Chapter I

A Knowledge Strategy Oriented Framework for Classifying Knowledge Management Tools

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ABSTRACT

Many classifications and taxonomies of knowledge management tools highlight mainly specific characteristics and features of a single tool, by ignoring the holistic and systematic dimension of the classification, and the explicit elements of linking with the knowledge management strategy. This chapter aims at proposing a general framework that integrates the technological side of knowledge management with the strategic one. Thus, this framework could represent a powerful instrument to guide knowledge engineers in the implementation phase of a knowledge management system, coherently with strategic choices for knowledge management. Chapter is articulated in two main parts: the first one is focused on reminding some relevant approaches to knowledge management (Hoffmann 2001; Skyrme 2000; Ruggles 1997; Radding 1998; Maier 2002); the second part presents the framework, with a detailed description of its components.
EXISTING APPROACHES FOR KNOWLEDGE MANAGEMENT TOOLS CLASSIFICATION

This brief review starts with the classification proposed by Hoffmann (Heisig et al., 2001), based on the concept that categories of knowledge management tools miss of an explicit reference to the knowledge strategy they enable. These categories are: search engines / categorization tools / intelligent agents; portals; visualizing tools; skill management; complete knowledge management suites; toolkits for developing individual solutions; learn and teach; virtual teams / collaboration.

The only one relation with the knowledge strategy is the knowledge management process that each tool enables, chosen among the processes characterizing the knowledge management model of CCKM Fraunhofer Institute of Berlin (Heisig et al., 2001): knowledge creation, knowledge storing, knowledge delivery, knowledge application. Table 1 shows this relation:

Another approach is the Skyrme’s classification of the hard tools for knowledge management, that highlights some categories of technological macro-functionalities, by associating to them some specific strategical impact (Skyrme D. J., 2000). This classification is mainly based on three groups of tools (Information Resource Management, Knowledge Bases and Collaborative Technologies), and it is not inspired to a pure technological perspective, since the categories are not homogeneous in terms of size and they are not strictly aligned with the market offer and the operative tools known by ICT expert.

Also Ruggles (Ruggles, 1997) proposes a classification characterized by a processes-oriented approach. He distinguishes three principal categories of knowledge management tools:

- Knowledge Creation tools, represented by tools that encourage individuals to think beyond their current limits. In particular, this category includes acquisition tools, synthesis tools for integrating different sources

<table>
<thead>
<tr>
<th>KM Process</th>
<th>Tools Categories</th>
<th>Creation</th>
<th>Storing</th>
<th>Delivery</th>
<th>Application</th>
</tr>
</thead>
<tbody>
<tr>
<td>Search Engines / Categorization Tools / Intelligent Agents</td>
<td></td>
<td></td>
<td>X</td>
<td></td>
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<tr>
<td>Portals</td>
<td></td>
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<td>X</td>
<td>X</td>
<td>X</td>
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<tr>
<td>Visualizing Tools</td>
<td></td>
<td>X</td>
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<tr>
<td>Skill Management</td>
<td></td>
<td></td>
<td>X</td>
<td>X</td>
<td></td>
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<tr>
<td>Complete Knowledge Management Suites</td>
<td>X</td>
<td>X</td>
<td></td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Toolkit for developing individual solutions</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Learn and Teach</td>
<td></td>
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<td></td>
<td></td>
<td>X</td>
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<tr>
<td>Virtual teams / Collaboration</td>
<td>X</td>
<td>X</td>
<td></td>
<td>X</td>
<td></td>
</tr>
</tbody>
</table>
of knowledge to obtain new ideas, creation tools for stimulating users’ creativity and encouraging a new thinking style, out of classic and traditional mental schemas.

- **Knowledge Codification** tools, that concern knowledge representation in order to enable and simplify its accessibility and transferring. This category contains knowledge bases and knowledge maps (in order to identify *just-in-time* the necessary knowledge to perform an activity and to represent knowledge flow within the organization), dictionaries and thesauri (to create common language inside the organization), simulators (to understand previous experience and design possible future scenarios).

- **Knowledge delivery** tools, allow going over temporal, geographic, physic and social distance inside the organization, such as virtual spaces, groupware and web-learning systems.

The main limit of these classifications is the excessive emphasis to explicit knowledge, neglecting aspects mainly connect to tacit knowledge, that represents a fundamental component of organizational knowledge. In fact, for example, some informal organization models, such as *community of practices* (Wenger E. C., 1998), are characterized by strong tendency to learning and innovation, often created by exchange of tacit knowledge (Maier R., 2002).

