"An Integration Framework for e-Learning and Knowledge Management- the LKM Framework"

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Integrated e-Learning and Knowledge Management (LKM) is defined as an approach aimed at delivering enhanced efficiency of training processes or programmes by utilising organizational knowledge as a learning resource for user oriented learning services.

A key challenge for LKM relates to the need for

- Combining different types of learning services (content, mode and delivery methods/media) to suit the specific requirements and preferences of individuals;
- Creating a balanced approach for guiding learning and supporting learner control.

Integrated e-Learning and Knowledge Management is an essential part of strategic knowledge management.

Definitions on e-learning

ADL Advanced Distributed Learning	Initiative by the U.S.A. department of defence to achieve interoperability across computer and internet-based learning courseware through the development of a common technical framework, which contains content in the form of reusable learning objects.
Asynchronous learning	Provision of learning opportunities and support that can take place at any time. Examples are self-paced courses taken via the internet, online discussion groups, and email.
Authoring tool	A software application used by trainers and instructional designers to create e-learning courseware.
BBS Bulletin Board System	An electronic message centre. Most bulletin boards serve specific interest groups. Users can log in to post messages on public discussion boards, send and receive email, chat with other users, and upload and download files.
Blended learning	Learning events that combine aspects of online and face-to-face instruction.
CAI Computer-Assisted Instruction	The use of a computer as a medium of training instruction (e.g drill and practice, tutorial, simulation or games). Computer-based education (CBE) and computer-based instruction (CBI) are broader terms that refer to virtually any kind of computer use in educational settings.
CBT Computer-Based Training	An umbrella term for the use of computers in both instruction and management of the teaching and learning process.
Chat room	A virtual meeting space on the Internet, intranet or other network, used for real-time text discussions.
CoD Content on demand	Delivery of an offering, packaged in a media format, anywhere, anytime via a network. Variants include audio on demand (AoD) and video on demand (VoD).
Collaboration solutions	Software programmes or services that enable people at different locations to communicate and work with each other in a secure, self-contained environment. May include capabilities for document management, application sharing, presentation development and delivery, white-boarding, chat and more.
Competency management	A system used to evaluate skills, knowledge, and performance within an organisation; spot gaps and introduce training, compensation, and recruiting programs based on current or future needs.
Content	Information captured digitally. E-learning content includes text, audio, video, animation, simulation, and more.
Customer capital	The combined value of all the relationships an organisation has with its customers (current, past and potential customers). This includes intangible factors such as customer satisfaction and loyalty to the organisation or its products. Customer capital is one component of intellectual capital.
Delivery	Any method of transferring content to learners, including instructor-led training, books, web-based training, etc.
Distance Education Distance Learning	Educational or learning programmes via synchronous or asynchronous means of instruction in which the instructor and students are separated by time, location, or both.

E-learning **Electronic Learning**	The use of electronic information systems (especially internet technologies) to deliver learning and training. E-learning covers a wide set of applications and processes, such as web-based learning, computer-based learning, virtual classrooms, and digital collaboration. It includes the delivery of content via Internet, intranet/extranet, audio- and videotape, satellite broadcast, interactive TV, etc.
Ergonomics	Design principles relating to the comfort, efficiency, and safety of users.
Expertise directory	A staff directory in the form of a database that includes details of people's skills, knowledge, experience and expertise so that users can search for people with specific knowledge.
Extranet	A website that links an organisation with other specific organisations or people. Extranets are only accessible to specified organisations or people and are protected via passwords.
Human capital	The knowledge, skills and competencies of the people in an organisation. Human capital is one component of intellectual capital.
Hypermedia	Applications or documents that contain dynamic links to other media, such as audio, video, or graphics files.
ILS **Integrated Learning System**	A complete software, hardware, and network system used for instruction. ILS usually includes a number of tools such as assessments, record keeping, report writing, and user information that help to identify learning needs, monitor progress, and maintain student records.
Intellectual capital	The value, or potential value, of an organisation's intellectual assets (or knowledge assets). Intellectual capital is often defined as the combination of three sub-categories: human capital, structural capital and customer capital.
Intellectual property	Explicit intellectual assets (or knowledge assets) that are protected by law. Includes patents, trademarks, copyrights, licences etc.
Intellectual property rights	The legal rights associated with intellectual property.
Intranet	A computer network that functions like the Internet, but the information and web pages are located on computers within an organisation rather than being accessible to the general public.
Knowledge audit	A method of reviewing and mapping knowledge in an organisation including an analysis of knowledge needs, resources, flows, gaps, users and uses.
Knowledge harvesting	A set of methods for making tacit knowledge more explicit - getting people's knowledge into documents, so that it can be more easily shared with others.
LMS **learning Management Systems**	An LMS automates the administration of training, registers users, tracks courses and learners and provides reports to management. An LMS is typically designed to handle courses by multiple publishers and providers.
Learning objects	A reusable, media-independent collection of information used as a modular building block for e-learning content. Learning objects are most effective when organised by a meta data classification system and used by learning management systems.
Learning organisation	An organisation that views its success in the future as being based on continuous learning and adaptive behaviour. It therefore develops capabilities for acquiring, developing and using knowledge and then modifies its behaviour to reflect new knowledge and insights.

