From Learning Objects to Knowledge Nuggets

Contextual Model for Workplace Learning On-demand in Practice

PhD Thesis

Submitted to the Faculty of Business Administration,
Business Information Systems and Economics

Fakultät Wirtschaftswissenschaften

University of Paderborn

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Paderborn, July 2007

Acknowledgement

I give sincere thanks to my thesis referees, Prof. H.-Hugo Kremer and Prof. Joseph W. Holland, and the thesis committee members, Prof. Peter F. E. Sloane and Prof. Bernd Hellingrath, for their openness to accept me as myself, support for my work, and their patience.

During the course of this thesis, I own many thanks to my colleagues at the Groupware Competency Center (GCC) of the Department of Business Information Systems, University of Paderborn, Germany. Bernd Hesse, Holger Ploch, Ingo Erdmann, Olaf Hahnl, and many more at GCC have offered me their insights, chances for open debate and discussion, and humor during my research work. I thank you all for your support.

Howard Almond has done an uncompromised job at proof-reading and editing my work. His diligence is deeply appreciated.

Finally, this thesis is a dedication to my parents for their belief in me and unconditional love.

Paderborn, July 29, 2007

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Abstract

This thesis contributes to the development and practice in facilitating e-learning effectiveness and efficiency at the workplace. The demand of today's workplace requires constant recurrence of learning processes, inseparably interwoven with daily job tasks. To be agile in business, every knowledge-intensive organization faces the challenge of supporting this non-classroom, non-instructional type of learning on-demand. The author reviews the important role of information technology in increasing the efficiency of knowledge creation processes at the workplace in a collaborative way. Approaches having found wide adoption under the "Web 2.0" umbrella are reflected upon. Issues of learning objects development are examined in detail because of their premises in supporting sharable and reusable digital resources for learning at the workplace. Although job context drives what is to be learned at work, the enterprise development of learning technology so far has followed the classroom instructional model, a centrally organized process that is led by predefined content. Conceptually as well as from the technology side this classical instructional model no longer satisfies current learning and knowledge management needs sufficiently.

Against this the thesis presents a context-driven knowledge management model focusing on learning through contextual collaboration at the virtual workplace (CM-WLOD). CM-WLOD comprises a pragmatic meta-data model matching employees' needs of both dealing with daily organizational processes and learning endeavors in an integrated and collaborative fashion. The prototypical implementation of this model denotes a decentralized, learner-generated learning process which is driven by contextual collaboration with digital resources, peers, and experts in an organizational workplace setting. The standpoint is that in addition to content, the enterprise information systems shall provide the employees a set of tools seamlessly merging informational content with the context of job and needs in learning together. CM-WLOD is implemented in a layered approach on top of IBM Lotus Notes and K-pool, a knowledge management system. A variety of practical use-cases and application scenarios is constructively examined. Especially, these cases deal with the ever changing patterns of re-use and re-purposing of information and their underlying re-contextualization in an effective way at the e-workplace.

Keywords / Tags

Blended learning, lifelong learning, e-workplace, on-demand, information management, knowledge management, contextualization, meta data, content, learning objects, knowledge nuggets, collaboration, tagging, granularization, re-use, IEEE LOM, Dublin Core DCMES, Lotus Notes

1 Introduction

> ***The practitioner must choose. Shall he remain on the high ground where he can solve relatively unimportant problems according to prevailing standards of rigor, or shall he descend to the swamp of important problems and non rigorous inquiry?***
>
> *(Schön, 1987, p.3)*

1.1 Scenario – Research Setting

1.1.1 The Days of Changes

These are the "days of changes" wherever you turn in the world, socially and economically. The consequences of changes in most cases have to be addressed immediately. This needs people and teams with skills and competence to enact going from here to there.

At the time this thesis was finalized the French people had just voted for a president who is spirited with change (and promises). The first ever woman chancellor in Germany is trying to push radical economical and social changes in areas, the stable settings of which have dominated the country after the Second World War. Changing the image of America in the world is on the campaign agenda of leading American presidential candidates.

In business, mergers and break-ups are not surprises on the front-page of today’s newspapers. A 20-year old Chinese company, Lenovo, purchased an important business segment from the hundred-year old information technology giant IBM (Hamm, Roberts & Lee, 2005). Not so long ago, the car manufacturer Daimler/Mercedes proudly merged with Chrysler in the US, and now, they are happy to find a buyer for the Chrysler share at a loss of $29 billion (DaimlerChrysler, May 14, 2007; The Economist, May 19, 2007). Another giant, Siemens AG, often perceived as conservative and sticking to an old value system, is replacing its 40ish Chief Executive Officer after less than three years (Süddeutsche Zeitung, April 25, 2007). An Egyptian billionaire is investing to transform a sleepy Alpine village, Andermatt in Switzerland, from a former frugal army property to a luxury oasis with pool, indoor beach, and a golf course (Foulkes, April 9, 2007).

All these changes will force people back to their study rooms again and again. In France and Germany, the bureaucrats must study reform politics and laws enforced by the new president or chancellor. At the Lenovo Group of China, employees have to adjust to their new foreign partners, and managers must learn how to conduct business on a global platform. In a break-up situation or a replacement of top managers people in the organizational hierarchy must be prepared to be laid off from their routine-jobs, and to re-train themselves for new skill sets; others have to execute the change management to new grounds they are not familiar with so far. And the farmers of Andermatt, Switzerland, need to radically transform their agricultural skills of the past to services catering to tourists in the future.

Globalization, individualization, new information and technologies are "mega-trends" that influence the changes at the workplace and the day-to-day work life of individuals (Kremer & Sloane, 2001, p. 5). Today and beyond, continuous learning is an essential requirement for a working adult who wishes to survive or thrive on the waves of changes of a knowledge-based economy. Workplace learning is a critical component of lifelong learning which is repetitively prescribed to cope with the vast changes in the 21st century (Gardner, 2007, p. 1). Formal learning used to be perceived as a one-time shot education or training period. In today's global economy, learning is not only a continuous endeavor, but the cornerstone for a successful organization. Particularly, in knowledge-intensive industries - e.g. education & research, information & communication technologies, life science & health services, finance, business consulting, media & entertainment, etc. - sharing information and knowledge shall be nurtured as a long-term organizational process (Senge, 1990, pp. 4-26; Vera & Crossan, 2004).

Another facet of change in learning is aided by the advances of information technology (IT). The rise of electronic learning (e-learning) is at first, a response from organizations that take advantage of efficient access to information anywhere at anytime. Over the years, the development of e-learning at the workplace has gone through hypes and experiments. The early stage of e-learning was simply putting old wine into the new bottle, i.e. cataloging books, or publishing text descriptions of a course in an organization's intranet or the World Wide Web of the Internet. Then, varieties of blended- and competency-based e-learning came in. Following the classroom-based instruction approaches, none of those has shed the traces of taking employees as button-pushing, passive, and thus in a way "dumb" learners. When employees are not actively involved in generating their own content and process, neither a trainer nor a perfect IT system can cater to their exact learning needs and styles at the time and place they need it. In reality, unless it is required or rewarded, people tend to be less motivated and assign less time for learning while simultaneously juggling a full-time job and an equally demanding family life (in case they choose to have one).

1.1.2 The Convergence of Learning and Knowledge Management

Hence, the next stage of e-learning at the workplace is to facilitate employees in knowledge creation processes that are embedded in their job context, i.e. at the right time fitting into their availability and schedule supported by the right content delivered to them in appropriate digital assets and tools at the workplace. This is titled as *learning on demand (LOD)* (Bersin & Associates, 2005; Fischer & Palen, 1999; Hartley, 2000, pp 17-27; O'Driscoll & Briki, 2004). In this thesis, the LOD approach is focused and elaborated on. The workplace setting as the virtual and physical embedding part of learning on-demand and will be refered to as *workplace learning on demand (WLOD)*.

After years of experiences and development, the emergence of WLOD reveals three trends in e-learning at the workplace:

1) The extension to knowledge management (KM) on an organizational level.
2) Leveraging an existing virtual IT infrastructure for learning integration at the workplace technology layer.
3) And finally, as most important, a flexible provision of embedded contexts combining both knowledge discovery and construction from design and support perspectives on the one hand and the content side of related or directly involved organizational processes on the other hand.

If the extension of learning to KM is a strategy embraced by the label "workplace learning", then, the next phrase "on-demand" reflects tactics in implementing that strategy – leveraging an existing IT infrastructure for just-in-time learning, and facilitating just-in-need knowledge creation within job contexts.

Ad 1): The convergence of e-learning and knowledge management derives from informal and collaborative processes in knowledge construction at the workplace (Masie, 2006). In contrast to the classical interpretation of e-learning as instruction, workplace learning is often an informal activity, depending on the sharing of information and knowledge among colleagues and experts (Hansen, Nohria & Tierney, 1999). Finding a solution often happens in – what is called in the IT industry among KM and learning products developers - "knowledge accidents", by talking to peers next to the water cooler, discussing with experts online or at coffee breaks, or discovering materials from external and internal databases for a presentation (Mahon, 1999; Sadeghpour, 2000). These are examples of an informal and unstructured part of learning at the workplace. Smith argues that - comparing to centuries ago - in the modern time, “Learning need not necessarily imply discovery of new technical or scientific principles, and (it) can equally be based on activities which recombine or adapt existing forms of knowledge” (Smith, 2000, p. 9). Thus, informal collaboration for acquiring knowledge is “a natural aspect of everyday work, and work itself is seen as a rich source of learning” (Collin, 2002, p. 133). In the knowledge-based economy with unforeseen changes, learning and innovation can give organizations a competitive advantage. Therefore, organizations realize the urgency to support and leverage the unplanned and informal activities of knowledge gathering in transforming them into more planned and structured regular processes for sharing and collaboration in knowledge creation at the everyday workplace (Cross, 2003; Lytras, Naeve & Pouloudi, 2005; Marsick & Volpe, 1999; Scott, 2006).

In the workplace setting, there is neither a physical nor a virtual border between learning and knowledge management. This can be best explained in a project environment. For instance, when building a resort with a sandy beach and a golf course in an unknown Alpine village in Switzerland, the project leaders and the team members must acquire numerous information and knowledge in different phases of the project. At the beginning, the project manager needs to know the local people, administration body, culture and custom in requesting collaboration and support. In the construction period, team members are required to learn the local logistic chain, how to persuade farmers to sell parts of their land, how to build and maintain beaches and a golf course in the Alpine climate, etc. At the beginning of managing the resort, team leaders must learn how to attract tourists to an anonymous village deep in a Swiss valley. All this knowledge and skill sets cannot be pre-packaged and delivered as classical formal instructions. Rather it is an on-demand requirement for the managers and team members in this specific project. And, it is hard, if not impossible, to distinguish between content material related to the customary communication, planning and reporting sides of project management, and complementary material solely dedicated to learning as a byproduct to become familiar with aspects of the project so far unknown to the team members involved in the project. As a result: it is rather artificial to construct a border between work and learning in today’s workplace.

Moreover, O’Driscoll and Briki (2004), Ravin (2006), and Rossett (as cited in Ellis, 2005b) articulate that the nature of workplace learning is informal, collaborative, and self-organized. At changing workplaces, instructors are able to foresee neither the content, nor the contexts, nor the processes of learning for all and for ever. When all is said-and-done when mergers, break-ups, new projects, and new management are completed, an individual employee has to rely on him/herself to discover learning resources and organize the process of learning on-the-fly. Instead of pre-defined and formalized assessment, the best test at work is the immediate application of what has just been learned to competently deal with the real world scenario. This is because, at the workplace, the outcome of information and skill update is recognized by the speed and the efficiency of generating tangible results, not grades.

Ad 2): To support learning as an integrated part of daily work, learning technologies cannot be an island of technology isolated from the employees' daily workplace (Golden & Loria, 2004). From the design point of view, "On-demand" is an idea borrowed from the utility industries. The access points for water, gas, or electricity are decentralized, and more important, integrated into private spaces at individual homes. At WLOD, this implies a decentralized learning approach which is integrated in the individual learner's virtual workplace. From the delivery point of view, like opening the tap for water, or plugging in for electricity, on-demand learning suggests that employees have the just-in-time access to resources and people from their workplaces at anytime anywhere. Bringing design and delivery together, the technological enablement of WLOD shall be seamlessly integrated into employees' workplace information and communication environments (The Conference Board of Canada, 2001, p. 30-32). In other words, the learner - i.e. the employee - shall leverage their existing technical knowledge of workplace usage for updating information and skills to get the job done rather than training and practicing specific learning technologies. Again, because workplace learning and knowledge management are merging closely, leveraging existing collaborative and KM technologies for learning purposes is a pragmatic approach (Jansen, van Laeken & Slot, 2004, p. 51-58). This is not only a cost-efficient solution for organizations, but also for the convenience of the users who are accustomed to their daily communication and collaboration techniques anyway.

Ad 3): The third attribute of on-demand learning corresponds to the trend of contextual embedment in acquiring knowledge at the virtual workplace. This refers to supporting employees in finding resources and people, and processing learning within their on-going job context. The model and implementation of contextual embedment of content material for knowledge management and thus learning purposes is the core focus of this thesis.

1.1.3 The Indispensable and Challenging Role of Context at Workplace Learning

A clarification has to be made before going any further investigating the complex topic of context. In this thesis, emphasizing the importance of context does not mean neglecting the aspect of content. With advances in IT and networked systems in Internet and intranet environments, content becomes more openly and freely accessible. Via free search engines, like e.g. Google [1], people are enabled to tap into the vast growing pool of information. Even in the American Ivy League, colleges and people start to open up valuable instructional content to the outside world. An excellent example is OpenCourseWare (OCW) at the Massachusetts Institute of Technology's (MIT). OCW from MIT has already published 1,550 pieces of instruction materials [2] on the web for free access. In a networked digital library system, virtually all research works and published books can be downloaded for free or economically borrowed (e.g. the digital inter-library loan systems of Nordrhein-Westfalen). However, Kremer states that the value of information, which is abundant on the Internet, lies in restructuring them into the right context (Kremer, 2004, p. 75). Hence, the free access of information and content does not automatically imply efficient approaches for appropriately processing the information for knowledge creation that can be used in a specific application domain of an organization at the workplace. It is the context that gives the content a life.

In the field of knowledge management, Nonaka and Konno (1998) have highlighted that context is the key factor which differentiates knowledge from information. According to them, context is "a shared space that serves as a foundation for knowledge creation" (p. 40-41). In detail, the context of knowledge includes information from multiple dimensions. These dimensions will comprise: physical spaces (e.g. conference rooms, offices), virtual workplaces (e.g. replicated content repositories, online meetings), collaboration tools (e.g. wikies, white boards, web conferencing), office systems (e.g. based on IBM Lotus Notes middleware), mental spaces (e.g. shared business goals, experiences, plans), any combination of these three spaces – and more. Individuals, project teams, work groups, interaction networks among people are "phenomenal" context platforms that hold knowledge. Nonaka and Konno's theory indicates that in a project-based workplace, for example, without knowing the local physical (e.g. climate, logistic chain), mental (e.g. culture, custom) and/or virtual (e.g. Internet infrastructure, mobile network) contexts, including their interactions, building a modern resort in a Swiss farming village can be difficult and daring.

In the classical education field, many scholars also challenge that learning out of context (formal or informal) is useful or applicable at work (Fischer, 2000; Sugrue, O'Driscoll & Blair, 2005; Sambrook, 2005). Lambe (2002) points to:

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[1] http://www.google.com
[2] http://ocw.mit.edu/, section: about)

> “All learning has context, and it has historicity. In both dimensions, [it] is imbued with meaning and emotion far beyond its informational content, and it is netted in a social understanding of the world. … It has a past and a future. It means different things to different people …” (pp. 5-6).

Unlike the school education, learning by itself is not the ultimate goal at work, but rather a "by-product of workplace activity" that is set in the organizational context and following work process (Fuller et al. 2003, p. 5). Further, Ertl & Sloane (2004) point that situated in job contexts, learning at the workplace is a self-initiated endeavor by employees, whereas "particular content will be less important" (p. 30). Masie (2006) states clearly that context is more important than content at the workplace. According to Masie, from the employee’s point of view, an individual is longing for peer-validation of the official, sometime all too politically correct, content (2006, p. 24). Therefore, at the workplace, not only content needs to be disseminated, but also context shall be conceptualized and managed for sharing and reusing in the on-demand process of knowledge construction.

Apparently, another development in the e-learning field is the *learning objects* (LOs) approach to modular or granular design of digital learning resources (Duval & Hodgins, 2004; Dharaskar & Thakare, 2007; Hodgins, 2000b; Green, Jones & Pearson, 2006; McGreal, 2004; Reilly, Wolfe & Smith, 2006; Shepherd, 2002; Wiley, 2000a & 2000b; Wiley, Waters, Dawson, Lambert, Barclay, Wade, et al., 2004). In the scope of this thesis, learning resources refer to digital content information and knowledge. The concept of LOs is aiming at granulizing learning resources in order to increase sharing and reusability of information and knowledge in multiple contexts in a knowledge-intensive community. LOs’ essential idea of granulated resources that can be used in different contexts caters to the sharing approach of on-demand workplace learning. This is because on-demand learning requires facilitation of modular knowledge for just enough learning (Hartley, 2000; Ravin, 2006; Davenport, 2006; The Conference Board of Canada, 2001). Unfortunately, this innovative idea of LOs took twists-and-turns in real world developments and implementations. This will be examined in detail in chapter 3 of this thesis.

In both, workplace learning and LOs studies, researchers have probed the overall influences of organizational contextual factors in nurturing sharing of information and creation of knowledge at the workplace (Ashton, 2004; Collis & Strijker, 2003 & 2004; Schryen, 2001; Skule, 2004). For instance, shared business goals, an established reward systems, strong leadership, etc. have positive influences in supporting workplace learning. However, these are factors from a top-down organizational context which is not the prioritized organizational approach of this thesis. There are few studies taking both, bottom-up context from individual learner's position and the organizational contexts, into consideration in facilitating knowledge sharing and collaboration. Particularly, context turns out to be the most difficult factor and a vacuum with respect to practical application in LOs development and implementation (Parrish, 2004; Nurmi & Jaakkola, 2006; Wagner, 2002; Wiley, 2004; Wiley, 2006).