In the classification proposed by Radding (Radding, 1998), the technological infrastructure of knowledge management is slightly correlated with strategic elements. In fact, the categories of this approach are: **Networks, Storage, Capture and Collection, Dissemination, Access, Sharing, Middleware, Information Processing, Information Analysis**. Each category is formed by sub-categories, which are organized strongly in a technological perspective and don’t give precise information about the strategy they can support (for example, the *Dissemination* category includes these tools: *e-mail, data warehouse and data mart, publishing and subscribe, push, groupware, computer based technology, web*).

The Maier’s (Maier, 2002) approach, instead, provides a more clear vision about the direct and indirect bonds between knowledge management technologies and knowledge management strategies. In a general architecture of a knowledge management system, Maier joins the elementary classes of each tool to some knowledge management processes. For example, Maier connects the visualization process with some technological tools as knowledge maps, taxonomies, directory systems and catalogues; another example is the relationship between the discovery process and search agents, push technologies, profiling and filtering tools.

The proposed architectural schema matches the *theory-driven* approach with *market-driven* approach. The former is essentially based on: i) models that describe, in an abstract way, the knowledge types; ii) processes supported potentially by ICT; iii) the organizational levels of these processes (individual, group/community, organization, global scale). The latter is based on specific functionalities offered by a knowledge management system (repository, discovery and mapping, web learning, search engines, portals, community, collaboration and interaction, visualization). Moreover, Maier proposes a first schematic attempt to link technological knowledge management tools and strategical knowledge management approaches, by introducing *integrative* and *interactive* functions of a knowledge management system. The *integrative* functions provide a technology-oriented perspective about knowledge management systems, focusing on explicit knowledge and on search functionalities, access, presentation, acquisition, publication and organization; the *interactive* functions provide a human-oriented perspective, preferring the exchange, sharing and delivery of tacit knowledge through communication, cooperation, interaction and learning functionalities.
In the Maier’s model, this relationship is not always immediately identifiable and often the architectural design is mixed with technological and functional features of the tool.

**THE PROPOSED FRAMEWORK FOR KNOWLEDGE MANAGEMENT TOOLS CLASSIFICATION**

The following framework tries to join the technological aspects and the strategical one in a systemic way. This framework is constituted by a functional and technological structure, which represents the General Facilities layer, and it is divided into three components:

- **Enabling Infrastructure**: hard infrastructure concerning the aspects of connectivity of the system;
- **People & Task Management Tools**: tools about management and coordination of activities and human resources;
- **Knowledge Map**: tools that guide the users towards processes of knowledge search and recovery.

This General Facilities layer includes both typologies of knowledge management tools, which are linked to the two Hansen’s approaches (Hansen, 1999) for knowledge management, then discussed by Zack (Zack, 1999):

- **people-to-people tools**, essentially focused on processes concerning tacit knowledge;
- **people-to-document tools**: essentially focused on processes concerning explicit knowledge.

The following figure shows the logic structure of the framework.

*Figure 1. Logic structure of the proposed framework*
A Knowledge Strategy Oriented Framework for Classifying Knowledge Management Tools

General Facilities level assures the basis functionalities, on which other knowledge management tools linked to strategic approaches are integrated (people-to-people tools and people-to-document tools).

For each typology of tools, the framework proposes some dimensions and parameters to analyse it. In particular:

- for people-to-people tools, the proposed dimensions are connected to the typologies of communication that are enabled, and to mechanisms that activate the relationships among individuals (relationship trigger);
- for people-to-document tools, the proposed dimensions are related to processes and typologies of knowledge resources which are managed by tool (knowledge resources).

In the following sections, a detailed description of the three levels of the framework is provided.

General Facilities

The General Facilities of the proposed framework can be described along three main directions:

- **Enabling Infrastructure**: hard infrastructure concerning the connectivity of the system;
- **People & Task Management Tools**: tools for management and coordination of activities and human resources;
- **Knowledge Map**: tools that guide the users towards processes of knowledge search and recovery.