Lessons learned	Lessons learned are concise descriptions of knowledge derived from experiences, which can be communicated through mechanisms such as storytelling, debriefing etc, or summarised in databases. These lessons often reflect on "what we did right", "what we would do differently" and "how we could improve our process and product to be more effective in the future".
M-learning **Mobile learning**	Learning that takes place via mobile communications through wireless devices such as cell phones, personal digital assistants (PDAs) or laptop computers.
Mentoring	A career development process in which the less experienced workers are guided by more experienced colleagues.
Metadata	Information about content that enables it to be stored in and retrieved from a database.
Metatag	An HTML tag identifying the contents of a Website. Information commonly found in the metatag includes copyright info, key words for search engines, and formatting descriptions of the page.
Newsgroup	An online discussion group, sometimes also called a forum.
Open learning	Open learning encapsulate the features of distance learning emphasising open access to education or mass education through the widespread availability of self-instructional materials supported where necessary by tutoring and assessment.
Peer-to-Peer network	A communications network that enables users to connect their computers and share information directly with other users, without having to go through a centralized server.
Personalisation	Tailoring content and delivery methods to an individual user. Can be accomplished by a user entering preferences or by a computer matching each user to a profile.
Prescriptive learning	A process in which only coursework that matches a learner's identified skill and knowledge gaps is offered to him or her, with the goal of making the learning experience more meaningful, efficient, and cost-effective.
Role play	A training technique in which learners play roles in order to try out behaviours, practice interactions, communicate for a desired outcome, and/or solve a dynamic problem.
Simulation	Highly interactive applications that allow the learner to model or role-play in a scenario. Simulations enable the learner to develop competencies in a risk-free environment.
Storytelling or storyboards	The use of stories in organisations as a way of sharing knowledge and helping learning. Stories can be very powerful communication tools, and may be used to describe complicated issues, explain proposals or communicate lessons learned.
Structural capital	An organisation's 'captured knowledge' such as best practices, processes, information systems, databases etc. Often described as the knowledge that remains in the organisation 'after the employees have gone home for the night'. Structural capital is one component of intellectual capital.

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1. Introduction

The need of modern organisations to manage effectively their knowledge is recognised by the majority of business organisations[1]. For many companies, knowledge assets provide the basis for building capabilities delivering competitive advantage. Knowledge assets are frequently divided into two main categories: organisational or structural knowledge and human knowledge. Organisational knowledge also referred to as organisational memory represents knowledge that is embedded in its organisational design, relations, processes and IT applications as well as customer knowledge (the company's ongoing relationships with the people or organisations to which it sells). Human knowledge, also referred to as human capital, represents the human resources within the organisation and its business partners.

Corporate training is also becoming increasingly important in business strategies, sometimes as part of an overall knowledge management strategy, but more often as a separate initiative associated with developing core competencies, continuous professional development and life-long learning schemes.
The new generation of corporate training is likely to be dominated by e-Learning representing the convergence of the web and learning and used in a similar manner both in education and business training. **E-Learning encompasses several methods of learning, which are enhanced or facilitated by technology**. It offers all members of society easier access to information and learning flexibility by **matching learning to their specific needs and circumstances.**

A key challenge concerning corporate e-learning solutions is finding ways to use organisational knowledge as a learning resource to enhance the efficiency of training processes or programmes.
A further challenge relates to the need to combine different types of learning services (content, and delivery methods/media) to suit the specific requirements and preferences of individuals.
Overall integrated e-learning and knowledge management is a key challenge for many learning organisations and an essential part of strategic knowledge management.

In the first part of this paper the scope of Integrated Learning and Knowledge Management (LKM) is defined. A Learning Framework is then presented highlighting a learning control interface between the instruction environment and the learner environment to provide dynamic management of the conditions that stimulate learning. The instruction environment is then described trough the different learning modes and different delivery methods.
Learning Integration models are presented describing the interaction between business models with knowledge and learning models and the use of information, knowledge and learning in the

[1] "Strategic Knowledge Management Solutions" kBOS SKM 2

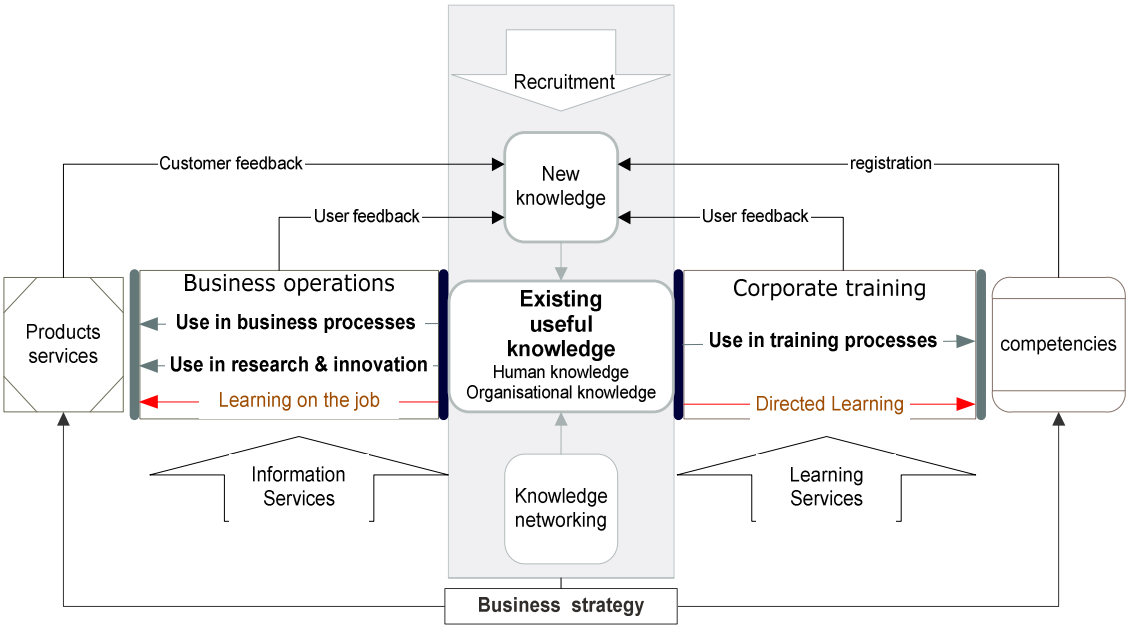
'work domain' and 'training domain'. Finally a LKM metamodel is proposed to facilitate building LKM applications and their integration with existing enterprise applications.

2. An integrated approach for Learning and Knowledge Management (LKM)

The scope for the LKM approach is described graphically in the following diagram.

Knowledge is depicted as a dynamic 'reservoir' which can be expanded with new knowledge generated internally or acquired through recruitment and business networking. Obviously knowledge can also be lost, either because people leave or when knowledge becomes obsolete due to changes in technologies and market conditions.

The important asset is therefore the **existing useful knowledge,** which should be protected and developed through continuous development of employee's competencies, including re-training in new technologies and or products.



With reference to the above diagram, knowledge is used in two distinct areas: business operations and corporate training.

In business operation knowledge is used directly in the implementation of business processes and in specific research and innovation activities. The main output from these activities is the company's products and services.