In summary, workplace learning on-demand decentralizes learning to be an individual responsibility. Learning experiences are acquired at just-in-time fashion with just enough material assembled, and processed within employees' working context. The WLOD approach bears benefits for both employers and employees. This is because success in a knowledge-based economy is defined by the capacity and the speed in constructing, conveying and applying knowledge for specific business purposes in a collaborative context. There is no specific business value if knowledge is passively owned by a single person or just stored in the machine environment of a KM-system. For organizations, WLOD is a resource-saving solution to multiply human capital without disrupting line of business processes. For employees, there are time savings from just-in-time delivery of needed resources while increasing work efficiency, competency and quality of the outcome via learning-by-doing for what is relevant to their job context. However, context relevance is a double-edged sword: the sweetest promise of on-demand learning as well as the biggest challenge to implement, because of its complex basic nature and mixture of contextual factors from different spaces (virtual, physical, mental, people, projects, business processes, date/time, etc.).

Today, the pendulum of focus in workplace learning is shifting from the sheer distribution of information and content materials to combining context information in the process of knowledge creation among employees. The topic of learning objects was inspiring at its time in focusing towards modular or granular design of sharing and reusing knowledge. This is attractive for just enough learning at the workplace. However, past efforts of developing LOs concentrated on a one-fits-all content packaging and sequencing model for reusing learning resources. But the evolution of integrated learning and knowledge management approaches, with their related technologies at a general workplace setting, is preceding the idea and development of learning objects solely based on an interpretation of instructional and one dimensional content classification. Far beyond an often found narrow view, the wider domain of LOs is a collaborative knowledge management sphere in which learning is not text book bound or instructor led, but consists of self-organized collaboration in organizational contexts within a community of colleagues - and learners (Downes, 2001 & 2004a).

After all, the world is multi-dimensional, neither one single standard nor one general model is able to disentangle the intermingled and evolving knowledge web. Meanwhile, coping with the right approach to reusability is at stake. When it comes to dynamically evolving knowledge at the workplace, granularity does not only pertain to content. Reusing means essentially re-purposing and re-referencing in different contexts defined by individual employees, the learners. There is a need to practice a bottom-up approach in context-driven knowledge sharing and collaboration at virtual workplaces. Issues like these will be a central part of this thesis.

1.2 Purpose of the Thesis

The purpose of this thesis is to contribute to the on-going research in workplace learning on-demand (WLOD). Based on the current state of this research the know-how will be applied in designing, prototypically implementing, and facilitating WLOD within the framework of an organizational knowledge management system specifically dedicated to WLOD. This will be achieved within a contextual model for WLOD, the author's "CM-WLOD" approach.

The main theoretical objective of this research is to model context information around given content elements in order to support on-demand knowledge construction in the course of interwoven business and learning processes at virtual workplace settings. The constructive and modeling parts of this objective are analogous to the endeavor of transforming the current state of a content-centric world-wide-web to a "Semantic Web" by adding metadata information around the content elements on the web.

Different aspects need to be explored in the course of building up and practicing the contextual model of knowledge:

- The aspect of information technology: a sound enterprise information system is the driving force in ensuring just-in-time information and knowledge acquisition. Therefore, this research first explores the effects of information technology in e-learning and at the e-workplace.
- The aspect of modular design of knowledge: on-demand learning requires the right amount of knowledge assembled or delivered for the job task or project work. Through a quality analysis, the author exams the development of learning objects as a catalyst for granular design in facilitating reuse of digital resources and "just enough" learning.

- The aspect of context: while deciphering some of the elaborate twists in the evolution of learning object understanding, this thesis approaches the concept of modular design of knowledge from a multi-dimensioned context point of view. This might serve as a contribution to keep the commendable thinking around learning objects moving along to action.
- The aspect of conceptual framework: a *Contextual Model for Workplace Learning on-demand (CM-WLOD)* is developed to facilitate a bottom-up approach of informal workplace learning driven by individual employees' job context. Against the background of knowledge sharing and collaboration in organizations, context information determines the meaning and usage of information rendered as content packed in digital assets at the workplace, and together, they make up enterprise/organizational knowledge. Context information under the scope of this thesis encompasses elements from different dimensions. For example, the context itself emerges from the dimensions of people and teams at their physical and virtual workspaces embedded in organizational projects and processes. There is a kind of "original" context information often bound to the content at its creation, and a follow up of added or modified context information during organizational processes of reuse or repurposing of already given content materials. All these attributes will be analyzed and conceptualized in the multi-dimensioned context modeling of knowledge.
- The aspect of know-how in implementation and application: the CM-WLOD contextual model described above is implemented as a prototype in a layered approach (see 5.1.2). A central part play the "K-pool" (i.e. "knowledge pool") system as state-of-the-art knowledge and content management system and IBM Lotus Notes as middleware layer which is integrated into employees' daily virtual workplace environment. From the learner's position, the author denotes possible solutions to solve on-demand learning needs against a real world project work at a non-profit organization as a case study. In order to leverage the related know-how, this project work is taken as a background scenario in which patterns and processes of contextual collaboration are generalized for future applications.

This thesis is intended as a step towards contextualizing knowledge that may empower employees more efficiently and effectively in information retrieval and knowledge collaboration in their job context – and thus contribute to their lifelong learning endeavors.

1.3 Methodology

This thesis has an action-based research focus on organizational challenges and practical know-how of enhancing the effectiveness and efficiency of workplace learning on-demand via general organizational information systems. The nature of this thesis and the action research is centered on a constructional approach in which a theoretical model is motivated and shaped in its essential building blocks and then applied to solve or improve organizational processes and behavior (Argyris, Putnam & Smith, 1985; Eden & Huxham, 1996).

Complementary, the practical and applied research method in this thesis follows the guidelines of research approaches at the Department of Business Information Systems of the University of Paderborn, Germany. Hence, core subjects are positioned as an inter-disciplinary field between social science in the area of business processes and organizational behavior on the one hand, and on the other hand applied computer science in the area of software engineering catering for enterprise IT system design, development, and applications. At the Department of Business Information Systems research is a process of applying theory to software and system prototypes in order to gain first-hand know-how in resolving or improving challenges of enterprise information system (IS). This pragmatic approach is also advocated in the IS research field because the action researcher aims to not only study the organizational process, but also to improve and change it by practice (Baskerville & Myers, 2004).

Moreover, from the beginning of this research work the author has decided to be more on the side of a "practitioner of business information systems", searching solutions in the "swamp of important problems and nonrigorous inquiry" (Schön, 1987, p. 3). Schön defines the application of research-based theory and technique as the highland of professional practice. But the important problems in the real world are often surrounded with specific contexts in the lowland of swamps, not bounded by standard methods taught in schools or written in textbooks.

Hence, in order to gain practical knowledge, the role of the author in this research is as a participant who worked collaboratively with other team members in analyzing knowledge sharing problems at daily workplace settings. In the sequence, a theoretical model is developed and implemented. This is accomplished in a layered approach, as mentioned, on top of the K-pool enterprise knowledge and document management system (K-pool is an academic research prototype system) and an industry-standard collaboration platform (IBM Lotus Notes). Again, whether it is a for-profit or nonprofit working environment, the nature of workplace learning is being integrated with job tasks and away from school education and instruction-based training.

In addition to the technical application, the second phase of action is revealed by applying the theoretical model to a real-world project scenario (workshop for workplace and KM learning at CDHK [Chinese German Graduate College] in Shanghai). The annual preparation phase of the project provides a workplace scenario to utilize the model of context knowledge sharing among the GCC project team members. Both the author and the team members are in the role of employees and workplace learners. This real-world scenario and a role-based "persona"[3] approach is a tactic to extend the know-how from one project domain to other organizational settings. Eden and Huxham specifically stress that the action researcher shall be able to envision the study outcomes going beyond the original organizational context (1996, p. 84).

In the arena of prototyping and creation of user centric application systems and software, the use of "persona" as a design concept has gained momentum in the new millennium. Major software corporations, such as SAP (Calde & Cooper, 2000) and IBM (IBM User Engineering, 2004; Raven, 2006), have all been constructing persona(s) into design guidelines for improving system development, software prototyping and production. The practice of "persona" is the essence of the Goal-Directed® interaction design for digital products. Coined by Alan Cooper (1999, pp. 151-159), the Goal-Directed® design aims at integrating the end-users' experience into the design process of a product via typifying the archetype of users' goals, habit, expectations, etc. There are four basic procedures engaged in the design methodology: (1) Site visit - interview and observe customers who will use the application; (2) Goal-directed – discover their goals; (3) Persona – create a persona, an archetypal user who embodies these goals; (4) Satisfaction – design something that satisfies this archetypal user (SAP Design Guide, 2003).

[3] A persona characterizes a role which represents a user group. A persona is often a fictitious user who is described using a combination of text, lists, and tables, etc. In practice, to make the application related more to the real-world scenario, a persona is given a name, for example "Smith", and should also include a photo of the fictitious user to be more present in the application (IBM, http://www-03.ibm.com/easy/page/4020).

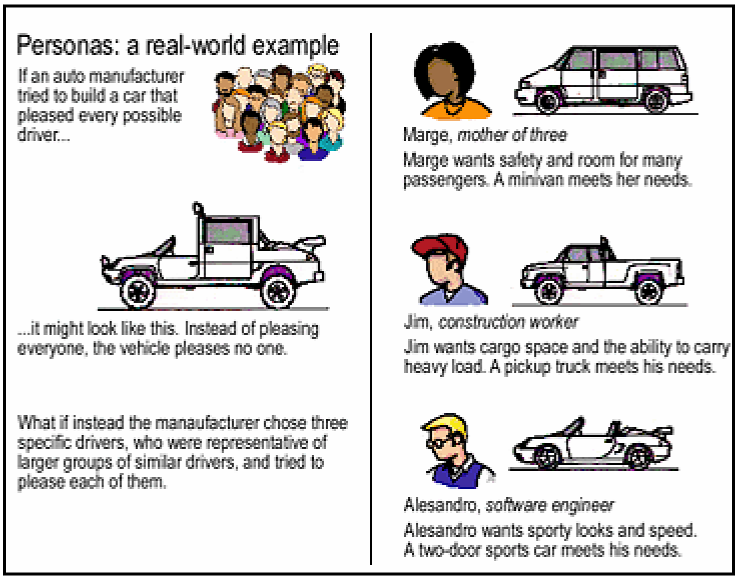

Figure 1-1: A persona as an archetypal user of a product (adapted by SAP Design Guide, 2003, from Calde & Cooper, 2000)

As Figure 1-1 displays it is impossible to satisfy every single user's expectation and profile when designing a functional product. Shown in the left area, the outcome of the product is a monster. It is useless because the design is based on a conglomeratic aggregation of the desires of all possible types of users. Therefore, a "persona" is placed to respectively represent the main characters of a group of archetypal users using the product. Fioretti & Carbone briefly summarize the application process of the "persona" (Fioretti & Carbone, 2007, section: Understanding the design inputs, para. 2):

- "The creation of personas, which are archetypal users of products with their goals, backgrounds, and mental models.
- The description of scenarios involving actions the personas want to perform and for which a product must be designed.
- The creation of storyboards of the product interface derived from persona scenarios and mental models, which then drive the rest of the product design."

In this thesis, the outcome of the "Site visit" of the Goal-directed software design emerges from the action-based research nature of this thesis. The author's participation and observation as a team member in the CDHK project and a member of the research group provides profound understanding of the "Site", the knowledge-intensive workplace. More important, working side-by-side with other knowledge workers and communicating with peers and colleagues in a team, the author captures the needs, goals, and motivation of a knowledge worker in updating skills and knowledge while processing daily job tasks. More detailed reference will be given in chapter 5.3 by applying elements of the persona approach.

The effectiveness and finding of the research practice is reflected and assessed in chapters 6 of this thesis, which completes one cycle of action (Checkland, 1991).

1.4 Justification

In this thesis, IT enablement in modern workplace and learning environments is assumed. Thus, instead of naming it as e-learning on-demand at an e-workplace, the “e” is omitted for simplicity. And as reasoned above, because “informal workplace learning” and “knowledge management” are converging, during the course of writing the author inter-changes the two phrases without further explanation.

Again, this thesis is an attempt to complement the formal learning process and content-centric development of information sharing systems. Generating content is not within the scope of this thesis, and content is taken as given entities of digital content materials.

Against the strong priorities of creating and designing content itself for learning purposes in much of the e-learning research this apparent negligence shall be justified further. Explicated content for learning has been bound to books and papers for centuries. With the advent of computers the creation of optimal instructional design approaches to guide learners through computer based content, when they are in the learning mode, has been in the foreground. Still in 1990, at the emergence of the Internet, content availability was the bottleneck. This was the time when Bill Gates, Microsoft Corporation’s founder, in his famous keynote address at the “Fall COMDEX” exhibition in 1990 (Gates, 1994) phrased his corporate strategy for the next decade to help bringing “Information at your Fingertips”. Now, more than 15 years later this vision has become true (surely not as a consequence of Bill Gates’ speech though): Information at your fingertips is abundant – all too abundant in the current Web 2.0 setting (chapter 2.4.2.2 of this thesis will deal with many aspects).

But, what apparently has not happened to a corresponding degree is to look at learning and knowledge creation processes under the assumption that learning content bound to digital assets is already there and needs no efforts to be developed still another time. Given the creative as well as chaotic nature of current Web 2.0 developments it rather needs efforts to properly select suitable content materials or references and contextualize them.

To counter, right from the start, the argument that this focus on re-use of content on the Internet or in organizational databases implies carelessness, disregard of the control of quality, or bending the facts for content not fitting sufficiently enough: One factor of contextualization, explicitly or implicitly, must be around the notion, for instance, “endorsed by XYZ Corp." or "authenticated by Helen Smith", "XYZ Corp." being the using organization and "Helen Smith" being a publicly well known person guaranteeing quality in her field of expertise. So, one justification for not focusing on the creation of content in this thesis is that from the author's understanding a current bottleneck is not availability of content any more. Rather selecting, structuring, categorizing, re-purposing, and process integration by connecting content to people and teams in a contextual collaborative manner currently need more attention and will be among the central themes of this thesis.

1.5 Proceeding Structure

This thesis begins in chapter 2 by analyzing the effects of information technologies in changing the landscape of workplaces and learning. In a knowledge-based society fostered by technology advancement, the rise of on-demand workplace learning is a response to global competition. Therefore, learning is a constant endeavor that cannot be separated from daily work.

Chapter 3 recaptures the history of the concept of learning objects as a ground-breaking modular design approach in facilitating just enough or just-in-need learning. Then, the author reassesses the development of learning objects based on its premises of being granular, contextually reusable, and interoperable chunks of information or knowledge. Further, a brief review of learning objects repositories is denoted in reflecting the first generation in modular design of digital information and knowledge. Mainly, chapter 3 reflects that the world is multi-dimensional. Neither one single standard nor one general model of granularity is able to untangle the intermingled and evolving knowledge web. This insight points to an avenue for further development of modular design of knowledge for WLOD.

In chapter 4, firstly, the author shows that sharing and reusing information and knowledge is context-driven, which cannot be pre-assumed or pre-defined. Then, secondly, the CM-WLOD contextual model for workplace learning on-demand is established and derived. Inspired by medical cell research, the contextual model is the conceptual framework for technical design and workplace learning practice. The author has developed this model during many discussions, observations, debates, and collaborative work with her team members at GCC.

The action is described in chapter 5. After denoting the prototypical implementation of CM-WLOD's essential building blocks (see 5.2) the author elucidates applications of her CM-WLOD approach. Consequently, this system is used to empower individual learners retrieving information and generating knowledge within their job context. Context driven ad-hoc knowledge sharing, reusing of content and related context information, together with collaboration services is enabled efficiently via the context-driven functionalities of the K-pool service layer which is integrated into employees' workplaces. Results of the conceptual analysis and constructive parts achieved in chapter 4 have been fed back to improve K-pool's functionality and generalize its application scope. This holds especially for adding the concept of multiple context information sets. This thesis advocates the standpoint of the individual employee. So, the general approach to WLOD is learner-driven, rather than driven by a training department. In this chapter, the author narrates the experience from a learner's standpoint.

Chapter 6 reflects and assesses the result of the contextual approach in order to fulfill the granularity, reusability, and interoperability features of modular knowledge. This is a result in facilitating WLOD effectively and efficiently.

At last, the author draws conclusions with a summary of this research. Additionally, suggestions for future studies are given in the context of workplace learning on-demand.

In chapters 2 and 3, due to the very nature of the research topic with respect to media and topicality, ample material has been drawn from ongoing content materializations and discussions in the e-world, i.e. on the Internet from blogs, discussion forums, web postings, etc. This content is publicly available on the web and reflects to a high degree a substantial and intense ongoing discourse amongst scholars (and also practitioners) about central issues of this thesis. Unfortunately, reality will show that some of these sources might not be available in the future in a way following traditional referencing of research "papers", i.e. information being rendered on paper as medium and being kept in libraries of the brick-and-mortar world. The author has nevertheless decided to add these references of electronic material to the literature list. Otherwise important actual facets of the research topic - with respect to the general picture of the research substance, threads of arguments, and especially schools of thinking and communities of the people involved - simply could not be appropriately covered and documented.

2 The Emergence of Learning On-demand in Virtual Workplaces

Wisdom is not a product of schooling, but the lifelong attempt to acquire it. – Einstein
(as cited in Fischer, 2000, p. 265)

2.1 Where Are You If Not Online? – IT Transformation of Work and Organizations

2.1.1 Global Access to Communication and Knowledge

Are you online? Do you google[4], YouTube[5], podcast[6], blog, or did you ever fly on Second Life[7]? Today, there is no need to explain what "online" means, or google, or blog, which are all becoming parts of our lives (or at least for the teenagers). This connectivity anywhere at anytime via any device is an admirable achievement of human-kind in less than 30 years: working, learning, and sharing with each other virtually at a few clicks away.