Enabling Infrastructure

The hard infrastructure concerning the connectivity of the system can be represented by its components, that are:

- **Host networks** – networks used to communicate and transfer data generated by heterogeneous systems.
- **Local Area Networks** (LAN) – networks that connect clients and servers of the organization. They constitute the backbone of the network, through which the codified knowledge is transferred and shared into the organization.
- **Wide Area Networks** (WAN) – networks that connect physically different LANs geographical distributed in order to share the access to informative resources or knowledge. WAN carry out a key role to allow access to geographical distributed data sources and knowledge repositories. Usually, the WAN architectures include tools and technologies to guarantee the security of the communication (integrity, confidentiality, authorization, authentication, non repudiation).
- **Intranet** – networks based on TCP/IP protocol and operating on LAN, accessible only by authorized users. In according to the user profile, a personal knowledge workspace is automatically and dynamically defined, constituted by reachable services, allowed contents, and authorized relationship.
- **Extranet** – networks constituted by secure integration of a set of Intranets (customers, suppliers, partners). So, extranet becomes a shared space in which organizations interact each other, by sharing information and knowledge. Usually, a firewall guarantees the privacy of communication and the security of all involved Intranets.
- **Internet** – public, global and interactive channel of communication, which promotes the access and sharing of information and explicit knowledge at global level, through its services (WWW, FTP, IRC, newsgroup, telnet, e-mail, etc.).

All the introduced components can be framed and used in a wired or wireless or mixed context,
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in according to needs and special features of organizational and operational areas.

People & Task Management Tools

Tools for managing and coordinating activities and human resources allow increasing effectiveness and efficiency in the use of knowledge assets in the organization. This category includes tools of workflow, project management and competence assessment.

Workflow tools allow defining the relationships and the interfaces among different process’ activities or phases. The identification and definition of the priority among activities and the setting of dynamics of evolution / control and coordination allow systematizing work processes, communication flows and human resources planning. In this way, modelling and activities’ parameter set up, together with the analysis of the specifications and mechanisms of activation / execution / control, create a favourable context for defining a strategic and operational framework to enhance knowledge flows, conceived as result of interaction and relationships among people, processes and contents.

Project management tools provide a set of functionalities to support processes management, by ensuring an effective usage of resources, an high level of control for project timing, a careful risk management and a constant quality monitoring.

A more important and strategic aspect, that the traditional project management tools are trying to embed, concerns the management of individual competences. Integration interfaces, more and more rich and complete, allow connecting traditional project management functionalities with monitoring of human resources competences, in order to consider typology and know-how requested for tasks execution as a fundamental driver in the staffing phase of the project team. This integration process points out the aspects of tracking, monitoring and individual competences development for a more careful project planning.

In this way, project planning functionalities include both quantitative aspects (number of available resources, available budget, etc.) and qualitative aspects (kind and level of required competences, acquired experience, etc.). So, apart from traditional functionalities, such as gantt, pert, resources management, notice mechanisms for meeting set up, alert mechanisms, monitoring and costs sheets, calendar, task-list and cash flow reporting, project management tools became integrated more and more with Human Resource Management (HRM) and web-learning tools, in order to provide a better support for competitive knowledge-based enterprise.

Finally, the more and more increasing requirement to concentrate strategic management of the projects in a single professional profile (multi-project manager), generates new requirements (and so new functionalities) that a traditional tool for project management doesn’t support, among which:

- budget controlling to optimize cash flows;
- verification of the existence of economy of scale or economy of scope among different projects to optimize the use of the resources and so the profitability of the projects;
- optimization of the available knowledge heritage, through the improvement of existing and available knowledge assets;
- development and improvement of new knowledge and competences, in the perspective of future organizational strategies for value creation.

Competence assessment tools allow monitoring dynamically and real-time the competences level achieved by each member of the organization, extracting useful information through techniques of user tracking applied to carried out activities, used application, produced documents/reports, in order to identify and analyze the knowledge gap and, potentially, propose ad-hoc learning path.
Knowledge Map

Knowledge maps allow representing, in a certain moment, the knowledge heritage existing into the organization, potentially comparable with the knowledge heritage of other competitors. Analysing these maps, it is possible to identify the specific competences of an organization, the competences which require reinforcement or those will disappear in the next future. Apart from the typology and the level of those competences, the knowledge maps allow identifying also the organizational areas they are located in, and the sources (individuals, documents, electronic files, journals, internal and external data repositories).

Another important characteristic of a knowledge map is the possibility to manage intellectual right property of different knowledge sources of the organization, defining the rule and application of the contents, access and distribution policy, update and publication bonds. To this end, Digital Rights Management (DRM) systems allow to manage these features in a complete and advanced way.