Existing knowledge is also used by employees in learning 'by doing' and as a result they generate new knowledge representing their increased experience. This particular knowledge development loop is very important in improving process efficiency and creating enhanced capabilities for process and product innovation.

Customer feedback represents the second knowledge development loop of business operation. It enhances the company's understanding of customer requirements and their perceptions of the company's products and is therefore crucial to the bottom line and the success of the company.

In corporate training the company's knowledge is used in training processes designed to establish specific competences. The training processes include the planning, development, coordination of learning services and monitoring of the results. The learning services include different modes such as instruction, forums, simulation, role play etc. Existing knowledge can be seen as a resource to be used by these different learning services.

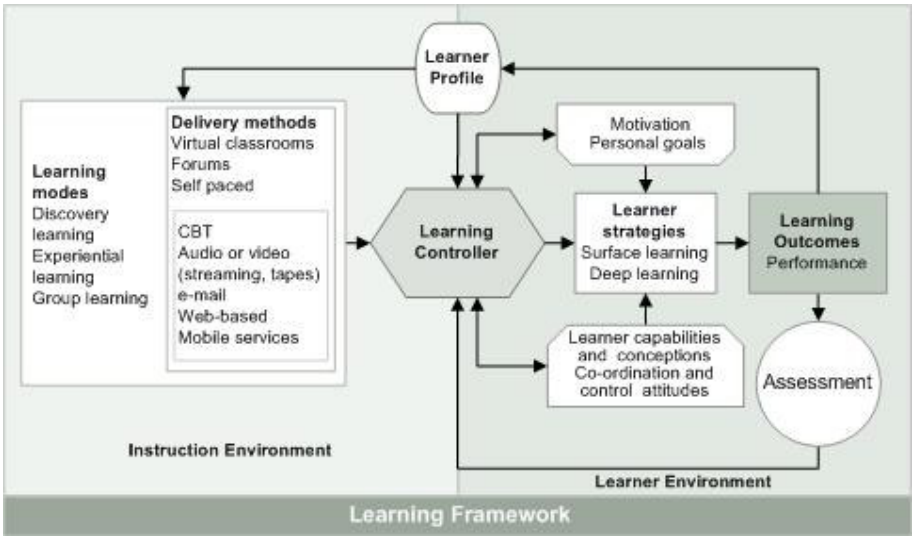
The output from the corporate training is the improvement in the company's competencies which should be sufficient to bring the company's competence to the required level in order to conduct its operation efficiently and maintain a competitive edge.

The required competences in terms of subjects are affected by market and technology changes and the required competence levels can change due to changes in the competitive environment. The competence level requirements are normally set out in the business strategy and change triggers are then monitored together with the actual situation to determine the applicable settings at any given time.

3. A Learning Framework

People learn in different ways and therefore a learning support system should provide:

- Different delivery modes and delivery methods which would give individuals choice to use what's best for them;
- Guidance to learners to select the most valid, appropriate and relevant resources for their learning.



The learning framework shown above consists of the instruction environment and the learner environment and should facilitate the balancing between guidance and learner control. A Learning Controller is therefore proposed as a key component of the learning system to manage the interface between the instruction and learner environments.
Good learning control should create and maintain the right combination of learning guidance and learner control over the learning content and in some cases over the learning processes.

In a corporate context a suitable set of learning modes and delivery methods would be normally used, selected according to the type of business, financial constraints and the nature of the workforce. E-learning is particularly important for companies as it supports efficient distributed learning which for large multinational organisations is essential both for implementing induction training and in training for collaborative projects.

3.1 The instruction environment – learning services

The instruction environment is characterised by different learning modes and different delivery methods. These provide a rich choice for creating learning services to suit the business objectives and the profiles of the target learners.

Learning modes

A classification for learning modes from a university perspective is given in Annex 1. The classification is also largely applicable in a corporate environment with the main learning delivery modes being:

- **Discovery learning**
- **Experiential learning**
- **Group based learning**

Discovery learning[2] encourages learners to ask questions and formulate their own tentative answers, and to deduce general principles from practical examples or experience. The main instruments are problem solving exercises and case studies. A tutor or mentor can be assigned to each learner to help as required. Case studies are used frequently for discovery learning particularly in law, social work, psychology and management. The idea is to learn from decisions made in real situations and from the lessons learned in the case study. Case studies provide users with the opportunity to tackle complex problems that represent realistic conditions that are likely to provide references for their future work.

Experiential learning can be described as learning that arises out of reflection on experience, leading to purposeful action in order to test out the 'hypotheses' that arise out of this reflection. The action in turn leads to further experience and reflection, so that experiential learning can be seen as a continuous cycle.

[2] Discovery learning emphasises what Bruner (1960, 1966) calls a hypothetical mode of teaching/learning as opposed to a more didactic mode.

Experiential learning emphasises the central role that experience plays in the learning process[3] . It is well known that theory is often detached from the realities of the business environment and it is only through practice that people become competent in their jobs. Experiential learning includes 'on job learning' as well as training methods such as simulation.

Simulation became particularly popular with flight simulators for pilots. The success of this approach has stimulated 'flight simulator' type training systems for many disciplines including navigation, engineering and management.

Many simulation training techniques involve learners in making decisions and communicating or negotiating with stakeholders in a particular organisational environment or with one another in a group of learners. The learners provide the human element in the system that is being studied and they are expected to react to the situation in a way that will be determined by how they and the other participants see their relative position, motivations and attitudes - in other words how they see their role within the system. Role-play is the name given to one particular type of simulation that focuses attention on the interaction of people with one another, according to their roles. It emphasises the activities performed by different people under various roles in different circumstances.

Simulation provides two key advantages:

- A 'safe', virtual environment in which learners can explore the impact of their decisions and actions without 'real-world' effects;
- Contextualises and facilitates integration of theory and practice.

ICT simulation and video game-based simulation projects are something that training centers and training directors often endorse. They claim improved training efficiencies, cost effectiveness, and a fine-tuned alignment of training with the actual job to be performed, particularly in terms of the development of cognitive skills needed in highly specialized activities involving highly technical equipment.

