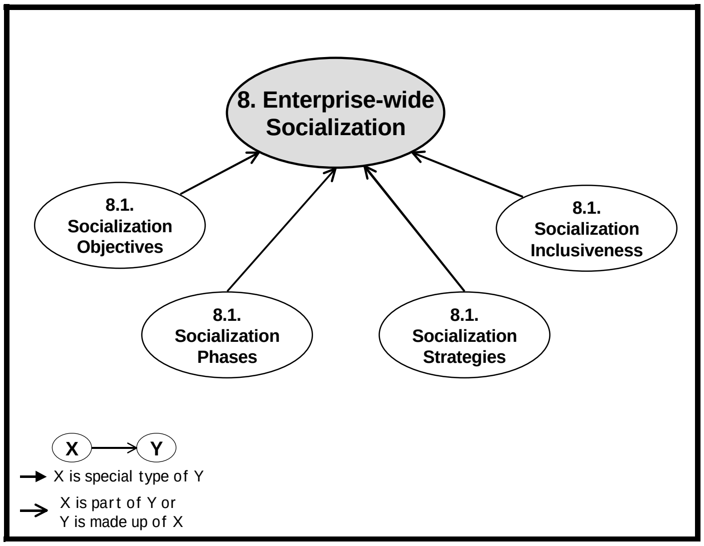

Figure 9 - Enterprise-wide Knowledge Socialization

Using the Domain Definition as an Appraisal Tool. In order to appraise an enterprise-wide KM initiative each discipline and subsequent specialty, or dimension, should be separately evaluated for each Knowledge Arena (Discipline 1). Referring to the Appendix, Attachments II - V, the authors have created a table for Disciplines 2 through 8. Along the left-hand column of each table the discipline is listed followed by the appropriate list of specialties or dimensions. For each specialty a weighting number is suggested, where 10 indicates the most important specialty within that discipline.

The middle 5 columns of the table list maturity metrics, increasing maturity or complexity from left to right. A group of metrics for a given specialty creates a maturity spectrum. For each specialty, the threshold of KM project initiation is identified as well as the threshold of KM sustainability.

The 7 columns along the right-hand side of the table are KM Domain core competencies. The competencies included are…

1. Appreciative Inquiry,
2. Organizational Engineering,
3. Program Management,
4. Organizational Change & Development,
5. Computer Science,
6. Ontology, and
7. Metaknowledge.

Figure 10 illustrates the table construction, Disciplines 2 through 8, the metrics and core competencies for each knowledge arena listed within Discipline 1. The tables can be used as an assessment tool by identifying an organization's current state in each spectrum. Noteworthy, when attempting to use the Domain definition as an assessment tool be aware that some spectra may need to be tailored to a specific phase of the knowledge-based, learning model. The authors have mapped each discipline and specialty/dimension to one or more of the learning model phases in the Appendix, Attachments XIII - XV. Using the same construct, the domain definition could be used as a tactical or strategic KM planning checklist.

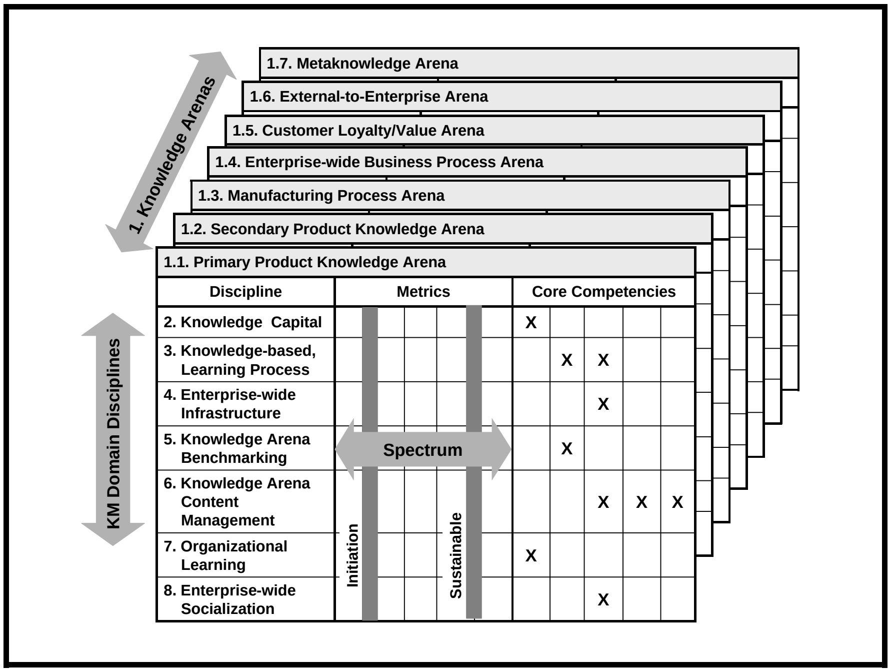

Figure 10 – Reconfiguring the Disciplines for Assessment

A closing comment on the first core competency, Cooperrider's Appreciative Inquiry, when mastered becomes a state of mind – a positive, appreciative state of mind. Adamson and Handford have captured the intersection of KM and Appreciative Inquiry stating, "…Appreciative Inquiry theory is well positioned to be re-evaluated in becoming a tool of facilitating organizational understanding by replacing the traditional negative approaches such as 'gaps' and 'needs' analyses." [Adamson, Handford (2002) p.487]