So, the knowledge maps allow to monitor dynamically the whole knowledge heritage of an organization, identifying sources, flows, bonds and relationships, in order to optimize the identification and retrieval processes. Moreover, the knowledge maps constitute the basis for recommendation systems, which give a high proactive level to the system, through suggesting services/contents/people organized coherently with user’s profile and context.

People-to-People Tools

The knowledge management tools that support people-to-people approach are focused on tacit component of the knowledge. These tools intend to activate interaction and socialization processes among individuals in order to strengthen existing (evident or/and latent) bonds and relations among them. Indeed, these tools aim at creating and strengthening social network through configuration of contexts that enable knowledge sharing and knowledge transfer processes.

The following table lists the two category of knowledge management tools oriented to people-to-people approach:

- Category characterized by typology of communication (synchronous or asynchronous);
- Category characterized by mechanisms of activation of the relationships among individuals – relationship trigger (cooperation or expertise search);

Synchronous and Asynchronous Communication Tools

The following figure shows classification matrix of tools related to synchronous and asynchronous communication, completed by the presence or not of a moderator. So, this matrix illustrates four sub-class of tools:

1. Moderate Synchronous tools: knowledge management tools that realize instantaneous

Table 2. People-to-people tools

<table>
<thead>
<tr>
<th>Communication typology</th>
<th>Relationship trigger</th>
</tr>
</thead>
<tbody>
<tr>
<td>Synchronous Communication Tools</td>
<td>Cooperative Working Tools</td>
</tr>
<tr>
<td>Asynchronous Communication Tools</td>
<td>Smart Mapping Tools</td>
</tr>
</tbody>
</table>
communications among users that are online at the same time. The presence of a moderator assures immediate interventions oriented to promote and manage the communication, accepting new users or excluding someone from the current session. This sub-class contains virtual classrooms, audio-video conference systems (one-to-one and many-to-one) and chat rooms.

2. **Moderate Asynchronous tools**: knowledge management tools that enable communication among users geographically distributed not only in space (as in the synchronous tools) but also in time. In fact, for these tools, the simultaneous presence of all users is not necessary, since everyone can contribute to discussions and activate communication in a postponed way, both individually and collectively. The presence of the moderator (especially if he is an instructor or tutor) guarantees that all contributions are coherent with the topics of the discussions and they have been introduced in appropriate and clear way. This subclass includes assessment tools (test, evaluation and verification tools), forums, newsgroups, mailing lists, web training tools supporting web-learning processes.

3. **Non Moderate Synchronous tools**: tools that support unstructured, instantaneous and no moderation communication. Spontaneity and rapidity of the interactions constitute the main strength of these tools. Integrated components to store discussion sessions can increase further the effectiveness of such tools. Typical example of this category are chat, both one-to-one and one-to-many and many-to-many. The integration of these tools with Voice Over IP systems increases the potentiality and effectiveness of the communication, by ensuring multimedia communication channels.

4. **Non Moderate Asynchronous tools**: knowledge management tools with strong func-

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**Figure 2. Synchronous and asynchronous communication tools**

<table>
<thead>
<tr>
<th>Technologies with Moderator</th>
<th>Technologies without Moderator</th>
</tr>
</thead>
<tbody>
<tr>
<td>VC (Virtual Classroom)</td>
<td>Chat Room</td>
</tr>
<tr>
<td>Audio-Video Conference</td>
<td></td>
</tr>
<tr>
<td>Mailing List</td>
<td></td>
</tr>
<tr>
<td>WBT (Web Based Training)</td>
<td></td>
</tr>
<tr>
<td>Assessments</td>
<td></td>
</tr>
<tr>
<td>Forum</td>
<td></td>
</tr>
<tr>
<td>Newsgroup</td>
<td></td>
</tr>
<tr>
<td>WBT (Web Based Training)</td>
<td></td>
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</tbody>
</table>
tional characteristics that exalt individual and collective aspects of the interactions. In fact, the absence of a moderator overburdens the individual actions of the user when he uses the tool and accesses to contents. The asynchronous way allows a good level of examination and elaboration, both for contents that are proposed and brought in the discussion, and contents that are accessed by specific tool. This subclass contains self-test tools (for auto-test and auto-evaluation), forums, newsgroups, mailing lists, computer training and web training tools to support individual and collective web-learning processes.