Group based learning is used primary for motivational reasons. Individuals learn from each other and from the experience which can be generated in group work. Further, learning in groups may be preferable on social grounds which create strong motivation to learn in order to excel as a team or reach specific goals.
The approach includes the following advantages:

[3] We learn by doing- *Aristotle;*
"One must learn by doing the thing. For though you think you know it, you have no certainty until you try"- *Sophocles (BC 495-406)*

- Engages individuals in the learning process;
- Provides an environment which facilitates interaction between learners;
- Promotes cooperative work;
- Enhances development of teamwork, communication and interpersonal skills.

Disadvantages include:

- Group dynamics may hinder learning;
- May not suit all learning styles;
- Difficult to assess individual learning outcomes;
- Tutors may be unsure of their role.

Delivery methods

The predominant learning styles are:

- Reading
- Seeing
- Listening
- Speaking
- Doing

The first three are passive types of learning, while the last two are active types of learning.
People learn best when they are actively involved in the learning process. People generally remember:

- 10% of what they read
- 20% of what they hear
- 30% of what they see
- 50% of what they hear and see
- 70% of what they say or write
- 90% of what they do and talk about.

In an online course there is a lot of passive learning done through reading text, listening to audio clips or seeing graphics. The active mode is undertaken through writing, emailing and chatting on line.

The e-learning delivery methods encompass virtual classrooms, forums and self paced learning using different technology options such as:

- CBT;
- Audio or video (streaming, tapes, etc);
- e-mail;
- Web-based training;

- Mobile services.

3.2 The learner environment

Learning strategies

Learners adopt different strategies which affect the outcome of the learning process[4]. The two broad learning strategies are the deep approach and the surface approach[5].

The deep approach is characterised by an intention to understand and reason with what is learned. Characteristics include:

- Relating new ideas with previous knowledge;
- Developing meaningful concepts and relating them to every day experiences/work tasks;
- Closely examining the logic behind theories or processes learned and developing own views.

The surface approach is characterised by an intention to reproduce the learned content. Characteristics include:

- Memorising information as discreet elements;
- Failing to derive concepts or principles;
- Difficulties in processing material and in discriminating where to focus;
- Treating learning as an external imposition.

Learning strategy influence factors

Learning strategies also reflect the following influence factors[6]:

a) Learner capabilities such as the cognitive processes reflecting the ways learners process information (e.g. relating, structuring, memorising);
b) Learning orientations reflecting the learner's personal goals and attitudes;
c) Mental models of learning reflecting learner's conceptions about the learning and teaching processes;
d) Regulation strategies reflecting co-ordination and control over the learning process.

Learning orientations are dependent on a number of motivational factors[7] , including:

- Intrinsic focus on learning and mastery rather than on performance;
- Professional importance/utility of learning outcomes;
- Self efficacy reflecting the person's judgements of their capability to learn;
- Degree of interest/enjoyment associated with learning services.

[4] Trigwell and Prosser 1991 "Improving the quality of student learning: the influence of learning context and student approaches to learning on learning outcomes".

[5] Marton 1975 On non-verbatim learning 1. Level of processing and level of outcome

[6] Vermunt 1996 & 1998

[7] Vanderstoep 1996

In conclusion the learning process is complex and everyone learns in different ways and is motivated by different factors. "We cannot talk about what is learned separately from how it is learned, as if a variety of experiences all lead to the same understanding. Rather, what we understand is a function of the content, the context, the activity of the learner, and, perhaps most importantly, the goals of the learner." *J. R. Savery & T. M. Duffy.*

3.3 Creating conditions that promote learning

Learning is more effective when an individual wants to learn. This point is elucidated by the well known quotation from the physics professor Victor Weisskopf: "People cannot learn by having information pressed into their brains. Knowledge has to be sucked into the brain, not pushed in. First, one must create a state of mind that craves knowledge, interest and wonder. You can teach only by creating an urge to know."

People learn easier when they have the motivation to know about a subject and certainly the speed of learning and the 'depth' of learning are fundamentally affected by the learning environment.

The following quotations indicate that people may have the capacity to learn but unless they are also motivated to learn, no training method can bring the desired results.
"I never teach my pupils; I only attempt to provide the conditions in which they can learn." *Albert Einstein.*
"Education is not the filling of a pail, but the lighting of a fire*." W. B. Yeats*
"Personally, I'm always ready to learn, although I don't always like being taught." *Winston Churchill*

Users of e-learning systems, even if they are motivated to learn, can suffer increased anxiety and loneliness compared to users in traditional instruction. These feelings sometimes are exacerbated by frustration due to technical difficulties (e.g., connectivity problems, unclear interfaces etc) which may cause learning failure.

A deep approach is normally associated with learner perception that there is choice in what is to be learned, that the learning service is of a high quality, and that there are clear goals and standards for what is to be learned[8].

Overall, the learning system control function is critical in matching learning services to learner profiles and importantly in managing the conditions that bring about the right level of motivation.

[8] Prosser and Trigwell 1999

Motivation control

An online learning environment can be effective in maintaining high user interest and motivation by providing:

- Learning processes that model each target user;
- Dynamic learning processes providing context based support ;
  - providing prompts and meaningful feedback if the learner deviates from the expected progress;
  - building in rewards and positive reinforcement based on monitoring the learner activities;
  - Providing a responsive help desk;
- Providing group activities to create a sense of social connection and team objectives;
- Guiding the learner to select services aligned to personal goals and learning orientation;
- Promoting practical application of newly aquired knoweledge;
- Providing an eclectic approach to learning and life interests.

Active Learning

The terms "active learning", "experiential learning", "learning by doing" and "hands-on learning" are often used interchangeably denoting participative learning as opposed to more passive forms of learning.

Active learning represents a learning environment stimulating learners to think about HOW as well as WHAT they are learning and to increasingly take responsibility for their own personal and professional development.

Active learning supports learners to know how to solve problems or perform tasks by asking the right questions, by initiating appropriate discussion, by explaining and debating in an effective manner.

E-learning systems support active learning by monitoring constantly the learner and creating new connections with learning services, with other learners, forums or tutors. Learning then becomes a multi-channel and multi-direction process for acquiring knowledge and applying it in problem-solving and decision-making strategies.