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Ref. No.	Author	Framework Model Name	Framework Element Name	Knowledge Management Domain Discipline Number
3	Chase Know_ Network	Knowledge Performance Dimensions	Enterprise Knowledge Culture	7.1 - 7.6
			Top Management Support for managing knowledge	4.2
			Knowledge-Based Goods/Services Delivery	3.1
			Maximizing the Value of Enterprise's Intellectual Capital	3.1 & 4.11
			Knowledge Sharing Environment	4
			Continuous Learning Culture	7.1 - 7.6
			Managing Customer Loyalty/Value Knowledge	2.4
			Generating Shareholder Value by managing knowledge	4.11
11	Lai & Chu	Activities (Stages)	Initiation	1. - 8.
			Generation	3.3.1
			Modeling	6.2
			Repository	4.6
			Distribution and Transfer	3.2.2
			Use	3.2
			Retrospect	4.11
		Influences	Organizational Adaptability	7.6
			Reward & Incentive Systems	4.1
			Leadership	4.2
			Measurement (Metrics)	4.3
			Value and Norms	8.1
			Culture	7.1- 7.6
			Technology	4.6, 4.8 - 4.10
			Education	Competencies
			Knowledge Architecture	6.2
22	Weidner KMPro	KM Universe Model	Learning (Life-Long Learning)	7.1- 7.6
			People (Motivated/Empowered)	7.1- 7.6
			Leadership (Vision/Purpose)	4.2
			Emerging Technology (Embedded in Product/Services)	5.1-5.8
			Applied Technology (Enabled Innovation)	4.6, 4.8 - 4.10
			Work/Processes ("Better" Practices)	3.1-3.4
			KM Methodology	1-8

Ref. No.	Author	Framework Model Name	Framework Element Name	Knowledge Management Domain Discipline Number
7	Holtshouse Xerox	Slide 5 - Framing Knowledge Management 10 Domains	Sharing Knowledge & Best Practices	3.1-3.2
			Instilling Responsibility for Knowledge Sharing	4.1
			Capturing & Reusing Past Experiences	3.3
			Embedding Knowledge in Products, Services & Processes	3.2
			Producing Knowledge as a Product	3.3
			Driving Knowledge Generation for Innovation	3.3
			Mapping Networks of Experts	2.1
			Building & Mining Customer Knowledge Bases	2.4
			Understanding & Measuring the Value of Knowledge	4.11
			Leveraging Intellectual Assets	4.11
13	O’Dell APQC	APQC Framework Model	Infrastructure	4.1 - 4.11
			Culture	7.1 - 7.6
			Technology	4.6, 4.8 - 4.10
			Measure (Metric)	4.3
18	Stanksoky Calabrese Baldanza GWU	Knowledge Management Pillars	Leadership	4.1, 4.2, 4.8
			Organization	4.5
			Technology	4.6, 4.8 - 4.10
			Learning	3.1 - 3.4
2	Bennet Dept of Navy	DoN Knowledge Management Framework	Content	6.1 - 6.6
			Process	3.1 - 3.4
			Culture	7.1 - 7.6
			Learning	3.1 - 3.4
			Technology	4.6, 4.8 - 4.10

Discipline	Specialty	Wt	Continuum (Spectrum of Metrics)					Core Competencies						
			1	2	3	4	5	Apprecia-tive Inquiry	Organiza-tional Engineering	Program Manage-ment	Organiza-tional Change & Develop-ment	Computer Science	Ontol-ogy	Meta-knowl-edge
2. Knowledge Capital (Sources)	2.1. Human Capital (People, Tacit)	10	Novice	Novice with Run Guide	Apprentice with SME	Experienced w/o SME	SME	X						X
	2.2. Organizational Capital (Explicit)	10	None	Checklists	Work Instructions or Work Flow	Wizards	Integrated Work Flow	X						X
	2.3. Commercial (Saleable) Knowledge	4	Library	Internet & Infranet	Knowledge Subscriptions	Integrated Knowledge Subscriptions	*Pushed* Integ. Know. Subscriptions	X						X
	2.4. Customer Capital (Tacit & Explicit)	10	Customer List	Brand ID Reputation	Customer Service & Warranty Policies	Customer Feedback & Clinics	Customer User Groups	X						X
	2.5. Supplier/Partner Capital (Tacit & Explicit)	10	None	Supplier Partner On-site	Supplier Partner Knowl-edge-base	Shared Knowl-edge-base	Integrated Bi-Lateral Pushed Knowledge	X						X
	2.6. Public Domain Capital (Explicit)	4	None	Access Public Libraries	Access Profes-sional Libraries	Access University Libraries	Published, Filtered Knowledge	X						X

Threshold of Initiation

Threshold of Sustainability

Discipline	Specialty	Wt	Continuum (Spectrum of Metrics)					Core Competencies						
			1	2	3	4	5	Apprecia-tive Inquiry	Organiza-tional Engineering	Program Manage-ment	Organizational Change & Development	Computer Science	Ontol-ogy	Meta-knowl-edge
3. Knowledge-based Learning Process	3.1 Plan, Deploy Phase	10	Self-Published, Multiple Sources, Non-Structured, Not Validated	Self-Published, Virtual Source, Non-Structured, Not Validated	Team-Published, Virtual Source, Structured, Validated	Team-Published, Virtual Source, Structured, Validated, Filtered	Team-Published, Virtual Source, Structured, Validated, Fil-tered, Delivered	X	X	X				X
	3.2. Apply, Re-Use Phase (Passive Application)	10	Ignored	Worker's Discretion, No Metrics	Worker's Discretion, Passive Metrics	No Discretion with Active Metrics	No Discretion with Active & Quantitative Metrics	X	X	X				X
	3.2. Apply, Re-Use Phase (Active Application)	10	Automated Checker	Standard Modules	Advisor	Wizard (pulls through)	Adaptive	X	X	X		X		X
	3.3. Compile, Study Phase	10	Design of Experiments	Full Text Search	Case-Base Reasoning	Data Mining	Neuro-Nets	X	X	X		X	X	X
	3.4. Collaborate, Innovate & Capture Phase	10	Informal Collaboration, Minimal Capture	Informal Collaboration, "Net Meeting with Discussion Thread"	Formal, Structured Collaboration, Structured Documentation	Informal Innovation, Structured Documentation	*Designed* Innovation, Structured Documentation	X	X	X	X		X	X