Unknown before 1969, now, the Internet is a massive global network comprising millions of computers interconnected over uncountable national and international networks, defining a global *network of networks* (Hoffman and Novak, 1996, p. 50; Rao and Natesan, 1996). The invention of the World Wide Web, *The Web*, with the reduced cost of personal computers and mobile devices is in its current evolution phase boosting a bottom-up personal usage of information technologies. The acceptance and usage of the Internet is so phenomenal that experts are having difficulty on monitoring its growth. Expressed in numbers, the growing number of Internet users and Internet applications can only be astonishing.

Some references shall give estimates on this obviously only vaguely to calculate numbers and various phenomena they imply. According to *Fortune Magazine* there were more than 700 million users all over the world in July, 2006. Ryan (2006) reported on May 29th, 2006 that there were totally 694 million Internet users over age 15 in the world. The U.S with approximately 152 million Internet users and China with currently 75 million are ranked number one and two among other countries. Yet, counting heads does not say much about the quality of usage. According to the report, average Israelis spent a record of 58 hours per

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[4] Google at http://www.google.com/ is a free Internet search engine.
[5] YouTube at http://www.youtube.com/ is a website for free video sharing.
[6] Podcast is broadcasting personal or professional audio content over the Internet and it is explained in detail in chapter 2.4.2.2.4.
[7] Second Life at http://secondlife.com/ is a three-dimensional, Internet-based virtual world where the user can create anything they desire and interact with other users' creation virtually.

month on the Internet, twice more than average Americans who trailed far behind 15 other countries. There is always a balance between sheer head counting and quality of usage. Kirkpatrick (2006) stated a growth of 6 million more users connected to the Internet worldwide in less than 45 days, on top of the existing 700 million. All indicators suggest that the number of Internet users is about to continue its growth for the time being. According to The Economist (March 10, 2007a), there were already 1 billion Internet users on the planet in 2005. This had been predicted by IDC, a leading research and consultancy group in the information technology (IT) sector worldwide, already four years ago in 2001 (as cited in Direct Marketing, 2001, p. 12).

The Internet and its most popular application, the World Wide Web, permits inexpensive, global, and interactive mass communication. The Internet transformation is ubiquitous in all spectrums of individual life, society, business, education and learning.

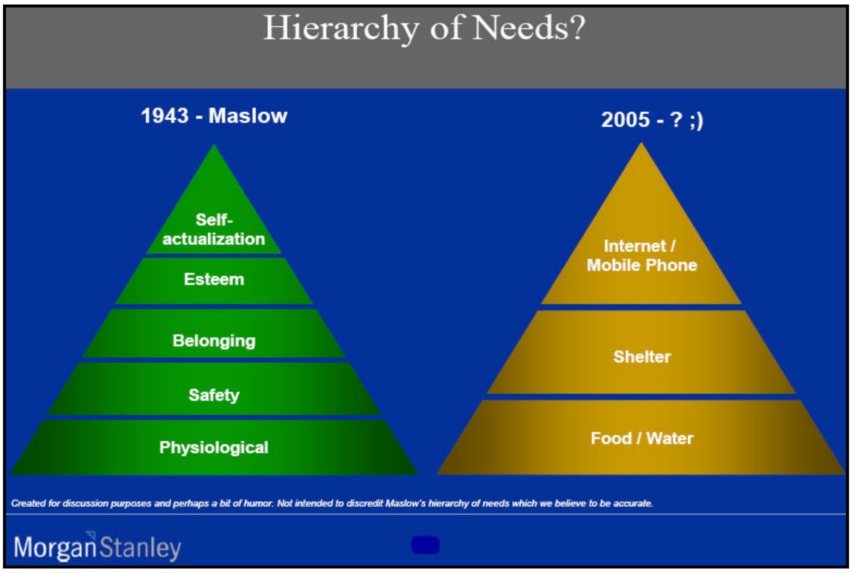


Figure 2-1: Hierarchy of needs from Morgan Stanley (Meeker, 2005, p. 23)

Witty as it may appear, Mary Meeker (2005) of Morgan Stanley stated that the Internet is to be regarded as one of the three basic human needs after food and shelter in the new millennium and beyond. This is quite a difference if compared to Maslow's human hierarchy of needs back in 1943. Figure 2-1 from Meeker indicates that a person in the 21st century cannot be a completely satisfied or motivated one without being "connected", to the Internet or via mobile phone. Maybe, this can be regarded as an exaggeration with a touch of humor, but it seems all too true to teenagers and young adults in China. As the second largest and the youngest group of Internet users in the world, more than 50% of Chinese Internet users (i.e. currently roughly 38 million) are under 24 years of age, and many of them are posting their distress under enormous pressure from school and parents in a website called Chinakids

(Fowler & Qin, 2006). American teenagers are said to spend an average 3 hours a day on the Internet, almost the same amount as watching TV programs. Michael Wolf, president of MTV Networks, asserts: "Connectivity has converted a generation of people from passive watchers of television into very active users of communications." (as cited in Kirkpatrick, 2006, section: Brainstorm, para. 8).

As for governments, most governments view global communication and the related access to knowledge a source offering infinite possibilities for the positive development of (their respective) society. Therefore, many are investing heavily in information technologies. The 34 European countries have committed themselves to an ambitious project (*EU i2010*) to strengthen investment in broadband Internet access to all citizens in both urban and rural areas. This is about to include especially the elderly, the disabled, and the unemployed to increase employment, business growth, and foster innovation. The European Parliament is aiming at creating “a single European information space … enabling the knowledge-based society to develop democratically and with the technological innovation it needs…” (Paasilinna, 2006, p. 5).

However, at the other side, bottom-up communication and access to knowledge has frightened some governments at the same time. The power of the Internet may nudge uneasy feelings in governments, such as the Chinese government, with a tight grip on all means of media with restricted freedom of thinking and speech. Google has entered the Chinese market with less social-networking services, as well as self-imposed censorship on content. This has stirred up many criticisms, both on the Chinese government and Google as the company being regarded as blocking the democratic and free-thinking nature of Internet technologies (Einhorn, 2006).

In the business world, early on in 1997, industry observers had predicted already that e-commerce would shake every industry up (The Economist, 1997, May 10). Now, ten years later, it is a reality that the Internet is re-defining rules and practices for customers, suppliers, and producers, as well as employees and managers in all sectors of industries by large. From the early 1990s booms of corporate intranet, Internet, and PC abundance, enabling the rise (or survival, respectively) of global IT-companies like IBM, Microsoft, Cisco, or SAP, to later 1990’s innovative e-businesses models like eBay, Amazon.com, Google, Skype, or YouTube, e-business is invigorating more or less all traditional business models and processes. This transition is especially extending to bottom-up business opportunities that facilitate highly customized and individual peer-to-peer transactions. Business owners also benefit from the popularity of the Internet. The emerging online communities have formed ideas and have contributed to product design on a large scale and variety, ranging from e.g. open source operating systems like Linux, to a wide range of innovative products based on lead users' ideas at 3M corporation (von Hippel, 2005, pp. 136-143), and to General Electric's (GE) three-dimensional heart scanner (The Economist, March 12, 2005). Eric von Hippel from the Massachusetts Institute of Technology (MIT) names these trends *Democratizing Innovation*, the title of his well acclaimed book. Von Hippel alleges that customers are the ultimate innovators of product improvement and innovation. Internet, collaborative tools and software, and online communities bring the end-user, the consumer of (physical) products and services to the foreground of innovation for effective and efficient business productivity (von Hippel, 2005, pp. 11-32, 121-126).

As for the individual professional, the World Wide Web, one of many usages of the Internet, poses as a free and vast pool of information and communication possibilities. McGuire (2006) noted that 50 percent of U.S. physicians devoted at least eight hours per week online; on the other hand only 10 percent spent two hours or less per week online. Meanwhile, 60 percent of total respondents stated that at least two-fifths of their time on professional activities is online. In Canada, at work, an increasing number of workers are accessing news and information online. The latest and fastest growth rate was 20.6% between June 2005 and February 2006 according to comScore Media Metrix Canada (Gerlsbeck, 2006).

Via the Internet, *being online* is a general term. This term does not distinguish between whether the user is browsing on the web, as the more common understanding, or whether the user is logging onto an intranet environment. In business, a deeper transition is happening from simply browsing the web to a variety of targeted methods of gathering information and knowledge. This is enabled at the workplace in the corporate intranet, which is more and more transparently interconnected to a comprehensive intranet-/Internet-sphere.

Outsell Inc. is a consultancy company, based in California, which provides market research and consulting services that focus on the entire information industry worldwide. According to Outsell Inc. (as cited in Training & Development [T+D, 2005, p. 13]) knowledge workers are turning to corporate intranets for tasks like finding colleagues, adding alert services, and leveraging digital resources much more than before. People at work, who take web-surfing as the main research tool, had a 12 percent fall from 79 percent in 2001 to 67 percent in 2004. On the other hand, more professionals are turning to the corporate intranet as research tool with a 10 percent increase between 2001 and 2004. Additionally, according to Outsell Inc., an intriguing point is that knowledge workers are more on the side of collecting information, rather than analyzing it. More in detail, Outsell Inc. found out that professionals in finance, human resources and legal sectors put more time in gathering information, but less in analysis as compared to 2001.

As for traditional education and training, all these groundbreaking developments have a similar and more or less disruptive impact. The Internet is democratizing learning by handing over main tasks, responsibilities, or freedom (as well as burden) of choice to its consumers, the individual learner. So called “e-learning” is entering another era. Downes (2006b) names this multidimensional transition “e-learning 2.0”, following the “Web 2.0” term. With all information technology advances - Internet, software, and tools - learners are given options and a rich environment for building virtual communities of all shades to be the learning initiators. Learners are content consumers and creators/contributors alike, via new concepts and systems such as wikis, blogs, and Podcasts. They are designers of learning activities. Moreover, they are not least the outcome practitioners in a whole circle of learning, enabling and enacting an “e-learning 2.0”-phenomenon on the basis of a true learner-centered design (VanderPo, 2005; Krau, 2006; Quintana & Shin & Norris, 2006).

The Internet and information technologies extend the ways of governing a country, being a customer, running a business, learning, and conducting research from within closed walls to an open, seemingly unlimited, free, and easily accessible sphere. In this sweeping change of ubiquitous global connectivity with increasing global access to technologies and information, the nature of work is becoming more knowledge-intensive. Organization structures are shifting from the old top-down and hierarchical paradigms to more decentralization, democratization, and bottom-up networks of information, knowledge, and innovation.

2.1.2 IT Effects on Work

In the past three decades, networked communication has been altering the nature of work, in industrialized countries as well as in emerging economies (e.g. China and India). It is apparent that the essence of work has changed from routine manual jobs to more knowledge intensive work, often by making use of networked computers.

A picture is worth a thousand words. The left picture of Figure 2-2 represents typical manual work as being initialized by the industrial revolution. A stark contrast to the picture on the right-hand side. Fig. 2-2 reveals the transition from yesterday’s technical requirement at work to today’s information and computer technology savvy workforce. When the fruit-selling grandma in Asia can type and use a computer (possibly ordering her orange supply online), all children in the country are already more than well-equipped with knowledge and skills of IT for their future workplaces.

Figure 2-2: Skills of the past (The Economist, October 30, 2004)
versus today's technology user (The Economist, June 17, 2006)

One significant outcome of mass adoption of computer technologies in the workplace is altering skill requirement in the workforce. Scientific evidence coming from researchers also reveals the same pattern of change in demand of skills on a more general level over the past 40 years. Frank Levy, an urban economist from MIT, and Richard Murnane from Harvard Graduate School of Education (2004) have conducted an empirical study that illustrates skill content required in the 21st century.

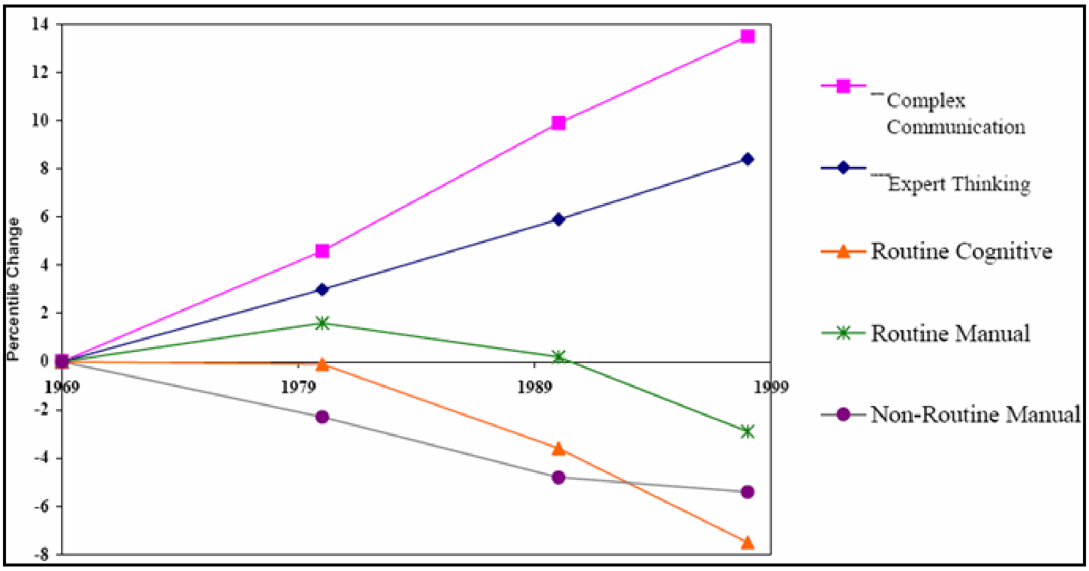


Figure 2-3: Skill content of recent technological change (Levy and Murnane, 2006, p. 15)

Clearly, from Figure 2-3, anything classified as rule-based - routine or manual - work is on the sharply declining side. Through globalization as well as rising labor costs in rich countries, an increasing amount of manual and labor intensive works (e.g. textile, automobile production, computer hardware manufacturing) has been either outsourced to less/under-developed countries, or done by robots (Levy, Murnane, 2006). The routine cognitive jobs, clerical jobs for instance, are also replaced by computers for simple rule-based tasks. The non-routine manual work includes physical jobs that currently cannot be simply replaced by "if-then-do" ruled computers. Examples of this type are driving a truck, or delivering post, or cleaning buildings, which are making a slight come-back between 1990 and 2000.

The other sides of the obvious trend of increasing skill demands are dominated by non-routine interactive work, complex communication skills and expert thinking – interacting and collaborating with others to interpret and manage information, as well as making decisions and judgments in unforeseen situations. Sales, management, innovation, research, medical diagnosis and complex analysis of business processes in general are all types of work that cannot be easily replaced by computer programs.

In one word, in rich as well as emerging economy countries, what remains is knowledge intensive work that is not rule-based, regularly involving communication skills to process, analyze and apply information in unforeseeable situations.

2.1.3 IT Effects on Productivity

Businesses across the world have embraced and bestowed the value of integrating information technologies at workplaces and in business processes. Information technology has been credited as a key to increase productivity, largely replacing routine and manual jobs

IT has not only transformed the nature of work from manual labor to information and knowledge-intensive work, but also it increases productivity in businesses. This well acclaimed relation is backed e.g. by a recent study on a wide scale from the U.S. Census Bureau (Atrostic & Nguyen, 2005). The statistics confirm a positive relationship between networked computing and labor productivity in manufacturing plants for a sample of 30,000 US manufacturing companies.

Mitra's (2005) research goes further to explain there is a positive correlation between IT investment and a firm's growth, a superior IT investment acting as an indirect but significant contribution to the growth rate of an enterprise. The enterprises with higher growth rates increase investment in IT infrastructure as cash flow increases. On the other hand, the low-growth companies have a persistent spending on IT not related to the rise or fall of their cash flow.

Apparently, with information technologies the U.S. manufacturing firms are producing more with fewer employees (Gomolsk, 2005). In general, IT seems to have a faster adoption rate and higher positioning in business in the leading economy of the world. The legendary

American Federal Reserve Chairman, Alan Greenspan has advocated in 2001: "Extraordinary improvements in business-to-business communication have held unit costs in check. ... New technologies for supply chain management and flexible manufacturing imply that businesses can perceive imbalances ... virtually in real time, and can cut production promptly." (2001, para. 12).

In Europe, Clark (2006) reports that an indicator that the UK government understands the positive effect of IT on productivity very well is to introduce a tax break scheme to encourage capital investment in information technology. According to the most recent report from the European Information Technology Observatory, UK's IT investment is the fastest growing among Western European countries. Currently, the largest IT growth is in China and India, meanwhile the UK is leading the U.S. (3.9%) as well as Japan (1.1%). Sweden and Denmark have the highest per capita spending on IT (Clark, 2006).

Another example is from Spain. An empirical study of 464 Spanish firms carried out by Sánchez, Minguela Rata, Rodriguez Duarte & Sandulli (2006) proves that both investment and usage of information technology at work positively contributes to increased workplace productivity. Internet and IT are just at the beginning of pushing up productivity in Spain where Internet usage in enterprises is only at the level of 10% of total working hours.

In Asia, scholars have measured information technology effects in Japanese business sectors. Jorgenson and Motohashi (2005) observe a sharply increased investment in computers, software, and other information technology equipment similar to the U.S, and especially, an enhanced productivity rate in the IT sector.

Internet and computers have given global access to information and knowledge. Consequently, this changes the way people work, increases workplace productivity, and marks the new millennium as a knowledge-based economy. These are all developments which challenge existing overall organizational structures including especially the individual workplace in the 21st century.

2.1.4 IT Effects on Organizational Structures - Decentralization

Thomas Malone, from the Sloan School of Management, asserts that structural changes of society and organizations are pulled as well as pushed by the decreasing cost of communication. In his book *The Future of Work* Malone reasons that in 1450 Gutenberg's printing invention pushed the democratic movement against a background of existing feudalistic kingdoms by offering mass production for books and thus cheaper availability of information and knowledge to common people, which had been reserved for the privileged classes – the rich and the churches - for centuries. The famed novel *The Name of the Rose* (Eco, 1983), though fiction, very convincingly hits the point of accessing information and knowledge as lying at the center of control and power struggles in the medieval churches. Illustrated in Figure 2-4, Malone sketches that mass access to communication and knowledge is a decisive factor in reshaping human society from independent bands/nomads, over centralized kingdoms to, finally, democratic societies. An analogous transition has been happening in organizations as well, from independent small workshops/businesses, over centralized corporations, to decentralized and networked teams. The driving powers behind this are sequential inventions of communication technologies - writing, printing press, and the most current advances in information technology.