Key active learning characteristics include:

- Focusing the user's attention on what needs to be learned and why;
- Guiding the application of knowledge in everyday tasks and the generation of feedback from the application of new knowledge;
- Guiding the interaction and knowledge transfer among users and experts (trainers, tutors) in discussion groups, collaborative compositions, simulations, case studies, brainstorming and forums;
- Providing an open-ended knowledge development process with tutors and learners participating actively by identifying new questions, ideas, relationships, debate themes and cases for study;

- Providing continuous self assessment of competence level achieved and suggests ways to reach the required levels.

Knowledge Networking

Evidence suggests that learning is enhanced in networks of people and organisations as different backgrounds stimulate new ideas and innovation. Indeed innovation takes place at the intersection of diverse information flows and knowledge exchanges.

Knowledge networking creates unique opportunities to cross-fertilize knowledge between diverse knowledge communities.
Annex 2 reproduces an article from the FEND (Foundation for Enterprise Knowledge Development) Bulletin in 1996 highlighting the principles of knowledge and learning networks and the approach adopted at that time using collaborative projects between business organisations, universities and local authorities.

E-Learning tools

Today companies have a wide choice of e-learning tools. Yet, the most commonly used ones are still the simplest – websites for information, email for support, course development work flow and e-libraries.

A Virtual Learning Environment is a collection of integrated tools enabling the management of online learning and providing:

- A variety of delivery mechanisms,
- Student tracking,
- Assessment of learning outputs
- Access to resources.

There are specialised tools to create specific types of content or focused applications such as assessments or simulations right through to products that create traditional online courses.

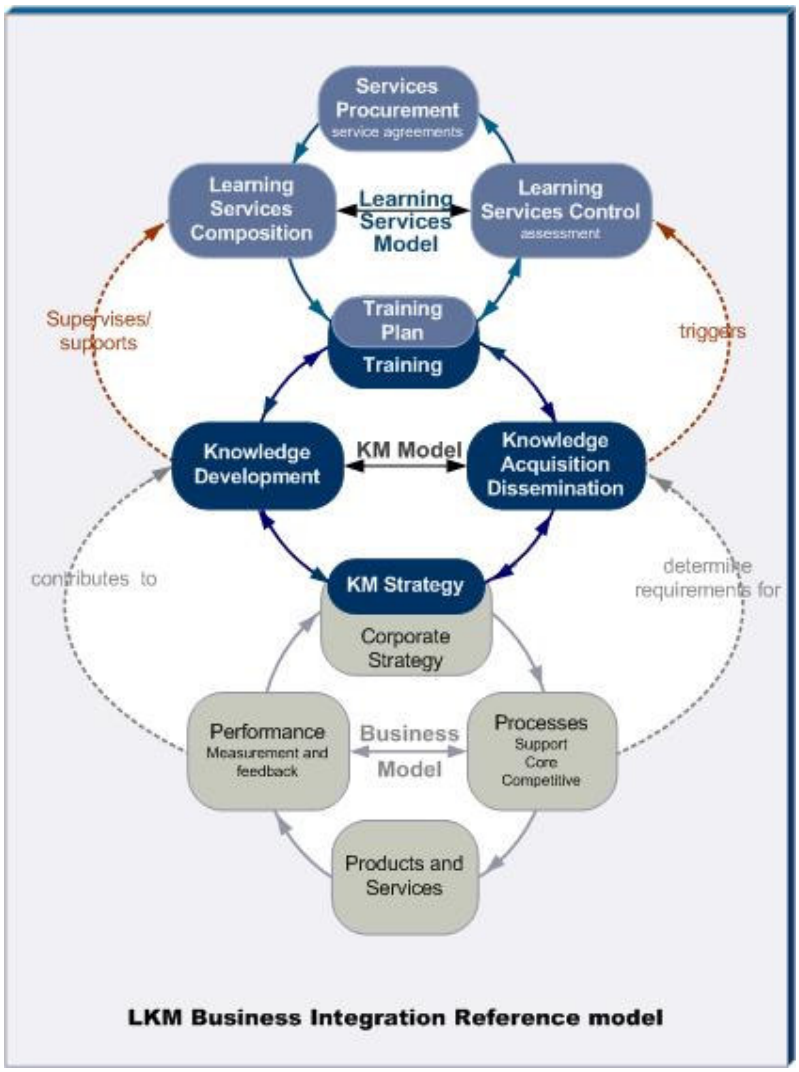
A particularly simple and effective approach is multi choice questionnaires, which utilises many active learning principles. Multi choice questionnaires can provide an interesting learning environment which is especially popular as an attractive group learning approach when results are compared and group competition is built in. Additionally, multi choice questionnaires serve the dual role of assessment and learning. The learner can be guided by the questions to explore and analyse a particular subject area and can verify his reasoning process by looking up the correct answers. Furthermore, an explanation can be provided for correct answers which can give an extended description of relevant principles.

4 Learning Integration Models

4.1 The Business Integration Reference model

The Integration Model shown below highlights the interaction between three different models:

- the Business Model which represents the overall business process consisting of strategy, processes, products and performance control and highlighting the way business drives the LKM process;
- the Knowledge Management process which represents knowledge acquisition/dissemination, training and knowledge development ;
- The Learning Services Model which reflects the processes to manage the provision of the right learning services to support corporate training., from internal and/or external learning service providers.



LKM Business Integration Reference model

The business model

The business model consists of the following four interconnected elements:

- Corporate strategy which encompasses knowledge management strategy;
- Business processes grouped under support, core and competitive categories;
- Products/services and other value outputs;
- Performance (emphasising both measurement and feedback handling).

Business processes implement corporate strategy to provide products and services. The overall company performance is then analysed based on process and product measurements and any performance deviations from expected targets would guide strategy and process improvements. These improvements are augmented from feedback obtained from process participants who maybe employees, customers or business partners.

The corporate strategy includes a knowledge management strategy. This defines the primary knowledge acquisition requirements (i.e. recruitment targets, training policy, etc). It also defines the primary knowledge development strategy in terms of R&D and specific knowledge development projects such as participation in knowledge clusters, collaborative projects, etc.