Threshold of Initiation

Threshold of Sustainability

Discipline	Specialty	Wt	Continuum (Spectrum of Metrics)					Additional Core Competencies						
			1	2	3	4	5	Appreciative Inquiry	Organizational Engineering	Program Management	Organizational Change & Development	Computer Science	Ontology	Meta-knowledge
4. Enterprise-wide Infrastructure	4.1. Reward & Incentive Systems (Knowing/Applying)	10	Rewarding Hording Trial & Error	Mix of 1 & 3	Rewarding Sharing & Problem Solving	Rewarding Sharing, Problem Solving & Reuse	Rewarding Innovation & 4	X	X		X			
	4.2. Leadership (Knowledge Responsibility)	10	None	Champion	CIO	CKO	CEO	X	X		X			
	4.3. Relevant Measurement (Metrics)	8	None	Number of Lessons or Practices Documented	Number of Peer Reviews conducted & Knowledge Applied	Quantitative measure of existing and new knowledge content in Primary Product	Correlation between Knowledge Re-use and decreased Structural Expenses	X		X				X
	4.4. Knowledge Communications	10	None	Website Posting	Newsletter	Regular Agenda Item	Knowledge Forums	X	X		X			
	4.5. Allocation of Resources - People (Utilization = Dedicated Time)	10						X	X	X	X	X	X	X
	4.5.1. Knowledge Asset Manager		None	25% ≤	50% ≤	75% ≤	100% ≤							
	4.5.2. Knowledge Builder (Design for Six Sigma *Black Belt*)		None	25% ≤	50% ≤	75% ≤	100% ≤							
	4.5.3. Knowledge Holder		None	25% ≤	50% ≤	75% ≤	100% ≤							
	4.5.4. Knowledge Tool Maker		None	25% ≤	50% ≤	75% ≤	100% ≤							
	4.5.5. Knowledge Innovator		None	25% ≤	50% ≤	75% ≤	100% ≤							
	4.5.6. Knowledge Worker		None	25% ≤	50% ≤	75% ≤	100% ≤							
	4.6. IT Infrastructure	8	Internet Intranet	Document Management	Net Meeting Discussion Threads	Gold Source Taxonomies	Knowledge-base & supports multi-media	X				X		
	4.7. Core Competencies (Training, Education)	8	OJT	eTraining	Professional Certification	Advanced Degree	Advanced Degree & License	X	X	X	X	X	X	X
	4.8. Budget	10	4% Operating Budget	11% Operating Budget	18% Operating Budget	25% Operating Budget	33% Operating Budget	X	X	X				
	4.9. Facilities	8	Conference Rooms	Conference Rooms with a dedicated projector	Dedicated Collaboration Rooms multi-media presentation ready	Dedicated Collaboration Rooms simultaneous presentation ready	Dedicated Collaboration Room multi-media capture ready	X	X		X			
	4.10. Equipment & Software	10	Assigned Computer & MS Professional	Assigned Laptops & MS Professional	Capture Software Suite	Digital Cameras & Software	Video & Audio Software Suite	X	X			X		
	4.11. Knowledge Asset Ledger	5	Cost of Minimal Documentation	Vignettes	Ledger	Collateral	Currency	X	X					

Threshold of Initiation

Threshold of Sustainability

Discipline	Specialty	Wt	Continuum (Spectrum of Metrics)					Core Competencies						
			1	2	3	4	5	Appreciative Inquiry	Organizational Engineering	Program Management	Organizational Change & Development	Computer Science	Ontology	Meta-knowledge
5. Knowledge Arena Benchmarking	5.1. Emerging Product Technology	10	None	Ad Hoc	Assigned	Notification	Integrated	X		X				
	5.2. Emerging Manufacturing Technology	10	None	Ad Hoc	Assigned	Notification	Integrated	X		X				
	5.3. Emerging Material Technology	10	None	Ad Hoc	Assigned	Notification	Integrated	X		X				
	5.4. Emerging Business Technology	8	None	Ad Hoc	Assigned	Notification	Integrated	X		X	X			
	5.5. Emerging IT Technology	8	None	Ad Hoc	Assigned	Notification	Integrated	X		X		X		
	5.6. Existing & Emerging Legislation	10	None	Ad Hoc	Assigned	Notification	Integrated	X		X				
	5.7. Existing & Emerging Customer Trends	10	None	Ad Hoc	Assigned	Notification	Integrated	X		X				
	5.8. Existing & Emerging Regulations	10	None	Ad Hoc	Assigned	Notification	Integrated	X		X				

Threshold of Initation

Threshold of Sustainability

Discipline	Specialty	Wt	Continuum (Spectrum of Metrics)					Core Competencies						
			1	2	3	4	5	Appreciative Inquiry	Organizational Engineering	Program Management	Organizational Change & Development	Computer Science	Ontology	Meta-knowledge
6. Arena Content Management	**6.1 Classifications**	**10**	None	Aligned to Primary Product	Aligned to Primary Product and Processes	Gold Sources	Independent, Cross Classification Functionality	X					X	X
	6.2. Knowledge Modeling	**10**	None	Non-Standard Modeling	Traditional Object Modeling	Knowledge (Ontology) Modeling	Knowledge Model creates Knowledge-base	X				X	X	X
	6.3. Topics	**8**	No Delineation	Delineated Topics	Delineated Topics with unique structures	Delineated Topics with shared structure	Cross-classified, delineated & shared structure	X					X	X
	6.4. Granularity	**8**	Ad Hoc	Book	Manuscript, Thesis	Papers & Articles	*Nuggets* of Truth	X					X	X
	6.5. Domains	**10**	Undefined	Lists	Outline	Hierarchy	Object-like	X					X	X
	6.6. Strategy	**10**	Experts Tacit Only	Primarily Tacit-to-Tacit Telling	Primarily Tacit-to-Tacit Coaching	Primarily Explicit-to-Tacit Routine Wizards	Primarily Explicit-to-Tacit Complex Wizards	X					X	X

Note: For Assessments, the spectrum for Strategy may be different for each of the 4 Phases of the Knowledge -based, Learning Model.