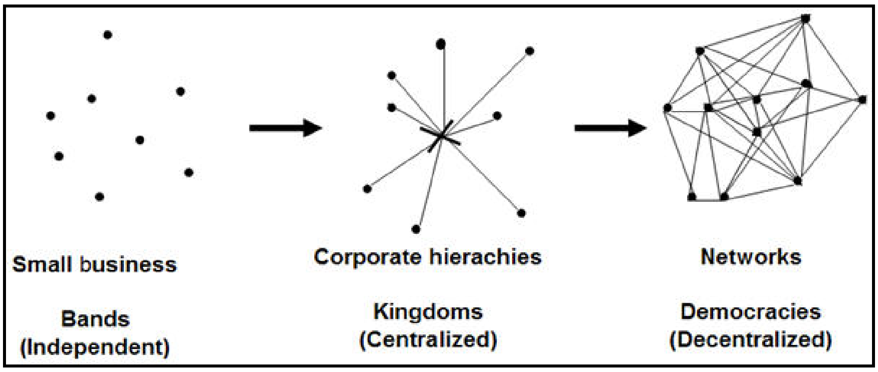


Figure 2-4: Organizational changes in business echo society changes (Thomas W. Malone, 2004, pp. 16-28)

Today, Internet and computers "make an efficient, decentralized system possible for the first time. Suddenly, it's cheap and easy for lots of people in an organization to get lots of information quickly and without distortion" (Malone, 2004, p34). Yet, cheap access to information alone won't make a successful organization. In the 21st century, motivated, creative and innovative employees are the drivers of success in our knowledge-based economy. An organization shall take advantage of information technologies to offer more freedom to its people, and enable its people to decide for themselves without the burden of complex hierarchy levels. Thus for all sectors of a company new options are given which allow, for example, that the time-to-market of products and services can be shortened, the cost of hierarchy imposed communication paths reduced, or production processes effectively embedded in new supply chains. Malone shows evidently that many successful international organizations are turning to a decentralized pattern, giving their people more freedom and flexibility at work. As an example, he takes how work is organized within Google Inc., one of the currently fastest growing technology firms. Google has grown to a large organization, built up by many small teams. Team members are given considerable own control of how they decide to work. Part of this is that each team uses blogs as a means of communication and updating processes to other teams without central-control communication or management. Creativity and innovation are the central drivers of a knowledge-based economy. Therefore, the Google example asserts on a company level that when people are free and equal, they are more motivated to contribute to innovation working together. In another arena the creation of Linux and Wikipedia prove the same.

This phenomenon is even more obvious within knowledge-based organizations, such as consulting firms and research institutes. Decision making relies on information and knowledge. Networked computing makes it possible and desirable for individuals to make decisions for themselves instead of waiting and obeying orders from above. Being flexible and innovative used to be the advantage of small organizations. However, enabled by the Internet, computers, and related advances of technologies, it becomes possible and desirable to decentralize decision-making processes in large organizations as well to "gain the economic benefits of large organizations, like economies of scale and knowledge, without giving up the human benefits of small ones, like freedom, creativity, motivation and flexibility" (Malone, 2004, p. 4).

Certainly, Malone as a highly regarded opinion pacesetter for leadership and information technology usage in organizations is not alone in his approach of the networked and decentralized structural evolution of organizations. O'Driscoll and Briki (2004), Bingham (2005), Mitra (2005), Hughes (2006) all reiterate Malone's belief that Internet and information technology empower individuals in organizations to communicate in a multi-dimensional, networked fashion bypassing the central control. The traditional centralized organization dominated most of the 20th century, handing down information for control and decision in a top-to-bottom manner against an infrastructure of disconnected information "silos" or "stovepipes" (Ozzie, 2005b). This is broken down by multi-channel communication to a shared, collaborative, and networked environment.

2.1.5 Emerging Virtual Workplaces and Collaborative Team Work

Johnson (2005) presents the concept of the virtual workplace as an environment where the individual employees work in different geographic locations from their managers or peers. Employees can work at home being connected to their team members and managers by computer networks. Complementarily, people in a classical office can also establish a virtual work environment at their office workplace by communicating and processing business tasks with peers who are in offices dispersed around the world. Johnson further explains reasons behind the growth of virtual workplaces and virtual workers. Obviously, considerable amounts of money are being saved from the decreasing needs to set up physical workplaces and the supporting infrastructure. In addition, the underlying IT-environment adds agility to business, the capability of a faster and anticipatory reaction to the increasing speed in change of markets and competitive patterns in a global economy.

Townsend, DeMarie and Hendrickson (1998) have already predicted some years ago that virtual workplaces would be the future for service-oriented and knowledge-intensive work, which covers most of industries in developed countries in the 21st century. The networked communication empowers not only multi-dimensional communication within the organization, but also, more important, closer communication with customers. In the decentralized virtual workplace, positively and successfully, customers to a much higher degree are involved in improving, innovating, and creating products. This is already happening in previously mentioned cases like General Electrics' three-dimensional heart scanner, BMW's online services, and eBay. All involve customers in their product design and creation via information technologies, such as e-mail, online discussion board, blogs, etc.

Today, for many companies virtual workplaces are already routine reality, not any more a vague vision projected from the past. Froggatt's book "Work Naked" (2001) points out that enabled by information technology, successful businesses such as Cisco and IBM from IT industry, Charles Schwab as an investment company, to name a few, have all implemented a flexible working policy to allow their employees deciding where, when, and how to work. Without advances in IT this would not be possible.

According to a study from Akkirman and Harris (2005), when it comes to communication in an organization, people working in virtual workplaces/offices are more satisfied than in the traditional, paper-based, environment.

For management, flexible working hours and places are not the only outcome of tangible decentralization pushed forward by IT. The style of managing people is also shifting from "a model to manage input to the business, to managing their output", says Phil Flaxton, chief executive of Workwise UK, a not-for-profit organization promoting flexible working (as cited in Lindsay, 2006, p. 55).

Another significant consequence of virtual workplaces is collaborative work in virtual teams. More and more organizations discover that collective intelligence contributes more value to business than the lonely (even though possibly excellent) maverick, an individual who works alone without communication or collaboration with peers (Sackmann, 1992; Huxham, 1996; Paul, 2006). This is true in the physical as well as in the virtual workplace - whether it might be information gathered during an inspiring conversation at the water-cooler or a chat in the connected virtual space, an automatically rendered tip from a team member's blog, an e-conference with peers, or a phone conversation via Skype.

An empirical study from Knoll and Jarvenpaa (as cited in Cascio, 2000, pp. 84-85) suggests that besides communication, virtual collaboration is the first and foremost key behavior to enhance productivity in virtual workplaces. "Virtual collaboration includes the ability to exchange ideas without criticism, develop a working document in which team members' ideas are summarized, exchange it among team members for editing, track member comments in a working document with initials, agree on activities, and meet deadlines."

The development of virtual collaboration in recent years has been earmarked by tools like wikis, blogs and Podcasts (all three will be explained in the next chapter 2.4.2.2). We are only at the "dawn of collaboration", as expressed by McAfee from the Harvard Business School (2006). When Bill Gates named the leading collaboration technology expert and inventor of IBM Lotus Notes, Ray Ozzie, to be his successor at Microsoft Corp. in 2008, this can be regarded as another signal for the IT departure from automation, machine replacing manual work, to a new era of collaboration, re-focusing on people and their communication in a knowledge-based economy (Guth, 2006).

In business practices, Gartner Executive Programs, an information technology research and consulting company, has pinned down three critical tactics for managing virtual workplaces: motivation, collaboration, and assessment. These tactics have been successfully implemented at the American cooperative financial institution Credit Union in Baltimore (Credit Union Management, 2006). In Gartner's solution, enabling a greater degree of collaboration and communication in virtual settings has been listed as an efficient tactic for enhancing performance by reducing the fear of being isolated from the center of action.

Collaboration technologies have helped many organizations, small or large, to solve mission critical tasks. For instance, CNA Insurance Cos. in Chicago utilized online collaboration technology to review and discuss strategies and business directions among 350 participants before a pressing large conference took place (Robb, 2002).

The world leading soap and razor seller, Procter & Gamble Co. (P&G), fosters real-time online collaboration among its multi-national employees, important customers and partner bases. Via collaborative technology and tools, P&G is aiming at maximizing direct, one-to-one communication among employees, developing more effective virtual teams, and consequently making faster and better decisions (Foley, 2005).

Orange PLC, one of the leading mobile service providers in Great Britain, sees collaboration in virtual teams as a key to improve product delivery and innovation (Lawley, 2006). At Orange, boosting trust in collaboration among virtual team members is their strategy to balance between cost, customer satisfaction and innovation for a sustainable long term growth.

In summary, IT has boosted productivity at workplaces, and transformed the nature of work from redundant manual labor to more knowledge-intensive work. To cope with globalization and ever-changing market conditions, organizations are progressing toward decentralization, a fundamental structural change on a global scale enabled by networked computers. Virtual workplaces and networked communication become a working norm regardless the size of organizations. Finally, collaboration is at the center of an IT evolution that goes far beyond the confines of corporations into the private sector and mass consumer markets, reaching out for ideas and knowledge from all corners of the world.

2.2 IT Effects on Learning

2.2.1 The Return of Lifelong Learning

In the 21st century with its swiftly evolving knowledge-intensive economies, the sheer form of compulsory education and training is no longer sufficient to cope with the ever changing demands of societies and markets. Today, the lead time of processing information into knowledge to generate value has been drastically shortened and pushed by the decreasing costs of Internet, personal computers, and global mobile connectivity. In order to stay competitive, governments around the world rush to promote learning, especially lifelong learning, on the personal, corporate, and political agendas.

Back in 2000, at the summit of the U.S. Department of Labor National Skill, Alan Greenspan as head of the U.S. Federal Reserve System examined the need for governmental efforts at promoting lifelong learning into the American work and life style. He stated that the notion of a formal degree serving till the end of one’s working life is challenged by information technology. Greenspan reminded everyone that technology innovations have permeated our lives, wiping out manual jobs, yet, at the same time, creating opportunities for new jobs and businesses. In the new millennium, simple technical know-how is not enough to meet the needs of work in the 21st century. In addition, workers must possess abilities to create, analyze, and transform information, and they must command communication skills.

Therefore, learning will be a lifelong effort in order to be competitive in a changing economy (Greenspan, 2000).

The United Nations Educational, Scientific and Cultural Organization claims that we are living in an era in which technology advances offer opportunities, generating 60% of trades and jobs in the next two decades, all of which are unknown or unheard of today (Medel-Añonuevo, Ohsako & Mauch, 2001). Therefore, there is an urgent need in transforming ourselves to a learning society in which learning is a constant personal, community, and organizational task to cope with the present and prepare for future challenges.

Governments from Europe are also promoting lifelong learning to their citizens and corporations. The European Union (EU) has determined to make lifelong learning a reality rather than only an over-heated strategy. Lifelong learning is set as the means to develop European citizens' employability and adaptability in a global market and competitive workplace (European Commission, 2001). In addition to rhetoric in a championship of lifelong learning promotion, practical collective actions encouraging lifelong learning are made by international organizations, such as members from developed countries in the Organization for Economic Cooperation and Development (OECD, 2001). Part of this action agenda is to support studies in search of the best methods of financing lifelong learning. Lee, from South Korea, finds lifelong learning cannot be a solely centrally planned as well as financed in a classical approach. He argues that it is not feasible to finance lifelong learning by public spending only, because the government, or at least the South Korean government, is neither prepared nor able to "provide on the additional resources required to expand and improve the national skills base" (2006, p. 124). In other words, the scale and breadth of lifelong learning is by far too weighty to be singly supported by governmental resources.

Numerous scholars advocate the needs and importance of lifelong learning in the new millennium as an endeavor for the individual on a personal level. Chute, Hancock & Balthazar (1991), Davis (1996), Hake (1999) and von Holzen (2005) all agree that the ability for constantly updating knowledge is an essential skill for personal survival because knowledge aging is faster and quicker more than ever before in human history. This is happening on a global scale and as a result of global access and dissemination of information and knowledge via networked computers and communication devices. Motley (2005) believes lifelong learning is an imperative strategy, not an optional one, for all people - as individuals as well as in the aggregated context of organizations or economies.

In industries like information technology, health care, financial services, education, or other knowledge- and service-based industries, lifelong learning is more compelling in order to keep up with the ever changing and competitive global economy. For example, in IT, having a university degree in computer engineering does not guarantee a job for life, because half of what an engineer student has been taught in school is obsolete in the market place by the time he or she receives the degree certificate. Meanwhile, the other half learned in classes, which could be useful at the workplace, would only last for 3 -5 years in his/her professional career (Finke, 2000). Engineers in other industries face the same challenge as their peers in the IT industry. In the U.S., currently, continuing education, learning, and re-training as an electrical engineer is required in over 30 states where engineers have to routinely reinstate new professional competency (CPC) requirements for licenses. Ireland reckons: "an engineer's life is one of continual study" (2006, p. 48).

From the corporation side, Nonaka and Takeuchi's claim in their highly influential book *The Knowledge Creating Company* (1995), we are living in an era in which the only certainty in our economy is uncertainty, and

> "…the one sure source of lasting competitive advantage is knowledge. When markets shift, technologies proliferate, competitors multiply, and products become obsolete almost overnight, successful companies are those that consistently create new knowledge, disseminate it widely throughout the organization, and quickly embody it in new technologies and products" (p. 6).

Clearly, continuous learning and leading innovation is an essential survival skill as of today and beyond. Organizations have to invest in human capital for staying agile in business. We all must learn for life.

But for enterprises, academic arguing won't go down easily in the boardroom. Tangible means, e.g. saving cost, boosting quality for products and services, generating revenues in new markets, or generating profits must be articulated in order to acquire support and resources. This evokes the rise of e-learning in the enterprise training and learning arena. Greenspan and many others have seen the advantage of marrying information technologies with learning, specifically e-learning by its virtues of cost saving, just-in-time delivery, flexibility, and collaboration with inside as well as external expertise (Clarker, 1999; Boisver, 2000; Chastain, 2006). According to the Gartner IT Research and Consulting group e-learning is "network-enabled learning that relies on digital content, experienced through a technology interface. Collaboration is a desirable feature, but not a requirement" (Gartner, 2004, p. 134).

E-learning combined with other classical learning methods (e.g. face-to-face classes, seminars, workshops, labs) is titled as *blended learning* that will enhance time to performance, improve productivity, increase competitive edge, and ensure successful business transformation (Robert, 2005).

Some successful corporations and organizations have already taken their human capital investment on a strategic level by integrating e-learning as one of many lifelong learning methods into their workplaces. UPS, the American-based logistics company, is among numerous examples. UPS's practice not only takes advantage of network-enabled learning, but is also ensuring commitment and budget for investing in human capital development from top management. Hollis (2004) reports that UPS is shipping physical goods to its customers as well as delivering lifelong learning to its employees. At UPS, there is a highly committed top management: its CEO Mike Eskew meets with heads of training and development each quarter to discuss learning and training of their workforce. A management development committee, at the operational level, collaborates with a training coordinating group, at the corporate level - a working together that guarantees learning and development is tied to UPS's strategic business initiatives. Such a rigorous process and collaboration has secured budget increase for three years in a row at a time when many companies were trying to cut the learning budget as the economical situation was not so promising.

On the learning side, with around 360,000 employees world-wide, UPS is keen on creating a lifelong learning environment for retaining existing employees as well as encouraging personal development as part of a lifelong learning effort. Dimick, the head of training and development at UPS, declares: "It is not unlikely for a person to start out driving a UPS truck and end up as the CEO" (as cited in Hollis, 2004, p. 48), thus referring to the case of their former CEO James Kelly. UPS shifts its traditional classroom-based training courses to computer technology based learning by leveraging the existing advanced technology infrastructure in the organization. Lina Hardenburg, UPS manager for learning and development marvels at the benefits of e-learning, namely, cost saving and its just-in-time delivery. Another practice is outsourcing. UPS contracts an e-learning provider on a pay-per-use base. This on-demand service significantly reduces UPS's cost for instructional design as well maintenance.

IBM, another internationally successful company, refers to lifelong learning as a DNA for its employees. "Learning is truly core to the DNA of IBM. We are a company focused on innovation, and our executives understand that we need to enable IBM employees to grow and to foster the practices that produce business transformation," said IBM Chief Learning Officer Ted Hoff (IBM, 2005). Accordingly, since 2004 IBM has been ranked at the top among the U.S. based corporations for its employee learning program in Training Magazine's annual evaluation.

Despite all the current excitement and energy, lifelong learning is a cliché. In China, the two characters representing learning in Chinese (Figure 2-5) reflect the thousand-year old wisdom and understanding that learning is a continuing process of practice and quest for knowledge. The first character symbols a child standing at the door of knowledge; the second character refers to a young bird constantly practicing how to fly. The combined meaning of these two characters is - as Peter Senge, the founder of the Society for organizational learning at the MIT Sloan School of Management, points out - that learning in the Chinese mind is a "mastery of the way of self-improvement" (Senge, Kleiner, Roberts, Ross & Smith, 1994).