New emerging tools that are obtaining considerable importance in the area of asynchronous communication tools are blogs. Blogs are virtual environment for communication and interaction in which the personal dimension emerges compared with group dimension. Advanced blogs supply services for user’s profiles recommendation, in order to promote the creation of Learning Community and community of knowledge practices.

**Cooperative Working Tools**

This category includes all tools that enable interdisciplinary groups of individuals, geographically and temporally distributed, to interact each other for carrying out a common activity or joint elaboration of a solution. Examples of these tools are e-meeting systems with audio-video conferences, desktop sharing systems and, in general, application sharing systems, shared tools for activities scheduling (calendars or virtual agendas), forums.

Beyond these systems, there are the traditional systems of document management to manage entire documents life cycle, from their initial creation to their filing. This management consists of structuring of documental workflow according to the different typologies of documents, in addition to definition of access policies to different work areas (personal and shared). Also, these systems offer a set of tools to support retrieval, manipulation, notice, delivery and documents versioning processes.

Very interesting cooperative working systems are the Group Decision Support Systems (GDSS), which combines communication and processing aspects with decision making processes. After the GDSS have contributed to the removal of communicative limits and obstacles, they propose models and techniques of “collaborative decision making”, creating an operative context to support joint and assisted formulation and elaboration of solutions about unstructured and not understandable problems.

**Smart Mapping Tools**

The category of Smart Mapping Tools includes all tools that support user to accelerate search and retrieval of specific competence profiles to establish a relation with. The quality, effectiveness and efficiency of these tools depend on indexing and classification techniques. To this end, it is possible to distinguish automatic and semi-automatic indexing techniques. Automatic techniques present a low level of “user intrusion”. They are based on analysis of user’s behaviours with reference to contents and/or documents accessed previously, the typologies of activated communication, users’ profile involved in the communication, number and type of documentation shared in that communication, value of proposals suggested in the meeting by participants.

Semi-automatic techniques, instead, require active and explicit (also periodic) intervention and participation by user aimed to update own profile of competences, interests and skills.

Both techniques allow to associate single individual with a set of metadata that contributes to organize and describe the human capital of an organization in a complete way.
Usually, Smart Mapping tools incorporate and improve both semi-automatic indexation techniques and automatic techniques, trying to increase effectiveness of the search processes carried out by users. The result is a more virtuous integration of human capital with knowledge resources (structural capital), in order to maximize the effectiveness of the social dynamics (social capital).

Smart Mapping tools exploit the potentiality of semantic layer of an organization (represented typically by ontologies, thesauri and taxonomies) in order to drive user through an intelligent and problem-driven exploration of the intellectual capital, also utilizing three-dimensional representation of the specific domain (example: yellow-pages).

**People-to-Document Tools**

Knowledge management tools, that support people-to-document approach, are focused essentially on the explicit knowledge.

These tools aim to strengthen mainly the processes of retrieval, transfer, use and application of the knowledge that is already created, represented and codified in documents, database, manuals, reports, deliverables, software, learning paths. For this purpose, two phases have particular importance:

- to identify ‘core’ processes to support and feed with such tools;
- to structure, systematize, characterize knowledge resources on which such tools operate.

Concerning the former phase, the proposed framework is based on a process-oriented analysis of some knowledge management approaches (Heisig et al., 2001; Maier, 2002; Tiwana, 2000). This analysis allows identifying the main processes on which it’s necessary to focus in order to transform knowledge in a value creation source.

Concerning the second phase, the framework is based on existing differences (both structural differences and typology/contextual ones) among several types of knowledge resource (Davenport, Prusak, 1998; Maier, 2002; Radding, 1998; ADL, 2001).

In the proposed framework, the process-based dimension is articulated into five levels:

- **Storage**: level of processes directly related to an effective organizing and structuring storage of the knowledge resources into appropriate data structure, which are capable to maintain logic and semantic links among several and heterogeneous resources, in the course of time.
- **Representation**: level of processes oriented to an effective representation of knowledge resources according to the specific user’s, in order to maximize the performance of understanding and elaboration processes.
- **Generation**: level of processes focused on knowledge generation, from the acquisition and integration of external knowledge sources (experts, documents, books, journals, patents, database, events and initiatives as conferences, meetings, workshops, projects, benchmarking, best-practices and special interest groups). Knowledge generation processes are based also on internal knowledge sources that feed learning processes and development of new skills, idea and innovative projects. Socialization and externalization processes (Nonaka, 1995) contribute positively to success of generation processes.
- **Access**: level of processes related to access, search and recovery of knowledge assets in an organization. For this purpose, the processes of resources identification are very
important, both at intra-organizational and inter-organizational level.