Threshold of Initiation

Threshold of Sustainability

Discipline	Specialty	Wt	Continuum (Spectrum of Metrics)					Additional Core Competencies						
			1	2	3	4	5	Appreciative Inquiry	Organizational Engineering	Program Management	Organizational Change & Development	Computer Science	Ontology	Meta-knowledge
7. Learning Organization	**7.1. Personal Mastery [1]** - Life Long Learner - Internalized Values & Goals - Balancing Personal & Work Life	10	Majority are not life-long learners	Majority are consciously aware of their values & goals	Majority have aligned with business values & goals	Majority have internalized business values & goals	Majority are life-long learners	X			X			X
	7.2. Shared Vision [1] - Unified individual visions - Shared meaning amongst partners - Enrollment & commitment by choice	10	Published Vision	Majority can map their annual objectives to vision	Localized enrollment & commitment	Majority enrolled & committed	Majority Partners are enrolled & committed	X	X		X			X
	7.3. Systems Thinking [1] - Looking beyond events - Reflecting on structure - Identifying loops, links, patterns & interactions - Structure affects behavior	10	Majority react to events	Localized reflecting on structure	Localized proficiency with identifying loops, links, patterns & interactions	Majority proficient with identifying loops, links, patterns & interactions	Business structure reinforces System Thinking	X			X			X
	7.4. Mental Models [1] - Our internal picture of the world - To be shared not imposed - Improve one's own models then contribute to others'	10	Mental Models about business are assumed & not shared	Management's shares their Mental Models	Localized dialogue	Forums are encouraged to discover each other's mental models	Mental Models are openly shared (published)	X	X		X			X
	7.5. Team Learning [1] - Intelligence & ability greater than the sum of individuals - Collective sensibility - Thinking together through dialogue, inquiry, listening & reflection - Shared understanding	10	At best, individual learning occurs	Localized team learning is consistently & repeatedly demonstrated	Shared understanding (Learnings) is reinforced with taxonomies	Majority of teams consistently & repeatedly demonstrate learning	Communities of Practice are encouraged and rewarded	X	X		X			X
	7.6. Human Information Processing [2]	10	Majority assume everyone processes information identically	Localized, understanding, analyses and sharing	Management shares their Information processing Preferences	Employees are encourage to share their Information Processing Preferences	All employee Information Processing Strategies are readily accessible	X	X		X			
	7.7. Business Strategy	10	Command & Control (*Telling& Hording*)	In Transition from C&C to QE	Quality Enhancement (*Sharing*)	In Transition from QE to I	Innovative (Innovating)	X	X		X			

[1] The Fifth Discipline. Senge, Peter M., (1990). New York, NY 10036: Doubleday.
[2] Organizational Engineering, Salton, Gary J. (1996)

Threshold of Initiation	Threshold of Sustainability

Discipline	Specialty	Wt	Continuum (Spectrum of Metrics)					Core Competencies						
			1	2	3	4	5	Appreciative Inquiry	Organizational Engineering	Program Management	Organizational Change & Development	Computer Science	Ontology	Meta-knowledge
8. Enterprise-wide Socialization	8.1 Knowledge Socialization Objectives [3]	10	None	1-2 of 7 are addressed	3-4 of 7 are addressed	5-6 of 7 are addressed	7 of 7 are addressed	X	X		X			
	8.2 Knowledge Socialization Phases [3]	10	None are recognized	Realistic expectations are confirmed	Familiarization period is accommodated	Process for the resolution of conflicts is operationalized	Balance between life interests & enterprise demands is rewarded	X	X		X			
	8.3. Knowledge Socialization Strategies [3]	10	None are recognized	1-2 of 7 are used	3-4 of 7 are used	5-6 of 7 are used	7 of 7 are used	X	X		X			
	8.4. Knowledge Socialization Inclusiveness	10	No Socialization Process for new employees	Socialize new Management	Socialize new employees	Socialize reassigned Managers	Socialize reassigned employees	X	X		X			

Threshold of Initiation

Threshold of Sustainability

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[3] A Diagnostic Approach to Organizational Behavior, Gordon, Judith R., (1991), Boston, MA 02194: Allyn & Bacon

Definitions

	Facts or Measurements	Context	Inference	Certainty	Correct Application	Achievement
Data	X					
Information	X	X				
Intelligence	X	X	X			
Knowledge	X	X	X	X		
Wisdom	X	X	X	X	X	
Learning	X	X	X	X	X	X

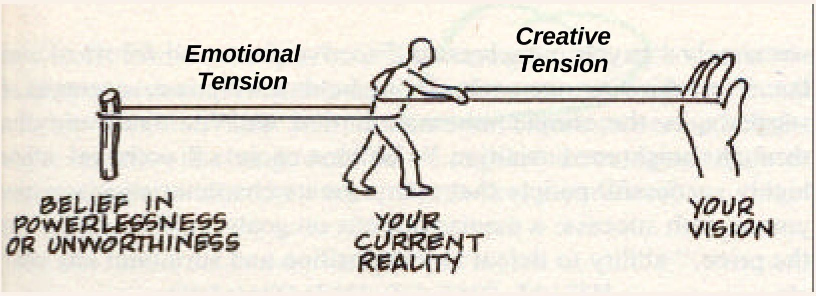
S. Wieneke (2002) **Note: Summarized from C. O’Dell (APQC), V. Barabba (GM) and S. Haeckel (IBM)**