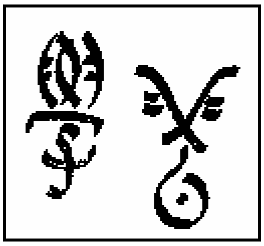


Figure 2-5: Learning in Chinese characters (Senge et al., 1994, as cited in Society for Organizational Learning, section: Organizational Learning/Lexicon)

Since the late 1990's, with the rising number of PCs, and fast adoption rates of new technologies, many scholars have reasoned, insisted, as well as proved the urgent need of integrating learning in one's lifetime in a knowledge-intensive economy. However, what is lifelong learning anyway? For decades, many have tried to define lifelong learning. Long before, Dave (1976) has already explained that the needs and meaning of lifelong learning "is a process of accomplishing personal, social and professional development throughout the life-span of individuals in order to enhance the quality of life of both individuals and their collectives" (p. 34). Figure 2-6, a framework according to the World Bank, outlines that lifelong learning embodies pedagogy comprehensively accomplished through school education, distance learning or e-learning, continuing education, training or correspondence courses from birth to the last stage of life (World Bank, 2004).

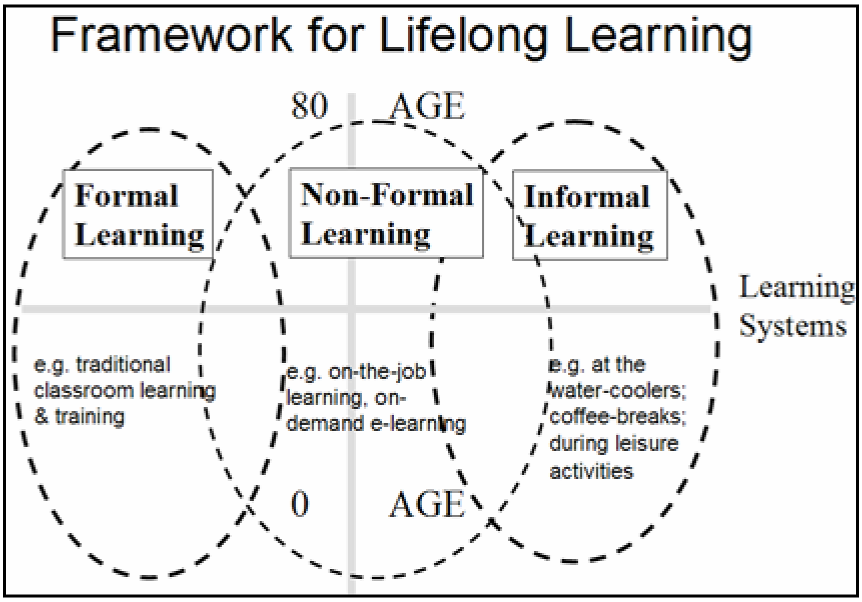


Figure 2-6: Lifelong learning framework (World Bank, 2004)

In Canada, Benedict, Collier, Masar & Wilkinson in their early report to the Minister of Employment and Immigration (1984) advocate on lifelong learning that "entails a cradle to the grave involvement of the individual with his or her learning and working environment. It implies a growth of all skills and accumulative interweaving of knowledge and experience. This learning is not packaged and does not cease when the individual completes his/her legal school requirements" (as cited in Jarvis, 2005, p. 658). Moreover, Benedict and his colleagues make two clear points in their report:

1. Workplace learning is becoming compulsory as a key portion of lifelong learning endeavor.
2. The major part of lifelong learning cannot be pre-packaged as a centralized process like in traditional education formed in the past.

These two focal points set the stage of this research work.

2.2.2 Bottom-Up Decentralized Learning

Nevertheless, typical legislative and corporate efforts of integrating learning into every day life are still derived from centrally planned and pre-organized education, from teaching concepts and structures inherited from the post industrial revolution era. But, enabled by technology, learning today is no longer authoritative, nor is it a solely centralized process. As argued before, reduced costs of communication accelerate the transformation of how society is organized to follow the same changing patterns like that of organizational structures (Malone, 2004).

As a key element of establishing society, learning and education certainly follow the same changing path as has happened to organizational and society structures, i.e. the transformation after the industrial revolution to organizations and a society depending on information, communication and knowledge. Following Figure 2-4, the author of this thesis accordingly displays in Figure 2-7 how education used to be organized dispersedly by churches (in most European countries), and only rich families from privileged classes had resources and access to scarce books in feudalistic societies dominated by agricultural economies. As a poor man's child, the only way to learn a certain skill for survival was via apprenticeships as a goldsmith, or a blacksmith, or a baker, etc., at scattered workshops.

With the invention of the printing press, and later on in the course of the industrial revolution, learning has been centralized as well as standardized according to industrial thinking. Government and corporations gradually took a centrally organized administrative role to plan, and then distribute learning. As a result standard training and learning programs to everyone are provisioned, with the same information and skill set to cope with the same (unexciting and) repetitive routine and manual work. From this pattern rose the industrial tycoons like the Rockefellers and the Carnegies in America, or the Thissens and the Krupps in Germany. And this is still strongly influencing the dominating form of education taking place today (Davis, 1996).

Now, at the upcoming 21st century where information is everywhere the dominating factors are a service-oriented and knowledge-intensive society. With a close distance of "one-click away" information technologies are about to transform learning, work, organizations, and societies to a decentralized pattern, a networked model.

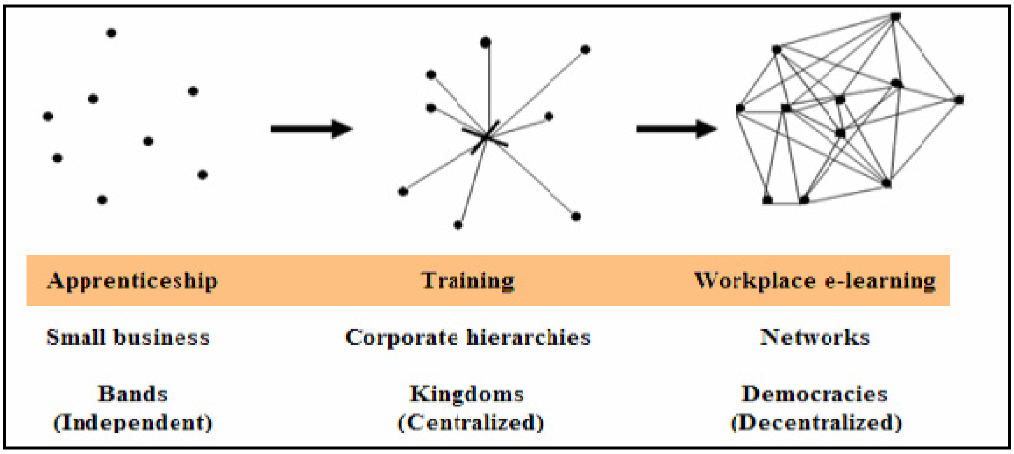


Figure 2-7: Learning changes echo organizational changes in business and society (extended from Th. Malone's Changing Model of Business & Society in History, 2004)

From the individual point of view, personal computers and Internet penetrate an individuals' life starting already from childhood. Meyrowitz (1986) argues that technology has a great impact on children's behavior at their future workplaces. Since late 1970, Tapscott (1998, p. 3) explains that with the personal computer and Internet evolution, more and more children are growing up digitally – the *Net Generation*. Instead of sticking to the taught or learned value from traditional education and training, these children will later join the workforce with much stronger senses of independence, entrepreneurship, and welcoming change from job to job, and skill to skill. This might be exemplarily displayed by famous luminary personalities. Take Bill Gates, who forgoes a Harvard education to run Microsoft. Or the example of Sabeer Bhatia from Bangalore, India, who skips a steady 20+ years of career at Apple Computer Inc. for his independent Hotmail business, which later sold for $160 million after a rather humble start of $300, 000 (Whitmore, 1999).

In a society driven by changes and the ability to bring innovation with speed to market, "goes the thinking, skills quickly become obsolete, and in this market four years of studying history — or even computer science at an academic pace — is just four years wasted" (The Economist, December 23, 2000, section: Inexperience is bliss, para. 4). It might be undervaluing the classical education in the knowledge economy, but the supremacy of learned skills and knowledge expertise from authorized institutions is certainly challenged (or, more likely, eclipsed) by another historical technology evolution – computers and Internet. This resembles a repeat of history and a long row of subsequent developments in the sequel of Gutenberg's invention of printing technology. At the core, reduced costs of accessing information and consequently gathering knowledge liberated common people from centralized distribution and authority of information and knowledge, thus efficiently spreading independent and individualized thinking and ideas. In his book about the female scientist Emilie du Chatelet and famous philosopher Voltaire, Bodanis (2006) comments on the excitement of accessing the economically printed book full of independent ideas in the 18th century:

> "It was a significant precedent, for in the decades to come many other seemingly conventional individuals would be inspired by Voltaire and Emilie - by their writings … to question traditions around them that had apparently been accepted since time immemorial. With this attitude, authority no longer had to come from what was told by a priest or royal official, and the whole establishment of the established Church or the State behind them. It could now come, dangerously, from small, portable books - and even from ideas you came to yourself" (p. 224).

This may be said as well to describe the current challenges and tremendous options by simply changing the notion of “portable books” to information and communication technologies (or to be more precise in this analogy, by “e-books”). Nowadays, armed with another wave of innovative devices like laptops, PDAs (personal digital assistants) or mobile phones, all connected to the Internet, young people with technology skills are not the ones waiting to be taught by the older ones. The code of learning is not any longer an imperative one, from one teacher, one class or one interpretation. Rather it comprises an individually initiated and independently enacted process bringing together multiple resources in multiple dialogues, discussions among peers via instant messages, blogs, chat, wikis, etc. Or, it combines abundant results generated by various search engines, says Yvonne Fritzsche, a researcher at Frankfurt’s Psydata market-research institute (as cited in The Economist, December 23, 2000).

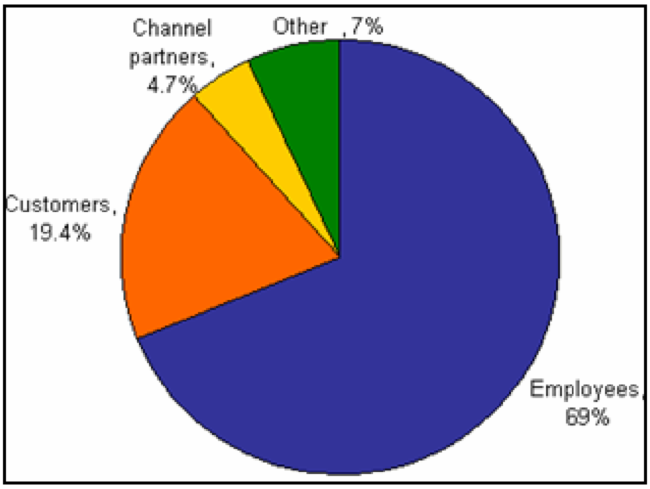
In summary, information technology is transforming our society to a knowledge-based one in the new millennium that demands lifelong learning endeavors from everybody to cope with changes. Constant updating of skills and knowledge at workplaces, in a working and business process environment not predominantly dedicated to learning and training in a classical understanding, is a major portion of this lifelong learning effort. Hagevik (1998) declares that individuals of today must adopt a lifelong learning philosophy, complementary to anticipating innovation and uncertainty which invoke job changes in one’s career path and which entail building different skills all over again.

Today, the workplace territory and the nature of work are moving towards a decentralized organizational structure coping with the constantly changing business environment. Therefore, the traditional centralized, authoritative training and development paradigm can no longer satisfy learning needs of a workforce in a virtually connected arena facing globalization, competition and ever changing non-anticipated information pieces from all directions. As a solution, learning, specifically electronic learning at virtual workplaces, is becoming more individualized and decentralized being delivered in a just-in-time manner and coping with challenges in an information rich knowledge economy (Longworth, 2003; Heraty, 2004; Von Holzen, 2005).

2.3 Workplace Learning On-demand

As accentuated many times in this work, to pro-actively cope with a rapidly evolving and changing world, creating, supporting and enacting innovation is becoming essential for individual as well as business survival. Therefore, employees’ brain power is the crucial answer to this furious competition. The Canadian Futurist, Richard Worzel (2006) exclaims that whenever people talk about the future, regardless of the starting point, and if people think long enough, they often end up focusing on learning. Downes (2006a, p. 34) categorizes the knowledge management and just-in-time support learning design at the workplace as "non-instructional performance interventions".

Increasingly organizations, both for-profit and non-profit, across different industries are taking advantage of e-learning solutions to update their employees' skill sets at workplace. Figure 2-8 presents the outcome of a study organized by the American Society for Training and Development (Ellis, 2005d). On the right-hand side, the table illustrates the demography of the survey respondents. The 133 responses are from a range of industry sectors, i.e. financial services, healthcare, utility, higher education, computer software and state/local government. Apparently, compared to "customers" and "channel partners", employees are ranked as the most important user group of e-learning solutions in the organization as shown in the pie chart on the left-hand side of Figure 2-8.



Aerospace	2.7%
Commercial training (classroom or online)	.9%
Computer hardware	.9%
Computer software	6.2%
Consulting	4.4%
Custom instructional development	2.7%
Energy & petroleum	1.8%
Federal government	3.5%
Finance & investment management	9.7%
Healthcare	8.8%
Higher education (Universities, Colleges & Tech Schools)	8%
Hospitality/food service	3.5%
Insurance	5.3%
K-12 Education	.9%
Manufacturing	3.5%
Military	3.5%
Non-Profit	1.8%
Pharmaceuticals and biosciences	2.7%
Publishing/advertising/media	.9%
Retail	1.8%
State/local government	6.2%
Telecommunications	4.4%
Transportation	5.3%
Utilities	8.8%

Figure 2-8: Types of learners using e-learning applications in different industries (Ellis, 2005d)

2.3.1 From Training to E-Learning On-demand at the Workplace

Today, e-learning has taken hold in workplaces, but many people mix up the words training and learning without any differentiations. But, the continuous lifelong learning endeavor is much more than ephemeral training efforts, which is the most transparent timely difference between training and learning.

In the context of this research work, more explicit differences between training and e-learning exist many-fold.

First, training and e-learning at workplaces have certain intersections in which processes of acquiring certain skills and knowledge are involved. However, apparently nobody tries to replace e-learning by naming it e-training, as expressed by e-learning expert Marc Rosenberg (as cited in Ellis, 2005a), because training feeds to only one part of needs in e-learning at workplaces, but not all. And there is a hierarchical relation among training, learning, performance improvement and knowledge management. Training is one way of learning, which serves the need of performance improvement. Knowledge management embraces all processes more generally, comprising creating, delivering, accessing, consuming, and sharing intellectual capital.

Second, training is apt to a passive behavior, as commonly goes the expression “to be trained” for accomplishing a specific job task or goal. Also there is *trainer* versus *trainee,* the master teaches his/her pupil/apprentices. Since the late 1980’s, the aviation industry has pioneered integration of information technology into training by taking advantages of its 24/7 availability and cost saving virtues; this initiative marked the breakthrough of computer-based training (CBT) in industry (Finke, 2000). This type of training fits the classical definition of training as “systematic instruction and exercise in some art, profession, or occupation, with a view to proficiency in it” (Oxford English Dictionary [online version], 1989). However, it does not fit learning. Learning is *to learn* as individual *learner* – to actively engage in “acquiring modifications in existing knowledge, skills, habits, or tendencies through experience, practice, or exercise” (Encyclopedia Britannica, 2007). Learning is more than passively being trained or taught (Illich, 1970, pp. 1-5).

The Encyclopedia Britannica’s definition ratifies the third, often ignored, difference between training and learning: Learning is an accumulated process based on and related to “existing” experience, the comprehensively accrued knowledge base of individuals. Training, on the other hand, can have a rather primitive starting point from zero experience or knowledge. This understanding can be exemplified by areas where labor-intensive manufacturers increasingly outsource from industrialized countries to developing or under-developing regions (e.g. China, India, Vietnam, etc), depending on a labor force where individuals might never have seen a mobile phone or a computer before entering the factory. The upgrading of the labor force with the necessary skills for the respective manufacturing processes is regarded to be a focused “training process”, rather than the exposition to a general learning environment.

Sparrow (2006) adds that learning is going beyond the classical metaphor of classroom delivery of education and training. Learning, from the organization or instruction side, is more about processes of supporting, facilitating, and mentoring. Fischer (2000) articulates the different emphasis on training and lifelong learning in the context of e-learning in Table 2-1. As emphasized in the enlarged areas, Fischer argues lifelong learning at the workplace with networked computers is the best at on-demand mode within work or job context. The typified roles of participants in learning are more as engaging designers and developers of content and processes, right in the context of their work. After all, continuous learning at the workplace is more integrated in general business processes to be simultaneously worked upon in an interwoven fashion; it is not predominantly formally or centrally organized. At last, but not the least, this type of learning is mainly a personal and voluntary activity. Moreover, Fischer associates training with B.F. Skinner's behaviorism instruction theory and learning at the workplace or at leisure time with construction theory (Cohen, 1987; DeMar, 1998). So the learner is actively engaged in the creation of knowledge instead of being simply taught.

	Emphasis on training	**Emphasis on lifelong learning**
perceived role of new media	economical, productivity	Quality
epistemologies of knowledge	explicate and transfer existing knowledge	**understand existing knowledge and create new knowledge**
new media	learning about computers	learn with computers
impact of new media	make deliver method more efficient	allow new things to be learnt
teaching	add-on to current teaching methods	change what we teach and how we teach
assessments	number of facts known	articulating knowledge, reflective practitioner
mindset	passive consumer	**active designer, co-developer**
setting	schools, separate, formal, forced	**workplace**, families, museums; **integrated, informal, discretionary**
new knowledge	**assigned-to-learn, de-contextualized**	**need-to-know, on-demand, contextualized**
learning	rote learning	learning with understanding

Table 2-1: Emphasis on training versus lifelong learning (Fischer, 2000, p. 270)

Obviously, many researchers and studies favorite lifelong learning enabled by information and communication technologies versus training. As has been suggested, design of training and learning at the workplace are depicted by their mutual profile toward the extremes of their respective characteristics. But, after all, the two are not mutually exclusive. There are certainly appropriate scenarios to apply the ideas from each school. In order to not repeat the failure of a “one-fits-all” mistake, the differentiation of either training or e-learning at the workplace must not be the only dominating distinctive element for learning design. This brings e-learning together with other learning (and possibly training) events, such as face-to-face instruction or (physical) team workshops, in a new comprehensive understanding of learning and knowledge development in organizations – the concept of *blended learning*. Harris (2005), Kawalek (2006), McLean (2006), Snipes (2005), Stubbs, Martin & Endlar (2006) and many more have championed blended learning methods as a more efficient underlying notion of learning design at work.