• **Diffusion**: level of processes focused on distribution of knowledge to involved users, both through push and pull modalities. The knowledge-broker presence, together with personalization techniques - based essentially on user profile - represent two fundamental drivers for success of such processes. Combination and internalization processes (Nonaka, 1995) contribute positively to achieve the objectives of the diffusion processes.

Concerning the knowledge-resource based dimension, it is articulated into four levels:

• **Data**: level dedicated to collection and management of raw data, conceived as objective measures of the properties of an object (for example temperature, price, …), in relation to a specific event.

• **Document**: level dedicated to elaborated, aggregated and contextualized information, in relation to a specific objective, which are represented in the form of text with images, graphics, tables, comments, etc.

• **Multimedia object**: level of objects characterized by contextualized knowledge in the form of text, dynamic images, audio and video sources, interactive graphics, hyper-text, dynamic links with other objects.

• **Learning object**: level dedicate to all resources and digital links, that can be used to support learning processes, organized in learning paths with specific objective to achieve and competences to acquire. These learning objects are constituted by

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**Table 3. People-to-document tools**

<table>
<thead>
<tr>
<th>KR Tipology</th>
<th>Data</th>
<th>Document</th>
<th>Multimedia Object</th>
<th>Learning Object</th>
</tr>
</thead>
<tbody>
<tr>
<td>Processes</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Storage</td>
<td>Database, File System</td>
<td>Database, File System</td>
<td>Database, File System</td>
<td>Database, File System</td>
</tr>
<tr>
<td>Representation</td>
<td>Data Warehouse, Data Mart</td>
<td>Documental Knowledge Base</td>
<td>Multimedia Knowledge Base (Mediateca)</td>
<td>Multimedia Knowledge Base (Learning Object)</td>
</tr>
<tr>
<td>Access</td>
<td>Data Processing Tools, Data Analysing Tools</td>
<td>Search &amp; Retrieval Tools, Graphic Map</td>
<td>Search &amp; Retrieval Tools</td>
<td>Virtual Learning Environment, Managed Learning Environment</td>
</tr>
<tr>
<td>Diffusion</td>
<td>Help Desk, Query &amp; Reporting Tools, Linkopedia</td>
<td>Publishing Tools</td>
<td>Publishing Tools, Streaming Tools</td>
<td>Virtual Learning Environment, Managed Learning Environment</td>
</tr>
</tbody>
</table>
structured grouping of data, documents and multimedia objects, on which a structural and contextual metadata set is associated, to answer effectively to educational and pedagogical requirements of single learner.

The following figure shows classification of knowledge management tools, according to the above cited description.

A short description of each category of knowledge management tools, is follow presented.

Database, File System

Database and file systems represent main data structure for storing of the knowledge resources (data, documents, multimedia objects and learning objects).

In particular, according to resources typologies, some choices can be more appropriate than the other (for example, object oriented database is used for multimedia resources, relational database is used for banking transaction, or XML-based database for complex search into big and widen documental source). In all case, database becomes at the same time point of arrival of normal routine activities and point of departure for the creation of new multi-dimensional data structures. The database, often, is integrated with external data sources organized on file systems: hybrid structures for storing of different types of knowledge resources are so created.

Data Mart, Data Warehouse

Data Mart and Data Warehouse tools allow to create data structures, that are complex, mission-oriented, integrated, changeable in time, not volatile and that sustain and support activities of analysis and decision making. Data, contained in

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**Figure 3. OLAP and OLTP systems**