Requirements for knowledge acquisition are also created as a result of 'gaps' identified or generated during the implementation of business processes.
Finally, the performance management process creates a key input for knowledge development in terms of continuous improvement. Process knowledge management is intrinsically interconnected and indeed it would be possible to rely mainly on business processes as the diving force for knowledge acquisition and development requirements. The point to stress is that it is probably much more efficient to establish a simple high level knowledge management strategy and rely on an efficient business process management system to refine and eventually optimise the knowledge management process.

The knowledge management model

The knowledge management process model highlights the following four elements:

- Knowledge Management Strategy;
- Knowledge Acquisition and Dissemination;
- Training;
- Knowledge development.

is aimed at managing the collation of knowledge requirements from strategy and process inputs and at co-ordinating training and knowledge development to fulfil these requirements. The knowledge acquisition component also provides the input connection to the Learning Services.
The training component is aimed at using the learning services to establish the competence levels required and therefore is essentially linked to the knowledge development component.

The knowledge development component is aimed at maintaining the knowledge resources at the level required for a successful operation. The knowledge development component represents a highly dynamic process which can be compared to a knowledge 'stock control' process. It is therefore important to consider carefully the dynamics affecting the company's knowledge development so as to avoid potential deficiencies and to support maximum utilisation of the company's existing knowledge assets. This means that the level of knowledge 'stock' should be constantly monitored and projected development requirements and related actions should be revised accordingly.

The learning services model

The learning services model consists of the following four elements:

- Training planning;
- Learning services control;
- Services procurement;
- Learning services composition.

The learning services model represents a process for the composition of learning services that match the user specific company requirements. These requirements are transmitted to the 'learning services controller' by the knowledge acquisition component. The 'learning services controller' then triggers an assessment service to evaluate the current company situation and then co-ordinates the procurement of the required services. Procurement should be based on service agreements with internal or external providers specifying the quality requirements for the learning services.

The main feedback loop for continuous improvement of the learning services is initiated by an evaluation of training outcomes performed by the 'learning services controller'. Ideally user feedback should be also used to directly refine the process and technologies used for the composition of learning services.

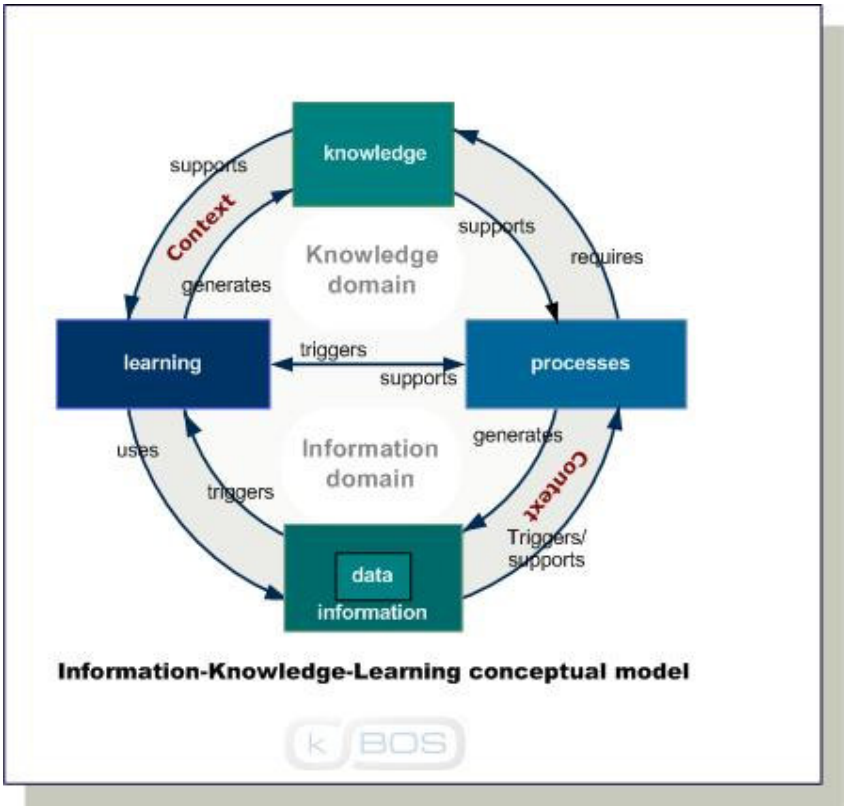
Service composition is intrinsically linked to the knowledge development process. Effectively learning services composition is part of the knowledge development process which should provide an appropriate supervisory function.

4.2 The Information-Knowledge-Learning (IKL) conceptual model

The IKL model is defined by the following five elements and their interrelationships.

- knowledge
- information
- business process/competence building
- learning
- context

The basic purpose of this conceptual model is to clarify the key entities that interact in developing and using knowledge within an organisation. It provides further clarification for parameters presented earlier and guides the formulation of the LKM meta-model which will be presented in the following section.



The information and knowledge domains

The model distinguishes between the information and knowledge domains. In the information domain data represent facts and becomes information when embedded in a context of relevance to a process. A process is frequently supported by learning as indicated earlier. Basically, every process implementation involves a highly dynamic sequence of using and developing information

and knowledge in different contexts. This can be best illustrated by considering a number of alternative scenarios.

A business process scenario

A business process task is activated by input information and is then executed either by a person assigned to the task or automatically, by for example a workflow based computer system using business rules. *Agents* (people or computer systems) undertake tasks using existing knowledge which predisposes them to act in a particular way in circumstances defined by the context.

People normally perform task using primarily their knowledge and possibly utilising information such as company instructions or relevant references. Apart from repetitive tasks, business processes are likely to involve complex decisions for which people use a series of mental processes. These processes are aimed at sorting the incoming information, identifying related information and trying to make sense of it in terms of what is already known. For complex decisions people are likely to consider different options until they discover what to do or they might generate questions to look up in various information sources including electronic content, experts or peers.

Decision making therefore involves learning which can be facilitated using the appropriate learning services. This will help users to make effective decisions faster. The experience gained through learning 'on the job' should then become reusable for other people in the company either by transferring some of the experience into explicit knowledge or by connecting the people engaged in similar tasks under similar circumstances.