Knowledge Structure versus Topic

Knowledge Structure	Overview	Performance	Balancing	Feature -to - Vehicle Performance	Feature -to - System Performance	Feature -to - Part Performance	Interface or Part -to - Part	Feature List	General Guidelines or Checklist	Application Guideline
Title	x	x	x	x	x	x	x	x	x	x
Description	x	x	x	x	x	x	x	x	x	x
Conditions	x	x	x	x	x	x	x	x	x	x
Formulas		x	x	x	x	x	x			
Consequences	x	x	x	x	x	x	x	x	x	x
Sources	x	x	x	x	x	x	x	x	x	x
Key Words and Classifications	x	x	x	x	x	x	x	x	x	x
Examples		x	x	x	x	x	x	x	x	x
Supporting Data	x	x	x	x	x	x	x	x	x	x
Approvals	x	x	x	x	x	x	x	x	x	x

S. Wieneke (2000)

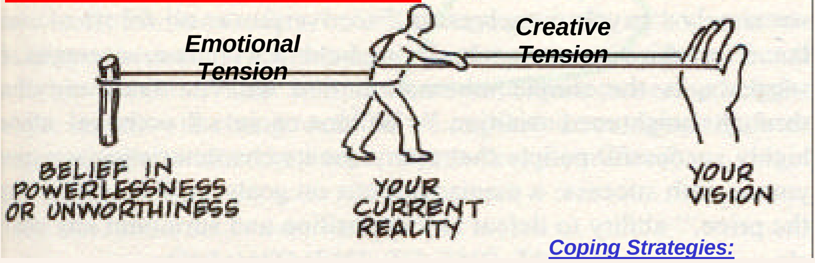
Robert Fritz's Structural Conflict Model



Ineffective Structural Conflict Coping Strategies

Noteworthy, in the long run the 3 typical coping strategies are ineffective at altering the underlying system of structural conflict.

<u>Coping Strategies:</u>
Increase the creative tension by
- ***a. fear of failure or reprisal, or***
- ***b. shear willpower***

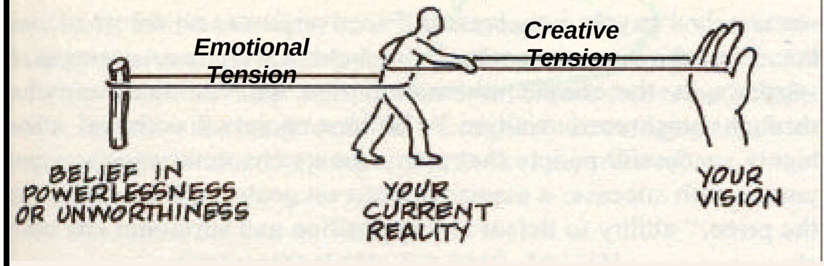


<u>Coping Strategies:</u>
Reduce both tensions by eroding your vision

Suggested 5th Discipline Mastery Approach

<u>Mastery Coping Strategy:</u>
Reduce emotional tension by re-evaluating your mental models of powerlessness or unworthiness.

<u>Mastery Coping Strategy:</u>
Increase the creative tension by limiting the uncertainty of the vision through scenarios and role playing.