<table>
<thead>
<tr>
<th>CHARACTERISTICS</th>
<th>OLTP</th>
<th>OLAP</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Number of users</td>
<td>Many</td>
<td>Limited</td>
</tr>
<tr>
<td>• Typology of users</td>
<td>Operators</td>
<td>Manager</td>
</tr>
<tr>
<td>• Typology of operations</td>
<td>Atomic (1 record at a time)</td>
<td>Aggregated/multidimensional view (Drill down - Drill cross)</td>
</tr>
<tr>
<td>• Frequency of data feeding</td>
<td>Real time</td>
<td>Batch</td>
</tr>
<tr>
<td>• Access</td>
<td>R/W</td>
<td>R</td>
</tr>
<tr>
<td>• Data volatility</td>
<td>High</td>
<td>Low</td>
</tr>
<tr>
<td>• Metrics</td>
<td>Throughput</td>
<td>Execution time</td>
</tr>
<tr>
<td>• Time reference</td>
<td>Present</td>
<td>Past</td>
</tr>
<tr>
<td>• Database dimension</td>
<td>From MB to GB</td>
<td>From GB to TB</td>
</tr>
<tr>
<td>• Data structure</td>
<td>Optimized for multi-user accesses</td>
<td>Optimized for analysis</td>
</tr>
<tr>
<td>• Focus</td>
<td>Process &amp; Application oriented</td>
<td>Subject &amp; Business oriented (DSS)</td>
</tr>
</tbody>
</table>
a data warehouse, come from heterogeneous and distributed sources and derived from OLTP (On Line Transactional Processing) activities.

Data mart represents a particular “view” on a data warehouse, built to optimize the access of high number of users to context-specific and problem-oriented data and information.

Data mart and data warehouse interact each other both in initial phase, during their creation with top-down and bottom-up approach, and at regime to support OLAP (On Line Analytical Processing) systems in the multi-dimensional analysis on data, by performing:

- ‘Slice and Dice’ operations (for the visualization of data at various aggregation levels and with different perspectives);
- ‘Drill-Down’ operations (for data analysis from aggregated and detailed forms);
- ‘Rotation’ operations (for the reversal of the axis of graphic representation related to data visualization);
- ‘Trend Analysis’ operations (for the prevision about data performance on temporal base).

The following table reports the main distinctive characteristics of OLAP and OLTP systems.

**Knowledge Base (Documental – Multimedia – Learning Object)**

Knowledge base allows systematizing the heritage of cognitive resources of an organization in an organic, systemic, logically structured and interconnected way. Knowledge base offers multifaceted semantic views on the same heritage of knowledge resources, which is created by processes of storing data, documents, multimedia objects and learning objects into file system or database. These views are obtained by introducing a semantic layer in the traditional data structure. This layer is constituted by ontologies, taxonomies, thesauri, metadata structures, through which realize real cognitive maps that provide a flexible, intelligent and user-centric representation of knowledge resources of an organization.

**Data Integration and Data Extraction Tools**

Data integration and data extraction tools, usually, take part in construction and generation of new data structures from existing sources. An example of tools of this category are ETL (Extract – Transform – Load) softwares that extract raw data stored in the original sources, submit them to cleaning process for the validation and store them in new data structures on which data mining algorithms and OLAP systems operate. EAI (Enterprise Application Integration) tools have particular relevance, since they realize integration of data, applications and entire informative systems, both intra-organizational and inter-organizational level, generating new informative structures, which are fed in a coherent way and aligned with operative processes of the organization.

**Authoring, Validating, Indexing and Workflow Tools**

Documents, multimedia and learning objects creation tools can be grouped into four main categories:

- **Authoring tools**: software tools for the ‘physic’ creation of specific knowledge resource. These tools can be very simple, as Office Automation suite (example: Microsoft Word or Microsoft Power Point) for the creation of text document or dynamic presentation, or can be complex, as Adobe Premiere for the realization of a multimedia object, or as IBM Content Producer (or Docent Outliner) for the realization of a web-learning path with assessment. Regardless of specific tool, it is fundamental that
authoring tools are user-friendly, have a set of standard templates which can be extended and personalized, have an IDE (Integrated Development Environment), offer the opportunity to recover and reuse contents already developed, generate output which respect the standard, support the collaborative development of the resources, give the opportunity to consult help on line and FAQ (frequently asked question) in a flexible way.

- **Validation tools**: tools for knowledge resources validation, by producer and by third parties. These tools allow also to highlight significant parts of the resources and to associate notes, comments and references for further elaboration.
- **Indexing tools**: tools for the indexing process of knowledge resources that associate a resource to a set of simplex metadata or complex semantic annotations, coherently to the structure of the adopted semantic layer. These tools can be stand-alone or web-based tools, owned by a single company or completely open source, used on internal knowledge base (example: intranet) or on public and shared knowledge base (example: web), automatic or semi-automatic or manual.
- **Workflow tools**: tools that define production process of knowledge resources, in relation to phases to complete, states to plan, version to produce, role to define, action to perform. Also, workflow tools act as coordination tools in the resources generation processes.