In summary a typical business process is triggered by information and is executed using information, tacit knowledge or explicit knowledge or a combination of the three. Often the execution of non-repetitive tasks triggers learning processes which generates new tacit or explicit knowledge that supports the execution of the activity and adds to the company's knowledge capability.

A training task scenario

Training is also a process in which information and knowledge are used in a similar way as in the previous business process case. Training tasks are normally activated by training plan information and executed by people using learning services. These learning services are to a degree different from the ones used in the previous case as they represent training specific methods/techniques such as simulation, role-play and testing.

In training processes the objective will be to increase the competence of individuals to a level that will minimise the time and related costs in performing processes assigned to them. With reference to the previous example the objective will be to enable a person to make complex decisions fast relying as much as possible on his own knowledge. This is important as strong reliance in learning

in time constrained situations poses substantial risks for making costly mistakes. Further, there are productivity gains to be made by ensuring that under normal conditions people have the competences to complete tasks assigned to them.

Context complexity and representation

Context provides the integration medium for all the elements in the IKL model. Context essentially supports information filtering in the information domain or reasoning (often including filtering) in the knowledge domain. Accordingly, context complexity is higher in the knowledge domain particularly in the tacit knowledge domain where people can take into account numerous real time factors before acting upon information inputs.

Context in computer systems can be represented by business models which can provide semantic representation of different dimensions of the business environment including strategy, process management, organisational structures and measurement. The advantage of this approach is that the context models can be also used to guide the integration of learning processes and people to strategy setting and processes design and implementation.

Additionally, context models such as organisational, process or product models can be used to filter information enabling the right information to reach the right person or application at the right time**.** This simplifies substantially the design and development process for Real Time Enterprise solutions.

5. LKM Metamodel

5.1 Background

Arguably an integrated Learning and Knowledge Management solution will include a distributed information system that will have to be developed on top of legacy applications containing much of the knowledge a company uses in its day to day operations.

Over the last two decades integration of legacy systems has been based on database schema integration and schema mapping which is also the basis for modern day XML based adaptors. Such approaches exploit metamodels, which are models about models and transcend the heterogeneity of the different data models to be integrated.

Schema mapping takes as input database schemas which are models describing the data. Schema elements are defined using *metadata* that describes data, so schema mapping invariably results in mappings between metadata. However schema mappings have been and remain problematic as there are always ambiguities and there not always one-to-one mappings.

The problem of metadata management, which hinders the ability to resolve differences and associate metadata from different schemas, is addressed by domain-specific metamodels which provide a higher level of abstraction to manage heterogeneity at the metadata level[9]. However, differences at the semantic level can be better addressed if the solution is capable of handling semantics.
Metamodels are therefore often enriched with **domain semantics** to better express metadata, resulting in less ambiguous information schemas. Schema translation and schema mapping tools are then used for semi-automated translation with adherence to the metamodel.

Domain-specific solutions involving domain-specific semantics have definite advantages in limiting ambiguity and facilitating interoperability. There are a number of techniques to achieve domain specific semantics including domain-specific languages, ontologies and various types of taxonomies.
The semantic web represents the current developments in this area. The semantic web brings meaning to unstructured data by managing to add metadata and semantics using languages such as RDF (Resource Description Framework) and OWL (Web Ontology Language). These languages all build on the foundation of URIs, XML, and XML related technologies. Ontologies are the backbone technology for the Semantic Web providing the required vocabulary of terms in a

[9] J. Sprinkle, A. Ledeczi, G. Karsai, and G. Nordstrom. The new metamodeling generation. In *Proceedings. Eighth Annual IEEE Int. Conf. and Workshop on the Engineering of Computer Based Systems, 2001. ECBS 2001*.

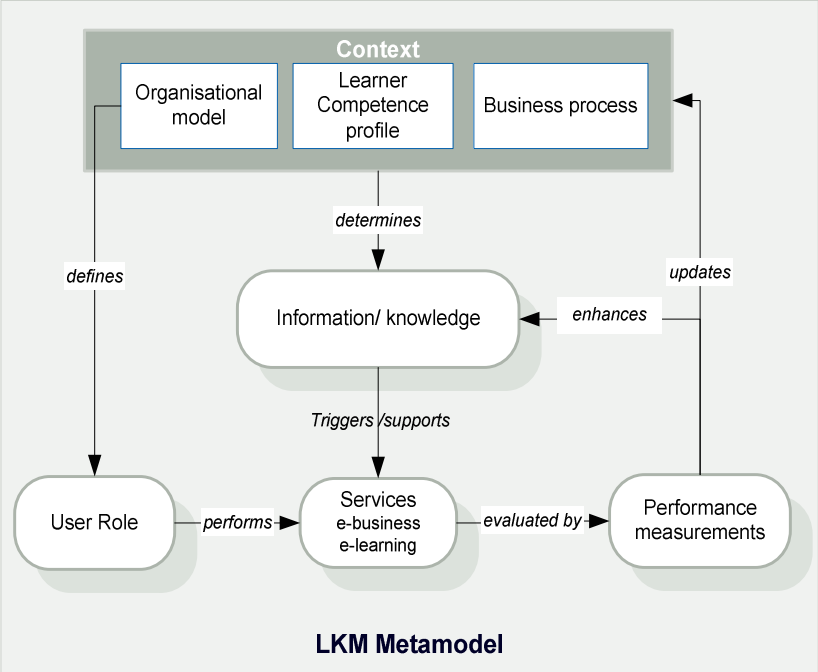
specific domain and the relations among them. As such they provide an important method for semantic enrichment.

Current developments also include Web Services which support process integration and therefore can deliver to users the knowledge and information required to achieve their tasks. In this area an important development is the BPEL4WS specification (from IBM, Microsoft, and BEA) that models the behaviour of Web services in a business process interaction. The specification provides an XML-based grammar for describing the control logic required to coordinate Web services participating in a process flow.

5.2 A simplified LKM metamodel

To build an integrated Learning and Knowledge Management solution on top of existing legacy applications, it will be advisable to utilise a middleware integration platform supporting application service integration based on SOAP, WSDL, UDDI and BPEL.
Such middleware integration platform utilising a knowledge oriented metamodel could prove exceptionally valuable, particularly in the context of strategic knowledge management. A knowledge oriented metamodel based approach is an essential element of building dynamic capabilities which are considered essential for sustainable competitive advantage.