But, the preference changes with different context and background. The IT Training (2006, p. 52) reports findings of a survey carried out among 100 IT directors in the UK, with a parallel survey being conducted in Germany. 85% UK directors favor blended learning. Meanwhile, their peers in Germany, with a certain tradition on preferring classical physical classroom training, think the blended method is the least important investment when training staff in Germany. Once again, context holds the key for learning design at workplaces, and there is no one-fits-all perfect approach. The other challenge of blended learning is the right mix. Rossett & Douglis (2004) point out that the right mix of learning modes delivered with the right quality, at the right level is an extremely difficult task for designers – and therefore not often a successful one. Long before, Bersin (2003) has warned already that the buzzword *blended learning* does not sound as straightforward as in reality, loaded with questions regarding when, what, and how to blend - or, blunder at the end? Blended learning in Bersin's view is simply a natural fall-out of abundant early failures of e-learning development. In the late 1990s, many organizations took on e-learning naively by merely taking a 'putting an old-wine-in-the-new-bottle' approach, taking the mindset of paper-based content and classroom instruction online. The function of e-learning at workplaces was dominated by replacing classical training or classroom learning with the traditional centralized organization and delivery. Such simple understanding of e-learning failed at both ends of learner and technology, stripping support for the learners and disregarding the abundant advantages given by information technologies - connecting people, crisscross and multi-dimensional structuring of content, sharing material, collaboration right at the working context, bringing current business issues together with learning in a contextualized manner, just to name a few.

Currently, learning and knowledge development enabled by information and communication technology is becoming more mature and stable. In Canada, in 2001, there were already 51 per cent of workplaces that utilized computer and Internet for formal or informal training (The Conference Board of Canada, 2001). After some early experiments of replacing classroom training by e-learning, a next innovative step for e-learning approaches at the workplace is coming on to the scene – e-learning on-demand, or simply learning on-demand (LOD). This is validated by a survey from Bersin & Associates, a leading provider of consultancy services in corporate e-learning technologies and their implementation. In 2005, Bersin & Associates interviewed 526 training and HR (human resource) managers in North American corporations. They were classified into five types of organizational e-learning adopters: early adopters, early majority, late majority, late adopters and laggards based on a widely accepted model of the technology adoption life cycle. In Figure 2-9, Bersin & Associates map out e-learning solutions into these different categories of organizational adopters. The mainstream of e-learning as of today is spread from digitized content catalogs to blended learning programs. To be noticed, at the far left side, for the early adopters, the rising star of innovative e-learning approaches is learning on-demand.

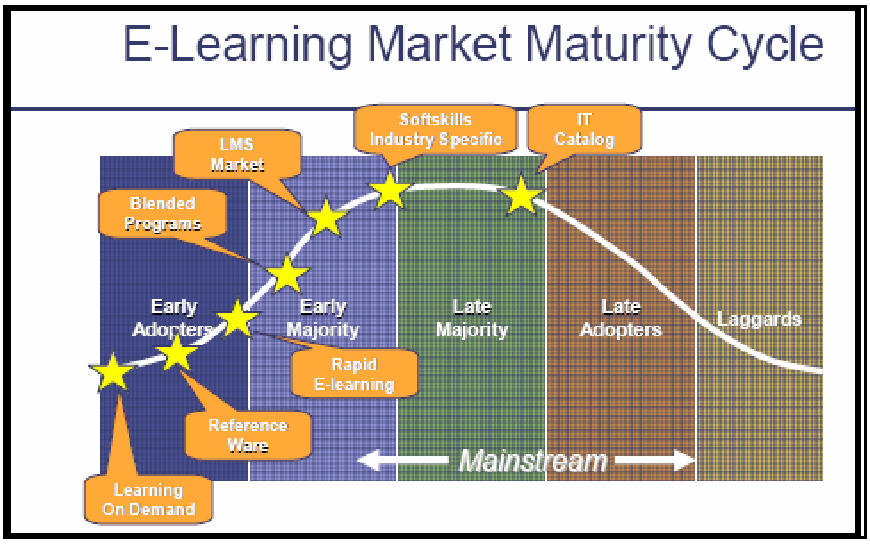


Figure 2-9: E-learning market maturity cycle (Bersin & Associates, 2005, p. 18)

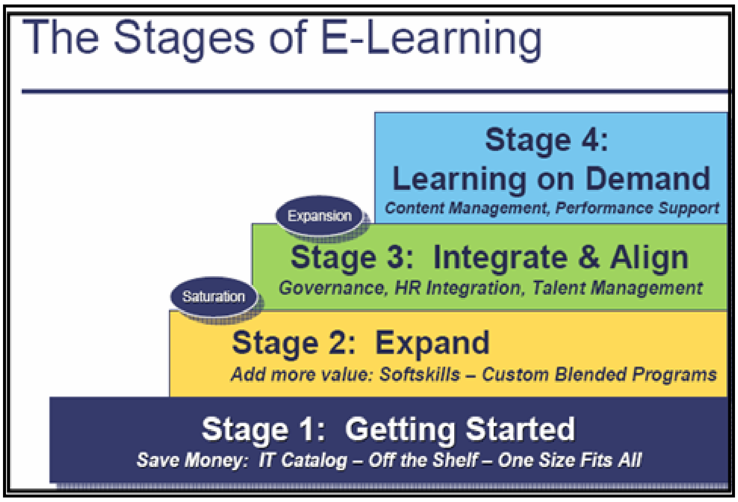


Figure 2-10: Stages of e-learning (Bersin & Associates, 2005, p. 20)

Additionally, Bersin & Associates divide the e-learning landscape in four stages as shown in Figure 2-10. The study highlights the learning on-demand solution at stage four as the upcoming trend of e-learning. Basically, learning on-demand puts the learner's workplace performance and content management at the centre. After organizations over the course of the last years have spent considerable amounts of resources in transforming product catalogs, marketing material, training courses, white papers, conference videos, or presentations in digital form, they realize that this ample amount of digitized content is the best intellectual assets they possess. It is against this background, that Bersin (2006) states that there is a need for an efficient as well as comprehensive content management system to enable employees to easily find and reuse this pool of learning objects/nuggets to align learning with business strategy.

Furthermore, Bersin’s study suggests that as it evolves from previous stages such as blended learning, learning on-demand carries on the blended feature from “the course-driven approach to training with online performance support” (Bersin & Associates, 2005, p. 44).

The British e-learning expert Steve Molyneux confirms the desire for and development of e-learning on-demand at the workplace. Besides being a positive evolution from a conceptual advancement point of view, Molyneux believes this new generation of e-learning on-demand approaches also serves a different workforce who has grown up digital since 1980s (as cited in Lloyd, 2004). With much self-taught computer skills, this generation goes online for information and knowledge, instead of joining a course or waiting to be taught. They may not even have patience to wait for an e-mail reply. They rather go for the option of instant messaging, or looking at relevant blogs for the latest information - which puts the integration of effective collaborative communication means for learning support at the workplace in the foreground. Robert (2005) concludes that the previous phases of e-learning driven by a course and paper-based instruction are no longer fit for these digital natives who want answers on-demand, right now, right at the context of their work and life.

Thirdly, O'Driscoll and Briki (2004) explain learning on-demand is also caused by a shortened cycle of products-to-market in a knowledge-based global economy. People are working in a much more complex market scenario, which is characterized by an ongoing stream of speedy transactions in a highly competitive environment. After number crunching and computer automation, the much more significant transformation of the Internet and computers has taken place on creating value by connecting people, and content nodes offering information and knowledge in a virtual place. In addition, another phenomenon in the modern business world is the booming e-business/e-commerce (e.g. Amazon.com, iTune, or eBay on the consumer markets, automated supply chains on the business-to-business markets), which provides content, material, services or business transactions with the desired quantity and quality just-in-time, on-demand, without as many physical contacts as before in history when Internet and computers were unheard of. Such a just-in-time business model and global knowledge-enabled economy is unprecedented in the past, calling for a much more open and flexible approach to learning. In another interview, Molyneux (Rhema Group, 2006) adds that the development and process of workplace e-learning must follow the suite of thriving on-demand e-business processes by designing small learning objects to feed a workforce's learning needs as and when and where their employees need it. He encourages organizations to build an e-learning strategy to not only deliver training, but also revolutionize its culture of learning and developments - from centralized to individual-centered. This kind of change will empower individual employees to take their own responsibilities in learning.

The concept of learning on-demand (LOD) is born within the conceptual and application arena of workplace e-learning. Hence, the widely adopted name is simply *learning on-demand* or *on-demand learning* omitting the “e” at the front.

The definition of learning on-demand is often centered on four dimensions: content management, workplace context, time, and technology. Trondsen states: “Multimedia technologies and IT infrastructures that can deliver material directly to employees’ desktops provide the foundation for LOD” (as cited in Downes, 2003a, para. 4). Later, Cummings (2001) defines learning on-demand as a process of “obtaining just the right amount of knowledge, at just the right time and in just the right setting”. It clearly reveals the issues involved in learning on-demand: content, time, and context. He continues that learning on-demand focuses on the best use of time with personalized needs and experience of learning as opposed to the traditional classroom learning or mass education with a centrally scheduled and planned curriculum, including the luxury of scheduling around a pattern of fixed blocks of time.

In a rather straightforward way, Stephen Downes (2003a, para. 1) links learning on-demand with knowledge management from the content side: “if you take knowledge management and apply it to learning, you get learning on-demand”. Crosman (2004) believes that learning on-demand keeps learners on the job while learning; additionally, short-segment content is better to engage learners than the traditional book format. Bersin & Associates (2005) puts learning on-demand as “all the digital learning assets (courses, references, help files, documents, and presentations) are made available on-demand – just as a worker needs them,” (p. 44). This is not merely a concept or “an idea” out of touch with the real world, but “it’s based on what’s really happening in the evolution of e-learning", Bersin concludes as an underlying and obvious result of surveys and interviews with 526 training managers and executives (2006, p. 20).

To sum up, via information and communication technology, learning on-demand entails learning content and learning activities to be delivered in a just-in-time fashion that is contextually as well as technically integrated in employees' workplace and tightly aligned with their mission critical job tasks.

It has to be pointed out again that due to the swift changes happening everywhere on a global scale many expressions are used for circumscribing learning in the on-demand mode. Whether to call this type of learning as "learning on-demand" (Bersin & Associates, 2005), or "just-in-time learning" (The Conference Board of Canada, 2001), or "enterprise e-learning" (Cumming, 2001), or "Enterprise 2.0" (McAfee, 2006), or "ad-hoc learning", or "work-embedded learning" (Davenport, 2006) - after all, it relates to the same phenomenon. Nowadays, because the workforce constantly has to adapt and adjust due to fierce global competition and shortened knowledge/expertise cycles, organizations look for learning solutions and technologies that will synchronize the dynamics of work and learning. Only this will allow the pursuit of the goal that employees learn the right amount of information and gather knowledge at the right time at the right workplace with minimum interruption of work and a maximum of applicable learning outcomes.

2.3.2 Benefits of Learning On-demand at the Workplace

The group for education and lifelong learning of The Conference Board of Canada is a not-for-profit research organization with affiliates in the United States and Europe promoting e-learning integration into the workplace, communities and traditional education entities. In 2001, the outcome from their extensive study shows that the emergence of just-in-time learning on-demand is much desired by both employees and employers for many of its flexible, just-in-time and learner-centered merits (The Conference Board of Canada, 2001). After early years with a focus on cost savings (this effect has never really been proven though), e-learning is now approached having more value-added integration in mind by bridging the gap between work and learning. The study also suggests that employers shall leverage the existing information and communication infrastructures to enable its more and more technology savvy workforce to use the same tools and technologies for work and learning in a seamless integrated process.

It should be noted that, the outcome following a cross-country survey with consultants, employees and employers with 10 site visits in various industries, the Canadian report establishes that “employers are most interested in the potential of e-learning for just-in-time, modular learning” (p. 1). Although the following findings identified by The Conference Board of Canada outline major benefits and motivations of implementing an overall e-learning strategy at the workplace, not specifically on learning on-demand, some key results as a matter of fact do imply exactly the advantages of implementing learning on-demand according to experts’ definitions of LOD mentioned in previous sections (Cummings, 2001; Downes, 2003a & 2003b; Bersin & Associates, 2005).

Figure 2-11 depicts that employers are excited by on-demand, just-in-time delivery of learning, which ranked as the first driver of implementing e-learning at the workplace. Cost has been a long-term issue for e-learning development and implementations at organizations. But the most interesting finding from the employers’ side is that they see employees’ control over learning itself as a great benefit. Finally, learning within the context of the workplace is another motivating factor for e-learning at the workplace. Employees realize the benefits of “learning in the work”, bonding learning with job and business processes more “timely” and “seamlessly” than traditional classroom training.

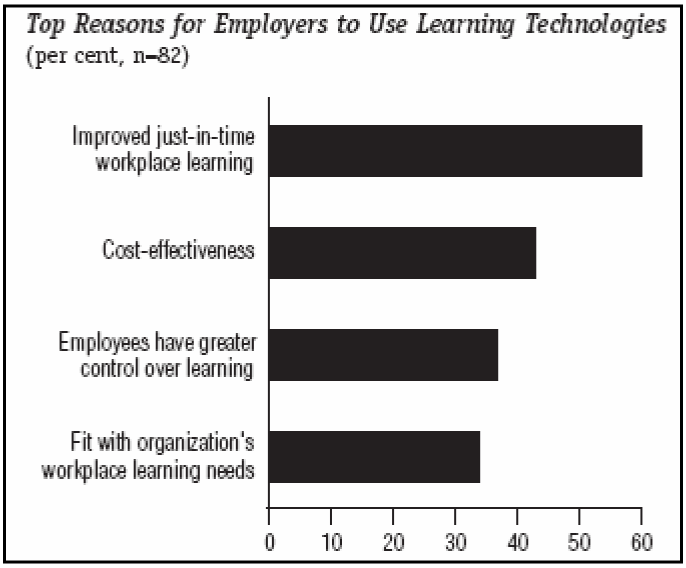


Figure 2-11: Top reasons for using learning technologies for the workplace (The Conference Board of Canada, 2001, p. 9)

On the other side, employees see the advantages of on-demand learning at the workplace offering them (The Conference Board of Canada, 2001):

- Flexibility: choosing when, where and what to learn as it is needed. 75% of the respondents consider flexibility the biggest advantage of e-learning at work.

- Relevant content and easy access of learning related to their job and professional development: Learning technologies enable employees to "focus on content that matches their learning needs when they need it" (p. 20).
- More control over learning: this is a benefit rated the same by employer and employee on giving learning control to learners at the workplace.

Comparing both the benefits ranked by both sides (see Figure 2-12), it is obvious that time is the primary concern regarding e-learning at the workplace. The greatest benefit of on-demand learning for an employer is its just-in-time implication, employees value the accessibility not restricted by time as the top benefit. For the learner, the employee, content in the context of his/her working environment is well desired. At last, but not the least, "more control over learning" is rated highly for employers and employees. Employees as adult learners shall be encouraged and empowered to design, select their own learning content and agenda, and then apply it directly to work in a simultaneously interwoven process chain.

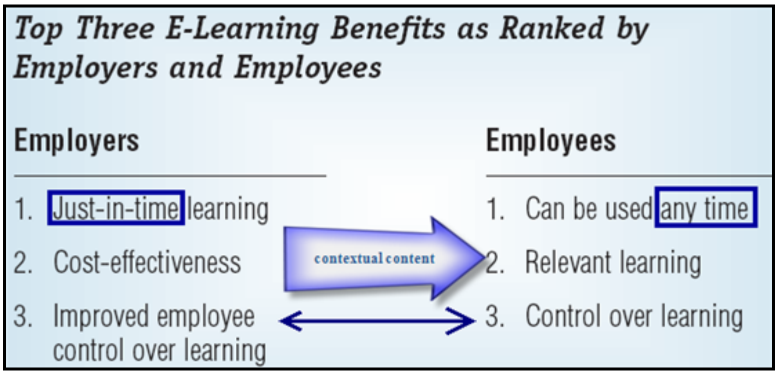


Figure 2-12: Benefits of e-learning for the workplace (The Conference Board of Canada, 2001, p. 20)

Confirming the view of Trondsen who has advocated learning on-demand since 1998, Downes (2003a, para. 5) goes further on explaining two significant benefits of learning on-demand: firstly increased speed of learning because "the learning occurs in a context of use", and secondly flexibility offered to individual learners so that "updates produced at the input end of a knowledge management system can immediately become new learning opportunities at the output end." Because the learning outcome is applied to work in an immediate fashion, Crosman (2004) believes learning on-demand increases productivity.

A successful practice originated from the highly ranked Nanyang Technological University (NTU) in south-west Singapore. NTU follows the on-demand learning vision so that both its staff and faculty members do update their knowledge anytime and anywhere. With the on-demand learning approach, NTU's faculty members are able to "create their own content while teaching and researching at the same time" (Thomson NETg, 2005, p. 1), once a challenge for the university. By use of the Thomson NETg's self-paced on-demand learning solution professors and instructors are enabled to update their professional learning needs while generating personalized content by "mixing and matching learning objects" from a pool of learning objects, and then integrating them into their teaching syllabus (p. 3).

2.4 Features of Learning On-demand

Viewed from the market side, content, technology, and services are three broad perspectives of e-learning development for the corporate e-learning world (Henry, 2001; Clarke & Hermens, 2001; Boehle, 2005). Therefore, when marking peculiarities of learning on-demand at the workplace, say a specific variant of an enterprise's e-learning approach, it is natural to depart from these three segments as well. However, services - here on the customer side - refers to the support and facilitation provided to the employees, the learners, which are often advised by field practitioners as the benchmarks of building successful e-learning solutions for workplaces (Salopek & Davenport, 2005; Baldwin-Evans, 2006; Goodwin-Maslach, 2006).