Recently, the four categories of resources above cited, constitute the main assets at the base of the architecture of a Content Management System (CMS). In fact, CMS allows organizing all processes of contents management, from the contents creation to publishing and storing, in a web environment, by coordinating the activities of all involved actors in the different phases of the content life cycle.

Particular tools that are acquiring considerable importance relative to CMS tools are wikies.

Wikies are web based tools characterized by distributed processes for the content creation (wiki-pages). The collaborative dimension of wikies characterizes site identity and users/navigators/authors identity.

Usually, wikies are outlined as self-organized environment, in which everyone contributes as authors or readers, respecting an explicitly or implicitly defined behaviour.

**Data Processing and Data Analyzing Tools**

Data processing and data analyzing tools constitute main point of access to sources of raw data. In fact, these tools allow to launch elaborations on huge amount of data, in order to extract useful information for operative and/or decisional processes. The elaborations are based on techniques of simulation, artificial intelligence, statistics, clustering, pattern recognition, decisional trees and “what if” scenario analysis.

**Search and Retrieval Tools**

Search and retrieval tools drive users toward localization of knowledge resources more adapt in relation to the problem to solve and/or to solution to formulate. For this purpose, traditional search (and meta-search) tools based on keywords or statistic algorithms often reveal insufficiencies and innovative approaches based on artificial intelligence and Semantic Web begin to complement the first ones. The tools of this category can use both push technologies (newsletter, mailing list, etc.) and pull technologies (web browsing, search engines, navigators, forums, etc.) and usually they are used to guarantee direct access to documents, multimedia objects and people.
Virtual and Managed Learning Environment (VLE, MLE)

Virtual Learning Environment is a virtual and interactive learning community on the web. The VLE represents the main point of access for delivering learning paths and it proves to be effective in the realization of non-hierarchical learning groups, aimed to share idea, opinions, projects and know-how, remaining active also after the institutional time deadline of training and learning. The VLE seems to be effective in the education, especially if it is in relation with on-line education of first generation (CBT – Computer Based Training), but it still presents some difficulties in the organization of learning contents, in the retrieval and reuse phases depending on educational needs of specific user profile. The production, classification and organization of learning contents represent a strong point of the Managed Learning Environment (MLE).

MLE aims to manage, in an integrate way, a complete system of analysis, competences development and evaluation, learning paths planning and organization, roles and virtual classes description, processes definition and results evaluation. In the MLE, the aspects related to privacy protection and DRM (Digital Rights Management) policies are relevant for the recognition of intellectual properties of available resources and for the allowed operation on these resources. Also, the elements that permit the semantic description of learning contents and its intelligent classification (oriented to application and user profile), are fundamental to maximize effectiveness of learning processes through the use of web learning technological platforms.

Help Desk, Query and Reporting Tools, Linkopedia

Help desk, query and reporting tools, linkopedia are particularly adapt for knowledge dissemination processes. These three typologies of tools allow individuating, organizing and delimitating intervention area, offering right aggregate data to user requirements.

The help desk captures a great quantity of information about products, systems and operative processes. After initial organization, these information are disseminated and distributed in different ways in order to make them rapidly accessible to users (for example customer care operator), by providing so immediate solutions.

Query and reporting tool supports users in the structured questions on the available data sources. The results of these questions are standardized with personalized reports (electronic and paper based) for the different users’ categories. For electronic reports, the tools for dynamic visualization of the data are very important, in order to look subset of data on-line, creating report on demand.

The linkopedia allows to organize and structure a set of links to web resources (identified by URL or URI) through the association of descriptive parameters that represent content, purpose and possible use.

Publishing Tools and Streaming Technologies

Publishing tools aim mainly to diffuse and delivery on Intranet, Extranet or Internet documents and multimedia contents (as reviews, elaborations, editorials, comments, seminars, multimedia events and objects in general) about interesting topic for users. Publishing process requires an high level of flexibility, easiness and immediacy, and it has not to require specific and technological competence about web editing. Forms, templates and models guarantee the efficiency in the publishing processes. Feedbacks about the quality of published contents guarantee high levels of effectiveness. Notification services of effective publication of a content increase both effectiveness and efficiency of the tool.
In this context, streaming technologies are particularly effective in order to increase the interest of final user, enhancing the level of understanding and elaboration of the distributed knowledge resources. If on the one hand this aspect is true, on the other hand it is necessary that the final user is appropriately ‘equipped’ (in term of bandwidth and available multimedia devices) in order to live emotions in the use of streaming of multimedia contents.

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