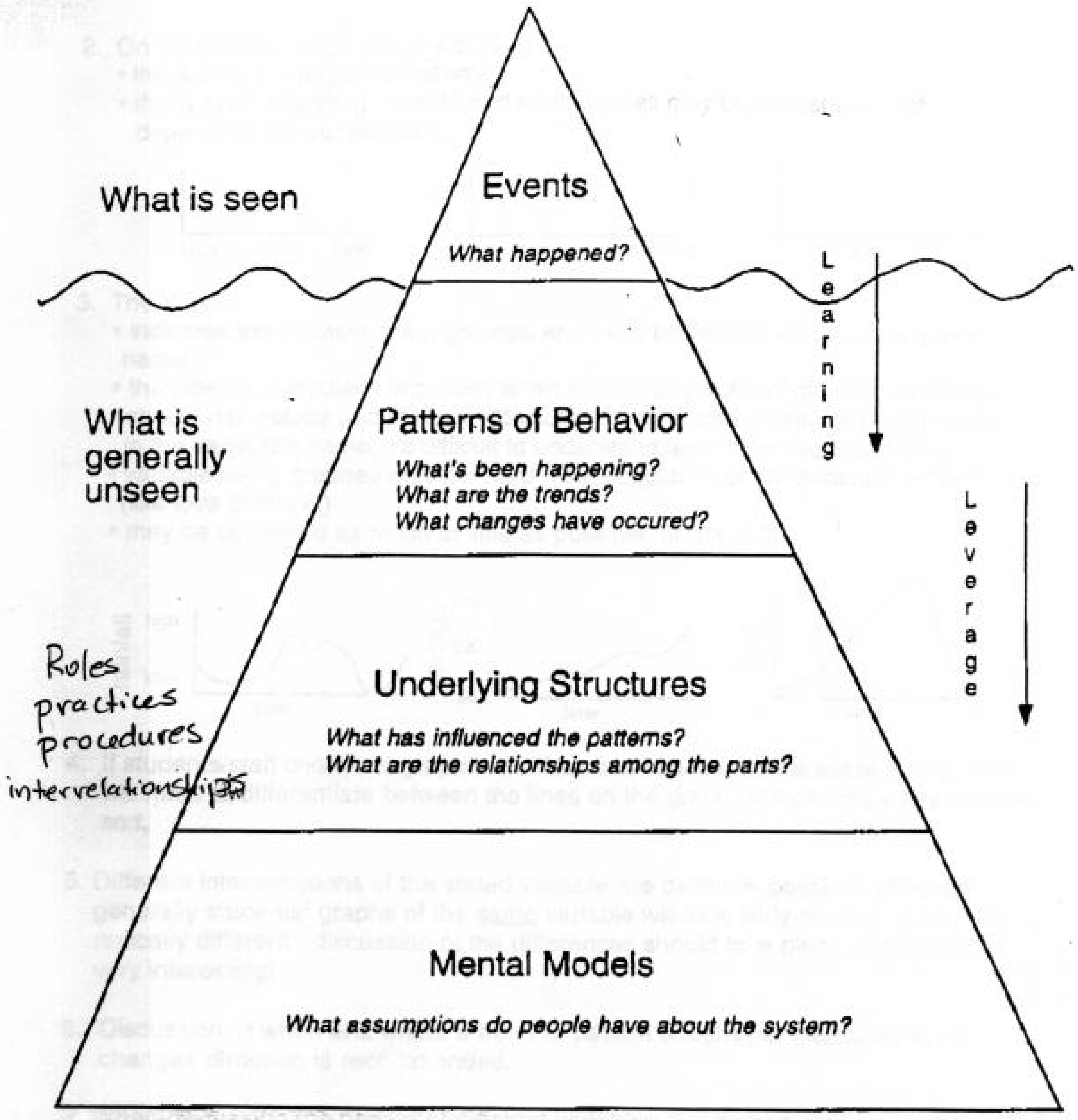


<u>Mastery Coping Strategy:</u>
Review the truth of the current reality altering mental models to create a state of dissatisfaction.

Five Perceived Demons

Demons:	Antidote:
1. Fear of not being good enough	1. You have untapped capacities within yourself
2. Fear of losing control	2. [Trying]…makes new things happen
3. It's a cruel world out there -- life is always a struggle	3. There is generosity all around-all you have to do is ask
4. I am in this all alone - I can't count on anyone but myself	4. There is help everywhere, just ask
5. Fear of losses too great to bear - our own mortality	5. Leaving something behind creates fear of space for something new

IMSE 588 November 8, 1999 Agenda. J. Lapides, Ph. D., (1999). The university of Michigan-Dearborn.



Iceberg...Seeing What's Below the Surface

Adapted from Innovation Associates, Inc.
9/11/97

Comparison

Attributes	Psychology	Organizational Engineering
Basic Instrument:	Myers Briggs Assessment	“I opt” Survey (1)
Respondent’s Orientation:	“I am”	“I choose”
View of Human Beings:	Psychological	Information Processing Organism
Base Theory:	Human Behavior (Psychology)	Human Information Processing (Sociology)
Applications:	Individual Counseling	Engineering High Performance Teams Improving Team Effectiveness Project Management - Assignments Organizational Development Leadership Training
Focus:	Individual	Networks of Individuals, Teams
Perspective:	Individual	Work Environment *(Making Decisions*)
Complexity:	16 Dimensions or Metrics per individual	4 Dimensions or Metrics per individual
Time Investment:	4 hours with coaching	10 -15 minutes, 8th grade reading level
Benefit to Respondent:	Self Awareness	Awareness of respondent's and team mates’ preferred decision strategy. (2)
Respondent's Leverage:	Personal Mastery	Group Mastery

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(1) Acronym for Input Output Processing Template. Survey asks respondent to *tradeoff* positions of equal value.

(2) A decision strategy defines amount and kind of information preferred, processing method and subsequent action typically taken.

S. Wieneke (1998)

Names, Definition, Examples and Hypothesized Consequences of Socialization Strategies

Strategy	Definition	Example
Collective	Puts newcomer through a common set of experiences as part of a group.	Freshman orientation
Individual	Processes recruits singly and in isolation from each other.	On-the-job training
Normal	Segregates newcomers from regular organizational members.	Basic military training
Informal	Treats newcomers as undifferentiated from other members.	Transferred employees
Sequential Steps	Requires entrant to move through a series of discrete and identifiable steps to achieve a defined role.	Specialized medical training
Non-sequential Steps	Accomplishes achievement of a defined role in one transitional stage.	Promotion
Tournament	Separates clusters of recruits into different programs on the basis of presumed differences.	Academic tracked programs
Contest	Avoids sharp distinctions between clusters of recruits.	Law school
Fixed	Gives the recruit complete knowledge of time required to complete passage.	Six-week managerial training program
Variable	Offers a timetable that does not fix the length of socialization.	Doctoral program
Serial	Provides experienced members as role models for newcomers about to assume similar positions to follow.	Apprentice program
Disjunctive	Has no role model available for newcomers about to assume similar positions to follow.	First holder of newly defined job
Investiture	Ratifies and documents the usefulness of personal characteristics of new recruits.	New faculty orientation
Divestiture	Seeks to deny and strip away recruits' personal characteristics.	Training for the priesthood

Based in part on J. Van Maanen, People processing: Strategies of organizational socialization, *Organizational Dynamics* 7 (1978): 19 –36.

Reference: Gordon, J.R., (1991). *A Diagnostic Approach to Organizational Behavior*, Table 3-7. Needham Heights, MA 02194: Allyn and Bacon.