2.4.1 Services - Just-in-Time at the Workplace

2.4.1.1 Support of Just-in-Time Learning and the Self-Managed Learner

The on-demand learner is a result-driven individual who takes responsibility in the learning initiative, information searching, agenda planning, and looking for support from experts. Hartley (2000) adds that this type of learner is looking for flexibility, and opts for a just-in-time learning mode. Long ago, Nonaka and Takeuchi (1995) have already put doubt in the western belief that knowledge is best passed on through education and training. In their view, tacit knowledge is the most important one defining innovation, but it cannot be explicitly and formally communicated. In their famed book *The Knowledge Creating Company*, they contend that the most valuable tacit knowledge is not learned, but created by ourselves, by the learner her-/himself. Hence, investing on the employees' self-initiative, self-managed learning will create more value for the organization.

With the penetration of IT technologies into day-to-day workplaces, Bob Mosher, director of learning evangelism and strategy for Microsoft Learning, states that "Most real learning is happening in the workplace, which is very poorly supported" and "…we (the learning facilitators) must migrate learners from acceptance of knowledge to knowledge application" (as cited in IT Training, 2005, section: News: Institute of IT Training, para. 3 & 4). Moreover, he adds, as employees acquire more sophisticated IT skills, they want to move away from dependency offered through the corporate hierarchy. Employees of today's workplace would like to be independent in learning what they need and at the time they need it, rather than being ordered or sent to study. Organizations need to treat this type of independent learner differently. And Martyn Sloman, an advisor to the United Kingdom-based Chartered Institute of Personnel and Development, adds: "Research suggests that a shift is taking place from training to learning. Learning is a self-directed, work-based process, leading to increased adaptive capacity. Learning lies in the domain of the individual." (as cited in Davenport, 2006, p. 42)

Table 2-2 is a result from a Delphi Group study (2000) on the characteristics of enterprise e-learning, which, as described by Cummings (2001), occurs at "just the right time and in just the right setting" with "just the right amount of knowledge" (para. 4), precisely, the scenario for learning on-demand. Eight distinctive differences are outlined between classical training and the ideal scenario of workplace e-learning. First, time at the workplace is a factor that no one can neglect. Time implies two layers in the context of learning on-demand. With "just-in-time" learning, the learner's availability and schedule cannot be predicted or planned prior to the learning event.

	TRADITIONAL TRAINING	**Enterprise E-LEARNING**
Delivery	Push – Instructor Determines agenda	Pull – **the learner decides the agenda and process**
Responsiveness	Anticipatory – Assumes to know the problem	Reactionary – **responds to problemat hand – the learner decides what needs to be learned**
Access	Linear – Has defined progression of knowledge	Non-linear – Allows **direct access to knowledge in whatever sequence** makes sense **to the situation at hand**
Symmetry	Asymmetric – Training occurs as a separate activity	Symmetric – **Learning occurs as a symmetric integrated activity** (of the workplace)
Personalization	Mass produced – Content must satisfy the needs of many	Personalized – Content is determined by **the individual users** – **individuality**
Adaptivity	Static – Content and organization/ taxonomy remains in their original authored form without regard to environmental changes	Dynamic – Places the learner at the center of the learning process – **the learner has control over both content and process**
Modality	Discrete – Training takes place in dedicated chunks with defined starts and stops	Continuous – Learning runs in parallel and **just the right amount of the knowledge with just-in-time delivery**
Authority	Centralized – Content is selected from a library of materials developed by the educators	Distributed – Content comes from the interaction of the participants as well as the educators – **A collaborative process**

Table 2-2: Traditional training vs. enterprise e-learning (adapted from Delphi Group, 2000, p. 4 & Cummings, 2001).

In Table 2-2 the Delphi study shows that an on-demand learner shall set their own priorities and schedule. The second layer implied by on-demand learning is that the amount of learning content cannot be excessively lengthy such that it exceeds the learner's time allowance while working on job tasks; this is highlighted in the "modality" section. The key points, highlighted in bold text in Table 2-2, illustrate that in order to effectively integrate e-learning with work, organizations need to put the learner/employees in control over content and process, entrusting them to solve their own challenges at the best time at their workplace. Content needs to be delivered in the right amount, and learning is a collaborative process.

Giles Cockman, a European learning and development expert, also believes that the support of self-managing learners is a growing interest from which both the business and employees benefit (Sparrow, 2006). The same view is being held by Martyn Sloman, advisor of learning, training, and development for the UK-based Chartered Institute of Personnel and Development. Research findings put forth self-initiated, self-managed learning embedded with work processes as the trend, emphasizes Sloman, "Never forget that we must start with the learner" (as cited in Davenport, 2006, p. 42).

2.4.1.2 Facilitation of Collaborative Learning Activities and Processes at the Workplace

For a successful enterprise e-learning application, the last column of Table 2-2 advises organizations to release the authority of learning content, leaving it to the collaborative efforts among the individual learners and learning facilitators/educators. This brings the topic of facilitating collaboration in enterprise e-learning into the foreground.

In the context of learning on-demand at the workplace, the learner's role is decisively characterized by a self-initiated, self-organized, and self-directed manner that determines the learning process, which in turn is centered on the individual learner. But it does not mean to leave the learner on a lonely planet. Lustig (2003) and Kirschner (2004) point out that effective learning at the workplace is essentially centered on multi-channeled collaborative learning activities and processes at work.

After all, people are social. For many years, numerous classical research works reveal that people are more satisfied while learning through interaction among peers. People learn better as an interactive group collaboratively, helping and stimulating each other, than as a single lonely ranger. Thirdly, the learning experience lasts longer than the experience of being taught through the one-teacher-to-many-students model (Beckman, 1990; Collier, 1980; Dillenbourg & Schneider, 1995; Ewing, Dowling & Coutts, 1999; Paul, Pearlson & McDaniel, 2000; Paul & McDaniel, 2004; Goodsell, Maher, Tinto & Associates, 1992; Slavin, 1980; Wegerif, 1998). Experienced e-learning facilitators contend that interaction and communication among peers is essential for effective e-learning, and without it a 15-20 minutes online course may generate zero outcome (Lustig, 2003). Additionally, Tony Terranova, vice president of product marketing and sales training for Genesys Conferencing in Denver, Colorado and Montpellier, France, notes that the need for collaborative learning is "from the grassroots of the end user" (as cited in Lustig, 2003, p. 35), whether it is the sales manager who must collaborate with his team members on the sales forecast, or the dairy farmer who gains valuable information and tips from his peers on dairy options.

One of the biggest advantages of e-learning is its collaborative facilitation of multi-channeled communications crossing time, space, and nationalities, providing the learner with a virtual community with just-in-time learning opportunities (Stage, Muller, Kinzie & Simmons, 1998). To seize these advantages, Kreijns, Kirschner & Jochems (2002 & 2003) identify conditions for the necessary supporting collaborative e-learning environment: Collaborative learning does not happen automatically. So organizations shall provide tools encouraging group interactions, and more important, tools for supporting job-task related context as well as encouraging community bonding in a non-task related social context. The latter as explained by Wegerif (1998) is aiming at: "Forming a sense of community, where people feel they will be treated sympathetically by their fellows, seems to be a necessary first step for collaborative learning. Without a feeling of community people are on their own, likely to be anxious, defensive and unwilling to take the risks involved in learning" (p. 48). The social context plays a crucial role in the success of collaboration. McFadyen and Cannella (2004), Inkpen and Tsang (2005) have stated that collaborative activities are a combination of personal and collective endeavors situated in a social context. By constantly updating their expertise, collaborative activities embody continuous learning processes that prepare knowledge workers for unpredictable business changes and complex working contexts (Schrage, 1995, pp. 4-5; Cropper, 1996).

Paul (2006) exams the collaborative processes of knowledge transfer, knowledge discovery, and knowledge creation in the healthcare industry. From his study, Paul proves the arguments of Wegerif and the other authors mentioned: Establishing a supportive social context is of equal importance as designing engaging collaborative activities. He discovers that without actively engaging individuals in the processes of information discovery or knowledge creation, the sheer transfer of data, information or explicit knowledge does not generate a positive influence on remote learners in a virtual environment. In other words, collaboration evolves as a set of knowledge processes dwelling in social contexts. Fehlemann-Heindoerfer (2006) point out that workplace collaboration is often a multi-dimensional interaction via distinctive communication patterns, as illustrated in Figure 2-13. Bringing these interactions and patterns to the learning context as well, the individual learner at the workplace may collaborate with peers, interact with learning objects (e.g. product information, whitepapers, business memos), and tap into on-going business processes.

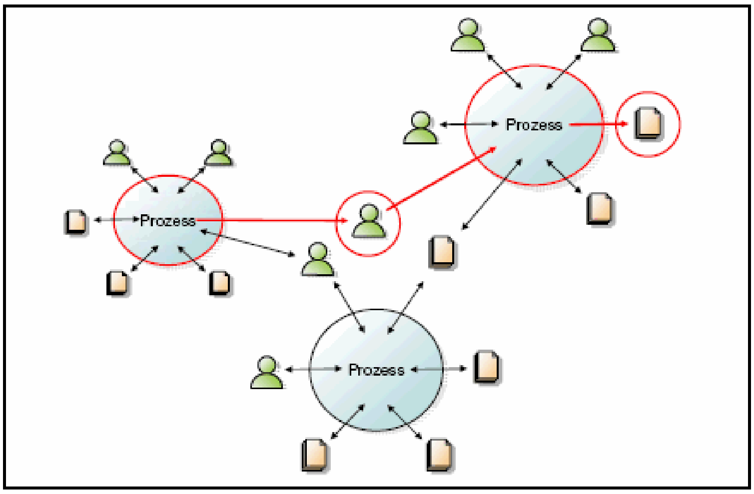


Figure 2-13: Navigation pattern of contextual collaboration (Fehlemann-Heindoerfer, 2006)

Hardy, Phillips, and Lawrence (2003) study three basic advantages of workplace collaboration among organizations: Firstly, resource sharing while facilitating knowledge transfer which boosts efficiency, a strategic decision; secondly, collaboration which generates synergies to create new knowledge, a learning perspective; thirdly, the result of the first two which leads the organization to a competitive position, a political effect as they put it. Their research also shows that while promoting collaboration the executives must balance between free sharing across corporations versus intellectual property rights, and knowledge improvisation versus goal and objective-driven approaches.

Today, organizations finally wake up to the call of collaboration, realizing it is the only way to capture, access, and - more critically - share information and knowledge among knowledge workers within a changing competitive and global workforce (Driscoll, 2004; Sambamurthy and Subramani, 2005; Goodwin-Maslach, 2006). Yet we are only at “the dawn of emergent collaboration”, calls out McAfee (2006) from the Harvard Business School. He suggests that today’s enterprises enter another era of the “Enterprise 2.0” platform, where collaboration makes its grand entry from the bottom level of the corporation hierarchy to the center of the enterprise, not the least enabled by end-user centric collaboration tools such as blogs, wikis, or Podcasts.

2.4.2 Technology – Knowledge Management Integration and Collaboration

2.4.2.1 Knowledge Management and Integrated Learning Delivery at the Workplace

In order to facilitate learning for effective on-demand delivery at work, many researchers come to the solution of integrating learning technology with the virtual workplace (Fischer, 2000; Golden & Loria, 2004). Because Internet and computers are essential components of the backbones of modern organizations, it is a logical solution that learning shall be part of the existing information and communication technologies that employees are using on a day-to-day basis. Pragmatically, The Conference Board of Canada (2001) recommends that organizations shall integrate "e-learning with knowledge management, performance management and communication systems" (p. 17).

It is a substantial task choosing appropriate tools and technologies from plethoric offerings at current e-learning market places. Figure 2-14, a survey done by Kim, Bonk, and Zeng (2005), shows that technologies catering to knowledge management, simulation, wireless technologies, and tools for reusable learning objects will impact e-learning delivery most in the near future. They also conclude that learners, executives, and learning facilitators welcome technologies that deliver just-in-time learning with engaging learning experience and performance support, such as peer-to-peer collaboration, and competency-based learning.

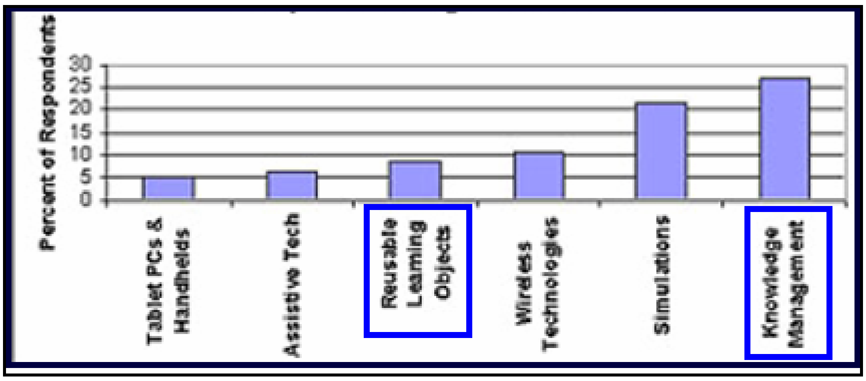


Figure 2-14: Technologies with most impact on delivery of e-learning in the next few years (Kim, Bonk, Zeng, 2005, section: Future of Online Trainers/Instructors, para. 3)

Golden & Loria (2004) group current e-learning technologies, tools, and systems into two schools: context-centric versus content-centric. Additionally, there is an overlapping area between these two schools of tools. Clearly, in Figure 2-15, knowledge management systems and technologies become the merging points between content-centric learning approaches, often used in formal learning environments, and context-centric approaches, often utilized in informal learning. Specifically, learning management systems and synchronized virtual classrooms are modeled after the traditional content-centric (physical) classroom delivery. On the other side, the context-driven tools, such as instant massaging, tools for searching experts and information, team workspaces, or conferencing, etc. are often dedicated to functions to facilitate bottom-up communication and collaboration among individual learners or a community of learners. Between formal learning tools and informal ones, a knowledge management platform congregates information and knowledge from both the content and the context sides, acting as a transition point between the two schools of learning technologies. Because learning on-demand is essentially centered on context-driven, informal, and collaborative learning from the edges of an organization, the success of on-demand learning depends on effective and efficient usage of bottom-up and decentralized technologies like online chat, discussion forums, web-conferencing, virtual team rooms and knowledge management systems in a workplace environment (Lustig, 2003).

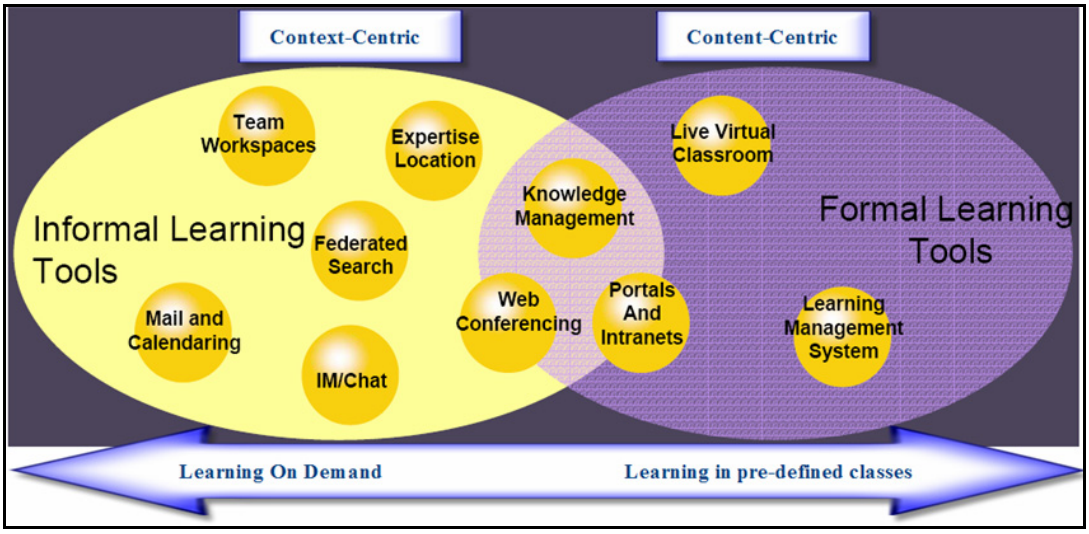


Figure 2-15: Context- and content-centric learning tools from informal to formal learning (Golden & Loria, 2004)

As the above studies show a knowledge management platform becomes the natural bridge connecting formal and informal learning when embedding learning at the virtual workplace. From another aspect, learning at the workplace can benefit greatly from the well-studied field of knowledge management.

In this thesis the concept of "knowledge management" is seen from a pragmatic point of view in the context of learning at the workplace and developing ideas as to how this could be practically implemented. It is not the goal to add to the profound research about knowledge management's additional facets. Rather the results of this research will be taken and applied. Against this background knowledge management is understood along the following lines. Van der Spek & Spijkervet (1997) suggest that knowledge management "strives for the optimal use and development of knowledge, now and in the future. It determines the form, the place and the time, as well as what kind of knowledge must be available in a company or network of organizations" (p. 46). Further, they add that one important aspect of knowledge management is as a continuous learning process. To increase an organization's learning capacity, "knowledge management is a continuous process of developing, evaluating, relating back, and adjusting. Ultimately, improvements will always be about changing people's habits and their way of working" (Van der Spek & Spijkervet, 1997, p. 47). Knowledge management is about improving organizational learning process and sharing practice for enhancing the overall performance of the organization. To achieve this the knowledge creation and generation process has to be decentralized in a way in which every individual worker is involved in knowledge and experience contribution (Hammer, Leonard & Davenport, 2004). Also, knowledge management shall support leadership and governance in an organization to better cope with knowledge as a practically useful resource. This includes individuals as well as the whole organization; it comprises operative as well as strategic aspects. (Probst, Romhardt & Raub, 1999, pp. 260-266).

Fitting the constructive parts of this thesis, knowledge management on the more practical side can be positioned according to the research from Mertins, Heisig and Vorbeck (2001): "Knowledge management describes all methods, instruments and tools that in a holistic approach contribute to the promotion of the core knowledge process – to generate knowledge, to store knowledge, to distribute knowledge and to apply knowledge supported by the definition of knowledge goals and the identification of knowledge – in all areas and levels of the organization" (p. 3). Furthermore, in a process-centered view knowledge management is to be understood as a system of activities which allows members of an organization to gain access to knowledge (Alavi & Tiwana, 2002; Hannig, 2002, pp. 63-76).