The kBOS simplified LKM metamodel is shown in the following diagram.
The purpose is to provide a common basis in developing LKM models which will provide the blueprint for integrated Learning and Knowledge Management solutions. The LKM metamodel abstracts to the highest possible level the main concepts in the LKM approach defined in the previous sections.



LKM Metamodel

The LKM metamodel is consistent with the kBOS knowledge definition based on context – information and action[10]. In this sense the LKM metamodel can be seen as representing a composite knowledge model containing many knowledge elements. Each of the knowledge elements can be implemented using different techniques. Some elements are likely to be implemented in the future as ontologies that can be used by any of the LKM services.

The LKM services represent the action part of the knowledge and include two main types:

a. E-business services;
b. e-learning services

Both these types of LKM services are likely to be implemented in the future as web services to satisfy the integration and extendibility requirements discussed previously.

The LKM services are evaluated using performance measurements and it is important to ensure that appropriate measurement constructs are used as part of the services definition. Performance measurements are used as indicated earlier to identify improvements for organisational structures and processes and therefore provide the driving force for enhancing the company's knowledge assets. Further the performance measurements will include the parameters required to be monitored in order to update the context.

Acknowledgements

The paper is based on the e-learning work undertaken in the CSRQuest project.

[10] SKM3 Defining Knowledge and Knowledge Networking – www.kbos.net

Annex 1 Alternative learning delivery modes

- **Discovery learning**
  - Case-studies
  - Problem-based learning
  - Project-based learning
- **Distributed learning**
- **Experiential learning**
  - Simulated experience
    - Simulations/games
    - Role plays
  - Structured experience
    - Apprenticeship
    - Outdoor activities
    - Service learning
    - Work placements
  - Methods for processing experience
    - Action learning
    - Coaching
    - Mentoring
    - Portfolios
    - Reflective journals
    - Storytelling
  - Video diaries
- **Group-based learning**
  - Collaborative/cooperative learning
  - Peer teaching
- **Independent studies**
- **Negotiated learning**
  - Learning communities
  - Learning contracts
- **Open learning – development focus**
- **Self-directed learning**
- **Student-centred learning**

Annex 2 Building a Modern Day Agora of knowledge

By A Katsoulakos 26th March 1996

The foundations for a modern day *Agora of knowledge* have been defined with reference to the relationship between the teachings of the Greek philosophers and the knowledge oriented business management approach advocated by FEND.
In this article the focus is on the importance of Network *Learning* for future business competitiveness and economic growth. Network Learning is supported by FEND through a network of *Enterprise Knowledge Development Laboratories.*

COMPETITIVENESS AND LEARNING

In the emerging global market, competitiveness is a key issue for both businesses and governments. Often competitiveness is confused with short term performance improvement and is misused as the excuse for cost cutting exercises. In a true sense competitiveness is not a target in itself but a means to achieve targets of profitability and rising standards of living by creating added value and growth potential. In this context it is increasingly recognised that competitiveness stems from the 'strength of intellectual capital', in other words , the knowledge and motivation of people.

In his well known book entitled The Intelligent Enterprise, J. Quinn highlights that 'the key to productivity and wealth generation in over three quarters of all economic activity is managing intellectual activities'. Treating knowledge as the only source of lasting competitive advantage is a common characteristic of many highly successful Japanese companies. There are now signs that attitudes are changing in western business communities where a number of success stories are directly attributed to interdisciplinary team work based on organisational learning principles.

COMMUNITY PARTNERSHIP FOR KNOWLEDGE DEVELOPMENT

The competitiveness of any economic system, whether this is a country, region, industrial sector or an enterprise, will depend critically on the investment in knowledge development, team work and motivation. These non basic factors of production are today the critical success factors for economic stability and growth. Regional, industrial or company success will depend on the ability to improve intellectual capital. For this, synchronised efforts are needed from governments, regional authorities and business organisations in order to provide efficient and effective:

a) community learning infrastructures.
b) enterprise knowledge development processes.

It is important to recognise that *the emergence of a knowledge based economy requires a new synthesis of education, professional development, technology transfer, communication systems and learning.* For this, strong community partnerships are needed between enterprises,

universities and government bodies. It is only such partnerships that can address the following key issues for innovation and the application of new technology:

a) Scientific education and research reflecting closely business requirements;
b) Customised support to local or enterprise specific needs for continuous professional development and enhancement of skills;
c) Support for exchange of information and knowledge between producers, consumers and suppliers to enable strategic business integration;
d) Organisation of innovative chains involving large companies, small creative enterprises and research centres.

Forging partnerships to address one or more of the above issues successfully has proved difficult and there is a growing need for organisations that can *promote and facilitate community partnerships for knowledge development.*

THE FEND 'NETWORK LEARNING' APPROACH

The FEND 'network learning' approach, based on a network of Enterprise Knowledge Development laboratories (EKD Labs), is designed to address directly the issues outlined above.

Each EKD laboratory has three core functionalities:

a) Organisation and management of collaborative projects with local industry.
b) Development of 'accelerated learning' facilities (business models, information filtering and feedback handling)
c) Provision of EKD services

The engine of network learning is the 'collaborative projects' enabling FEND members to efficiently solve their business problems using the collective expertise of the FEND network including universities, service and technology providers and companies with similar interests. Equally important is the fact that the underlying EKD methodology used in the collaborative projects supports the development of internal expertise in the member companies.

Each collaborative project is used by FEND to generate new insights and experience in order to develop new learning facilities and to enhance the EKD services. The educational and research members of FEND can utilise their experience to provide learning infrastructures that support more closely changing business needs and specific requirements of local communities.

The FEND network of EKD laboratories creates a business knowledge pool and an effective means for the diffusion and assimilation of this knowledge in enterprises and 'learning support' organisations.

Both FEND HQ and EKD laboratories, located in major cities, are engaged in collaborative projects with local industrial companies generating together new 're-usable knowledge' and additional EKD services. As the number of EKD laboratories and collaborative projects increase, the rate of producing new knowledge and EKD services will be accelerated, continuously giving us new material to build our modern day Agora of Knowledge.


Strategic
Knowledge
Management