Knowledge Sources mapped to Knowledge-based Learning Process Phases

Discipline	Specialty	Knowledge-based, Learning Process Phases			
		Plan & Deploy	Apply & Re-use	Compile & Study	Collaborate, Innovate & Capture
2. Knowledge Capital (Sources)	2.1. Human Capital (People, Tacit)		Yes		Yes
	2.2. Organizational Capital (Explicit)		Yes		Yes
	2.3. Commercial (Saleable) Knowledge			Yes	
	2.4. Customer Capital (Tacit & Explicit)			Yes	
	2.5. Supplier/Partner Capital (Tacit & Explicit)			Yes	
	2.6. Public Domain Capital (Explicit)			Yes	

Knowledge Sources mapped to Knowledge-based Learning Process Phases

Discipline	Specialty	Knowledge-based, Learning Process Phases			
		Plan & Deploy	Apply & Re-use	Compile & Study	Collaborate, Innovate & Capture
3. Knowledge-based Learning Process	3.1 Plan, Deploy Phase	Yes			
	3.2. Apply, Re-Use Phase (Passive Application)		Yes		
	3.2. Apply, Re-Use Phase (Active Application)		Yes		
	3.3. Compile, Study Phase 3.3.1. Create, Build Knowledge			Yes	
	3.4. Collaborate, Innovate & Capture Phase				Yes

Knowledge Sources mapped to Knowledge-based Learning Process Phases

Discipline	Specialty	Knowledge-based, Learning Process Phases			
		Plan & Deploy	Apply & Reuse	Compile & Study	Collaborate, Innovate & Capture
4. Enterprise-wide Infrastructure	4.1. Reward & Incentive Systems (Knowing/Applying)	Yes	Yes	Yes	Yes
	4.2. Leadership (Knowledge Responsibility)	Yes	Yes	Yes	Yes
	4.3. Relevant Measurement (Metrics)	Yes	Yes	Yes	Yes
	4.4. Knowledge Communications	Yes	Yes	Yes	Yes
	4.5. Allocation of Resources - People (Utilization = Dedicated Time)			Yes	
	4.5.1. Knowledge Asset Manager		Yes		
				Yes	Yes
	4.5.2. Knowledge Builder (Design for Six Sigma *Black Belt*)	Yes	Yes		
	4.5.3. Knowledge Holder				
					Yes
	4.5.4. Knowledge Tool Maker				
	4.5.5. Knowledge Innovator	Yes			
					Yes
	4.5.6. Knowledge Worker		Yes		
				Yes	
	4.5.7. Knowledge Supporter				
	4.6. IT Infrastructure	Yes	Yes	Yes	Yes
	4.7. KM & Core Business Competencies (Training, Education)				
	4.8. Budget	Yes	Yes	Yes	Yes
	4.9. Facilities	Yes	Yes	Yes	Yes
	4.10. Equipment & Software	Yes	Yes	Yes	Yes
	4.11. Knowledge Asset Ledger		Yes		

Knowledge Arena Benchmarking mapped to Knowledge-based Learning Process Phases

Discipline	Specialty	Knowledge-based, Learning Process Phases			
		Plan & Deploy	Apply & Re-use	Compile & Study	Collaborate, Innovate & Capture
5. Knowledge Arena Benchmarking	5.1. Emerging Product Technology			Yes	
	5.2. Emerging Manufacturing Technology			Yes	
	5.3. Emerging Material Technology			Yes	
	5.4. Emerging Business Technology			Yes	
	5.5. Emerging IT Technology			Yes	
	5.6. Existing & Emerging Legislation			Yes	
	5.7. Existing & Emerging Customer Trends			Yes	
	5.8. Existing & Emerging Regulations			Yes	

Knowledge Arena Content Management mapped to Knowledge-based Learning Process Phases

Discipline	Specialty	Knowledge-based, Learning Process Phases			
		Plan & Deploy	Apply & Re-use	Compile & Study	Collaborate, Innovate & Capture
6. Arena Content Management	6.1 Classifications	Yes	Yes	Yes	Yes
	6.2. Knowledge Modeling				Yes
	6.3. Topics				Yes
	6.4. Granularity				Yes
	6.5. Domains				Yes
	6.6. Strategy	Yes	Yes	Yes	Yes

Learning Organization mapped to Knowledge-based Learning Process Phases

Discipline	Specialty	Knowledge-based, Learning Process Phases			
		Plan & Deploy	Apply & Re-use	Compile & Study	Collaborate, Innovate & Capture
7. Learning Organization	7.1. Personal Mastery [13] - Life Long Learner - Internalized Values & Goals - Balancing Personal & Work Life	Yes	Yes	Yes	Yes
	7.2. Shared Vision [13] - Unified individual visions - Shared meaning amongst partners - Enrollment & commitment by choice	Yes	Yes	Yes	
	7.3. Systems Thinking [13] - Looking beyond events - Reflecting on structure - Identifying loops, links, patterns & interactions - Structure affects behavior	Yes	Yes	Yes	Yes
	7.4. Mental Models [13] - Our internal picture of the world - To be shared not imposed - Improve one's own models then contribute to others'	Yes	Yes	Yes	Yes
	7.5. Team Learning [13] - Intelligence & ability greater than the sum of individuals - Collective sensibility - Thinking together through dialogue, inquiry & reflection - Shared understanding	Yes	Yes	Yes	Yes
	7.6. Human Information Processing [12]	Yes	Yes	Yes	Yes
	7.8. Business Strategy	Yes	Yes	Yes	Yes

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Enterprise-wide Socialization mapped to Knowledge-based Learning Process Phases

Discipline	Specialty	Knowledge-based, Learning Process Phases			
		Plan & Deploy	Apply & Re-use	Compile & Study	Collaborate, Innovate & Capture
8. Enterprise-wide Socialization	8.1 Knowledge Socialization Objectives [4]	Yes	Yes	Yes	Yes
	8.2 Knowledge Socialization Phases [4]	Yes	Yes	Yes	Yes
	8.3. Knowledge Socialization Strategies [4]	Yes	Yes	Yes	Yes
	8.4. Knowledge Socialization Inclusiveness	Yes	Yes	Yes	Yes

Learning Model Name	Type	Phases
Dewey's Model of Experiential Learning	Individual	1) Impulse 2) Observation 3) Knowledge 4) Judgment
Lewin Experiential Learning Model	Individual	1) Observations & Reflections 2) Formation of Abstract Concepts & Generalization 3) Testing Implications of Concepts in New Situations 4) Concrete Experience
SCIS-Karplus Learning Cycle	Individual	1) Exploration & Observation 2) Invention & Generalization 3) Discovery & Application
BSCS 5 – E Learning Model	Individual	1) Engaging 2) Exploring 3) Explaining 4) Elaborating 5) Evaluating
Argyris/Schon DIPG Model	Individual	1) Discovery 2) Invention 3) Production 4) Generalization
Shewhart PDSA Learning Model	Enterprise	1) Plan 2) Do 3) Study 4) Act
Deming PDCA Learning Model	Enterprise	1) Plan 2) Do 3) Check 4) Act
Department of Navy KM Model	Enterprise	1) Join 2) Envision & Strategize 3) Develop Performance Measures & Incentives 4) Design & Deploy 5) Operate & Sustain 6) Measure Performance 7) Assess, Validate & Re-Strategize
77-APQC	Enterprise	1) Use 2) Create 3) Identify 4) Collect 5) Organize 6) Share 7) Adapt
The George Washington University	Enterprise	1) Plan 2) Design 3) Implement 4) Improve
General Motors Corporation Knowledge-based, Learning Model	Enterprise	1) Plan & Deploy 2) Design, Build & Test 3) Compile & Study 4) Collaborate, Innovate & Capture

A. Morgan October 5, 2003

Metaknowledge, Taxonomies, Ontologies, and Semantic Tags

Metaknowledge is strongly linked to taxonomies, ontologies, and semantic tags, as well as indexing. One of the elements we can bring to this now, that a librarian of 100 years ago couldn't, is a certain ability to be dynamic and flexible, in the way we capture, maintain, and use this metaknowledge. The basic purpose and function, however, has not changed.

There are technical differences between *taxonomies* and *ontologies*, but often these differences are not important, with ontologies simply offering more structure. See [Noy and McGuinness, 2001]. Taxonomies represent relationships between concepts, such as "is a" or "part of" or "precedes in time" or "manages" or "causes" or "evolves into" or any imaginable relationship that we want to use. We can organize the same terms via different taxonomies/ontologies. For example, clothing might be divided at the root into "men's clothing" and "women's clothing" or the gender difference might not be made until the leaf nodes.

Metaknowledge is for classification and retrieval of documents (and other things). Adding even a weak awareness of the difference between *terms* and *concepts* allows for much more effective retrieval. This might be implemented, for example, in the way queries are expanded or contracted: Does a query for *tank* mean *military vehicle* or *storage device for liquids*? In some systems, the user is asked to make the choice before the search is begin. Understanding taxonomic relationships allows for "query modification," often expanding (for example, with synonyms) but sometimes with more specific and even more general terms and sometimes with specific exclusions (e.g., no military terms). The following references specifically address ontology-guided search: [McGuinness, 1998], [McGuinness, 1999], [Sonderegger, 2002].

Ontologies can allow inferencing, so that the successor of a politician is found when the query was for heirs of the politician. (in a political context, an "heir" need not be a blood relation). Generally, AI practitioners look to have much structure in a limited domain, with a consequently powerful reasoning engine. Nobody expects to be able to do this broadly anymore, which has disappointed the dreams of the AI founders (from the 1950's). So for example, we might organize the knowledge for diagnosing a particular class of engine problems via specialized knowledge modeling and ontologies not particularly useful to diagnose anything else. This is often called Knowledge-Based Engineering, Expert Systems, Knowledge Systems, and so on. The point is that these are virtually defined by the concentrated power of their metaknowledge (along with appropriately defined inference engines). There is no clear distinction between knowledge modeling, knowledge systems, ontologies, and metaknowledge.

Taxonomies and ontologies are created, maintained, and used. However, the creation process is almost always a ramp-up that never ends, so there is a dynamic quality to taxonomies and ontologies. And ontology maintenance can be challenging. See [Das, 2002] and [Kendall, 2002]. There do exist "core" taxonomies and ontologies, generally just a few dozen or few hundred-core terms that are fixed, usually for some specific context. A related topic is synonym management, since people often have their favorite ways of saying things, which must either be related to the core terms or appended to them. Simple classification of documents might be accomplished with a relatively small and stable set of terms that everybody learns and uses. However, effectively searching large document collections often requires a larger and much more domain-specific collection of terms. A problem-solution archive at GM might need to be able to reference all parts and models and fault symptoms, a dynamic list and one full of synonym issues. Consider how many symptoms of trouble with automobiles involve characteristic smells or sounds. In such an archive, the taxonomies, ontologies, and synonym lists merely tag the documents in such a way that flexible retrieval is possible.

There are specialized tools for indicating the meanings of terms in documents, captured in various mark-up languages and their addenda. See [Connolly, 2001], [Dean, 2000], and [Hendler, 2000]. The dream for the "semantic web" [Fensel, 2001], [McGuinness, 2002] is that documents appropriately "marked up," will allow autonomous software agents to do business with a minimum of human support. Like all such schemes, the success of the semantic web hinges on the eventual adoption of standards. Thus, a zip code will always be recognized as a zip code in any document it appears in and will never be confused with part of a street address, because everyone agrees on how to mark a zip code. And so on.

The fundamental idea here is controlled vocabularies and human consensus, allowing for standards on which the various sophisticated structures noted above can then be built. A never ending task, but even partial successes can be very valuable.

A. Morgan October 5, 2003

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