Access to knowledge takes places at the computerized workplace in the flow of business processes pushing or pulling data to the workplace. A very intuitive way to illustrate the transition from data to knowledge is to quote Dee Hock, the founder of Visa Credit Card. In 1996, Hock voices his aggregated view on noise, data, information, knowledge and wisdom in 1996 (as cited in Stone, recorded by O'Reilly, 2006, section: Discernment):

- "Noise becomes data when it has a cognitive pattern.
- Data becomes information when assembled into a coherent whole, which can be related to other information.
- Information becomes knowledge when integrated with other information in a form useful for making decisions and determining actions.

- Knowledge becomes understanding when related to other knowledge in a manner useful in anticipating, judging and acting.
- Understanding becomes wisdom when informed by purpose, ethics, principles, memory and projection".

Linda Stone, previously corporate vice president of Microsoft, pushes the application of knowledge to a next stage: "our opportunity is to move from being knowledge workers to becoming understanding and wisdom workers" at work, at learning and at life in an age enabled by information technology (as cited in O'Reilly, 2006, section: Discernment, para. 5).

Knowledge Management Process	**Author**
Creating and sourcing, Compilation and transformation, Dissemination, Application and value realization	[Wiig,1993]
Sharing tacit knowledge, Creating concepts, Justifying concepts, Building an archetype, Cross leveling knowledge.	[Nonaka/Takeuchi 1995, p. 83]
Developing new knowledge, Securing new and existing knowledge, Distributing knowledge, Combining available knowledge	[Spek/Spijkervet 1997, p. 49]
Acquisition, Index/Filtering/Linking, Distribution, Application	[Alavi 1997]
- Acquiring knowledge (extracting, interpreting, transferring) - Selecting knowledge (locating, retrieving, transferring) - Internalizing knowledge (assessing, targeting, depositing) - Using knowledge - Generating knowledge (monitoring, evaluating, producing, transferring) - Externalizing knowledge (targeting, producing, transferring)	[Holsapple/Joshi, 1997]
Knowledge generation, knowledge codification, knowledge transfer	[Davenport/Prusak 1998, p. 111]
Knowledge identification, knowledge acquisition, knowledge development, knowledge distribution, knowledge application, knowledge preservation	[Probst/Raub/Romhardt, 1999, p. 53 ff.]
Initiation, Generation, Modeling, Repository, Distribution & Transfer, Use, Retrospect	[Lai/Chu 2000, p. 2 f.]
Knowledge procurement, knowledge development, knowledge transfer, knowledge appropriation, knowledge advancement	[North 2002, p. 4]

Table 2-3: Examples of knowledge management processes from different schools (Smolnik, 2005, p. 34)

Smolnik (2005) summarizes different knowledge management processes defined by a number of scholars, as presented in Table 2-3. Findings of knowledge management researchers assert that the key processes of knowledge management often involve four stages. These four stages best characterize the central approach taken in the later constructive parts of this thesis from an employee's/learner's point of view at the workplace:

- Knowledge acquisition via sharing, developing, and/or creating.
- Knowledge internalization by indexing, filtering, linking, assessing, and depositing.

- Knowledge distribution and dissemination.
- Knowledge application.

2.4.2.2 Sharing and Collaborative Tools for Learning

For the majority of the 90's and early years of the new millennium, e-mail is chosen to be the most dominant information allocating and distribution medium among knowledge workers. However, e-mail has failed in principle on yielding tacit knowledge, and even worse, interfering with productivity through gross misuses (e.g. junk mails; misuses of distribution lists, cc-mechanism, reply-with-history and attachments; general mail overload). According to Davenport's study (2005), 15% of surveyed employees think e-mail diminished their productivity, 21% are overwhelmed by it, and 26% think their own organizations overuse e-mail.

Today's organizations benefit significantly from a bottom-up flow of collective intelligence when individual knowledge workers are given tools to sharing their ideas, electronically delivered information and knowledge via collaborative technologies based on their job context. People who own, communicate, and create information and knowledge are the core value of the organizations in the knowledge society of the 21^{st} century.

Originating in the consumer world, people converse on blogs, they collaboratively generate knowledge via wikis, they share photos on Flickr.com and tags on del.icio.us, or they broadcast videos via youtube.com. Whether these decentralized, end-user-centric, consumer-oriented collaborative tools will benefit the corporate environment and e-learning industry are hotly discussed issues.

Dale Dougherty and Tim O'Reilly (2005) were the first to envisage this wave of new web technologies, and coined the term *Web 2.0*. They describe that the technology conglomerate "Web 2.0" marks the era of recognizing the important role of the entirety of individual users of networked computers, their collective intelligence as "co-developers" and their multiplying power of sharing in the framework of collaborative technologies (O'Reilly, 2005, pp. 4-5). The new generation of web technologies opens another door for sharing and collaboration spanning many aspects of lives, at home, at work, and at learning.

The following sections stress Web 2.0 phenomena like folksonomy and tools like wiki, blog, Podcast, or RSS feeds as catalysts for the next generations of social network technologies on the web. These in turn may push forward the idea of learning into the direction of a more democratic, collaborative, interactive, and dynamic integrated solution for learning in the workplace environment.

2.4.2.2.1 Folksonomy

In the course of the emerging Web 2.0 technologies the term “folksonomy” was created by Thomas Vander Wal. According to Vander Wal (2005), Winder (2005), Albrycht (2006), and McFedries (2006), folksonomy consist of two parts: *folks* refers to the normal users of the Internet, and *onomy* is borrowed from taxonomy. Together, folksonomy means the collective wisdom of the “normal” users of connected computers. As opposed to taxonomy, regularly defined by experts, folksonomy focuses on an end-user defined specification, classification and organization of information - rendered as texts, graphics, audio and video clips, images, etc. - via their own, understandable vocabulary. The enactment of this type of specification process often evolves around assigning keywords, category descriptors, and/or metadata tags to the information. From this the term *tagging* was derived as the essential mechanism of attributing metadata to information pieces, which altogether form a body of collective wisdom.

This genre of social networking technology has been pioneered by Flickr.com[8], a photo sharing application, and del.icio.us[9], an environment for sharing personal bookmarks on the web with other users. Both applications post similar explanations for what they consider as “tags”. According to this tags are “one-word descriptors” (del.icio.us, no date, para. 1), or labels, or keywords (Flickr, no date) that users may assign to the content (e.g. photos and websites) in order to “organize and remember” and retrieve them in later occasions. The ground-breaking fact is that tags in the context of folksonomy are chosen by the end-user, “and they do not form a hierarchy” (del.icio.us, no date, para. 1). Both Flickr and del.icio.us host *tag clouds* which reflect the popularity or most commonly used tags by the relative size of tags. As more a tag is used so larger it is rendered on the screen relatively to other tags. This approach creates an intuitive visual effect to easily identify information a user needs (if the tag happens to describe the information the user really is looking for). Illustrated in Figure 2-16, the circled tags “blogs”, “photography”, “web”, “web 2.0” of a Del.icio.us tag cloud, or „family”, “friends”, “party” of a Flickr.com tag cloud visually stand out as the most frequently used tags.

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[8] http://www.flickr.com
[9] http://del.icio.us

Figure 2-16: Tag clouds from Flickr and Del.icio (March 18, 2007)

This tagging concept is a flat and democratic approach to classification of information via the common sense of a user community instead of an authorized system of specifications by experts. Such a phenomenon reveals not only the maturity of the Internet users, but also the new wave recognizing the importance of information interactively organized by people, tagged by people, and used by people who process information and knowledge on a daily basis. Therefore, some researchers claim that the resulting folksonomy leads to a more accurate classification of information and knowledge based on mass interpretation and application as compared to classifications reflecting the opinions of a limited number of experts (Winder, 2005; Dye, 2007).

Yet, implementing folksonomy in an organizational environment is of dubious value. For organizational users, the folksonomy approach of democratizing information categorization will be a big attraction as well as distraction at the same time (Gordon-Murnane, 2006). The complete flat tagging of information can certainly be used to capture how the knowledge workers interact with information pieces and which contexts they ascribe to these pieces. However, Gordon-Murnane (2006) and Guy & Tonkin (2006) argue that the large body of unmanaged, imprecisely defined and excessively personal tags may result in ineffective usage in professional organizations. Crawford (2006) adds that the current application concepts for folksonomies neither show synonym control, nor reflect relations among tags. To avoid or minimize the drawbacks of folksonomies, Mejias (2005) suggests tactics to set up rules and train the end-users. Examples include avoiding capitalization and enforcing lower cases in typing, using synonyms in tagging, or adopting tagging conventions from previous users. In addition, Guy and Tonkin (2006) propose a system approach to control vocabularies, to add synonyms, and to create better user interfaces for tag retrieval so that existing tags can be reused more easily.

Allen (2005) adds that the folksonomy approach is not the silver-bullet for enterprise users, and “The way forward could be to combine the two approaches so that grass-roots folksonomy pump feedback into controlled taxonomies, which in turn become more textured, alive and up-to-date” (section: MARKET WATCH, para. 7). This view is agreed by Suster (2006) who praises the emergence of folksonomies on the one hand. But on the other hand he asserts that to increase productivity of knowledge workers in the workplace environment the concept and design should be a combination of top-down and bottom-up taxonomy with folksonomy approaches to effectively store, share, classify, and retrieve information and knowledge.

The essence of the above discussion is that folksonomy is a decentralized approach to classify information via collective intelligence of end-users. Nevertheless, to enhance productivity of knowledge workers, folksonomy shall be taken as a complement to centralized design manners based on corporate taxonomies in a professional workplace environment. In the constructive parts of this thesis later on this hybrid approach is taken. Especially, in the concept of “keyword-classes” as containers for groups of keywords (i.e. tags) which belong to a common application domain a folksonomy approach as well as a strictly controlled taxonomy approach can be taken.

2.4.2.2.2 Wiki

On March 25, 1995, Howard G. "Ward" Cunningham, a computer programmer, has first coined the word *wiki* (Wikipedia, 2007, section: Wiki, para. 1 & section: History, para. 1). He denominated this as an environment which enables mass-collaborative creation, editing and updating (including removing) of web page content by a group of users via any web browser without login or any registration. According to the Oxford English Dictionary ([online version], 2007), a wiki is “A type of web page designed so that its content can be edited by anyone who accesses it, using a simplified markup language.”

The world’s largest wiki website by database size is Wikipedia. Shown in Figure 2-17, from Wikipedia’s first launch in January 2001, it obtained a phenomenal growth rate, so quickly that Wikipedia is becoming an encyclopedia of its own genre that has more visitors than online CNN, or the New York Times in the English-speaking countries. Certainly, people may envy Wikipedia’s fast adoption rate and visibility. Moreover, it is completely free, which may explain its popularity. Meanwhile, some experts are skeptical on this approach of contributing professional content anonymously by the mass, while questioning the Wikipedia's credibility and accuracy. A review in the Technology Quarterly of The Economist (April 22, 2006 & March 10, 2007b) reflects that the Wikipedia may be prone to error and vandalism. However, no media or experts can convey 100% truth; even the acclaimed Encyclopedia Britannica has errors. The Wikipedia exercises a peer-control system that may be the means to protect against vandalizing. Some month later, the same magazine re-examines this issue and denotes: "… in short: it would be unwise to rely on Wikipedia as the final word, but it can be an excellent jumping off point" (The Economist, March 10, 2007).

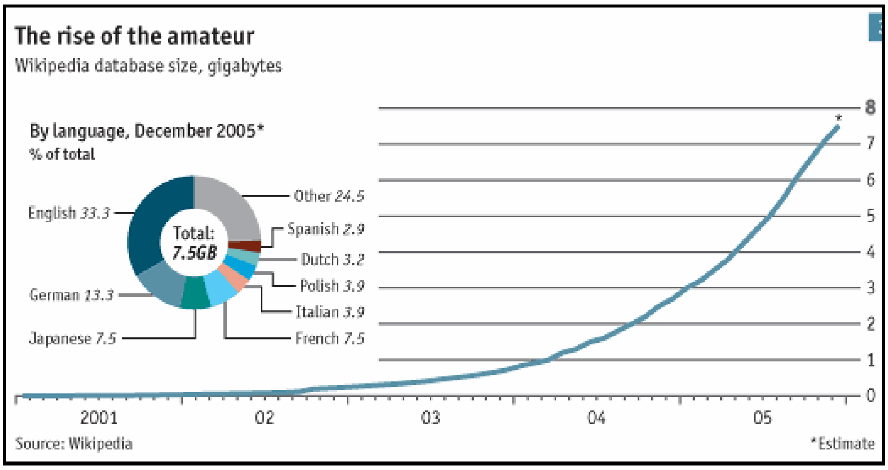

Figure 2-17: Survey on new media, the wiki principle (The Economist, April 22, 2006)

An aspect of wikis is that they have a strong inclination to communities of practice. Palloff and Pratt (1999), Van Winkelen (2003), Harris and Higgison (2003), Krieger (2006) address this issue and point out that communities of practice in the virtual space have been prevalent in both learning and enterprise environments. Wikis are built on an open philosophy, which their founder Cunningham is keen on, fostering collective wisdom in organizations by facilitating communication as well as content contributions among a large number of people (Taft, 2006).

Catering to the need of community collaboration, instead of only showing "what I know" in the traditional approach of content creation, wiki technology has found its way to both the corporate and the learning sphere by offering co-generating and co-editing content in a common virtual space. Saran (2006) reports that General Motor's Chief System and Technology Officer believes that enterprise wikis can save time and resources to add information and share ideas in organizations. This pertains to, for instance, the synchronization of terminologies, which often takes lots of time in physical meetings. In

Nokia, 13,600 employees, 20% of its total employees, utilize wiki pages to edit files, update schedules, manage project status, trade ideas, etc. (as cited in Carlin, 2007, section: Early Confusion, para. 1). At Xerox, a wiki is employed as a research and development tool by its researchers to define technology strategies for the company collaboratively (Tapscott & Williams, 2007, section: Bottom-up Knowledge Creation, para. 1). The central gravity of wiki's popularity is collaboration and participation:

> "Once people start using the wiki, they become part of the system it creates and, in turn, the wiki becomes part of the dynamics of the office. Those who don't participate are left out of the conversation and stand the risk of not being as informed as their peers." (Goodnoe, 2006, p. 4)

In the corporate learning and training arena, wikis encourage more active collaboration among participants in virtual learning at the workplace. Cross (2007) claims that any Chief Learning Office of an organization should understand wiki technology as a tool, promoting grass-root collaboration to share information and knowledge, which is the secret source of innovation and effectiveness in a knowledge-based organization (p. 17).

2.4.2.2.3 Blog / Weblog

A blog, or weblog, is a web-based personal journal, open to the public or to a professional group. According to the Oxford English Dictionary ([online version]), a blog is "a frequently updated web site consisting of personal observations, excerpts from other sources, etc., typically run by a single person, and usually with hyperlinks to other sites; an online journal or diary" (2003). A blog invites others to interactively add comment threads to the content presented, in a similar fashion like it has been done in interest groups based on forum software for a long time**.** Contrasting to wiki, a blog emphasizes a personal view or a theme from a community and in its content presentation it combines text, images, and links to other blogs, web pages, or media related to its topic (Hewitt, 2005, pp. 88-104 & 128-138; Hall, 2006; Guterman, 2007).

A "blogger", i.e. the owner of a blog, periodically posts messages, thoughts, and/or links focusing on particular topics, such as news, politics, history, art, software, weather, cooking recipes, field trips, or gossip about Paris Hilton, etc. Hence, virtually everything which can be talked about can be blogged online. Guterman (2007) argues that blogs are small talks multiplied by the web so that a personal conversation, when it is good, can swell to dialogues among thousands.

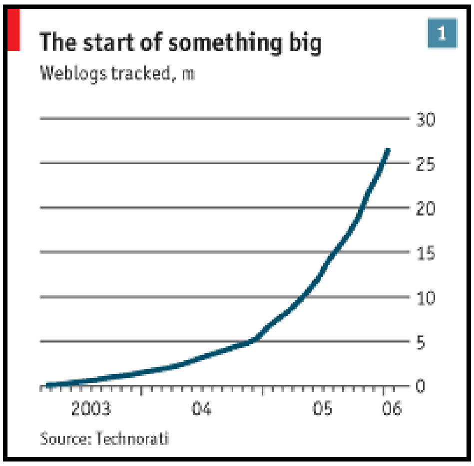

Figure 2-18: Survey on new media (The Economist, April 22, 2006, section: "It's the links, stupid")

Look at Figure 2-18, with a slow start in the late 1990's, at the dawn of a new millennium, blogs have surfaced as a phenomenon being adapted dramatically at the speed of a new blog at every second every day, doubling in size every five months according to Technorati.com, a blog search engine (as cited in The Economist, April 22, 2006). A blog is easy to comprehend as a journal and easy to use as no programming skills are required. These are decisive reasons for rapid adoption by anyone, from adolescence to adult, as long as he/she can type and write. Therefore, the quality of blogs on the web is very much mixed, and many blogs have a very limited number of readers. Eric Schmidt, Chief Executive Officer of Google Inc., ironically states that "The average blog has exactly one reader: the blogger." (as cited in Guterman, 2007, p. 16). On the other side, according to a survey from Technorati, the best of the non-average blogs are getting a huge audience. They are those associated with mainstream media as shown in Figure 2-19.

The blog phenomenon would be dull and boring, had it remained as the static and private metaphor of a personal journal on the web. As a grass-root tool, a blog takes its twist as being social with features like tracking back, the *blogroll* which links and communicates with other blogs, and *perm links* which are URL entries on the web for permanent accesses.

These linking mechanisms have proven an inspiring effect on the e-learning evolution. In 2005 more than a hundred and sixty professors have been reported blogging from China to Argentina, though mostly are from North American universities (The Rhetorica Network, 2005).

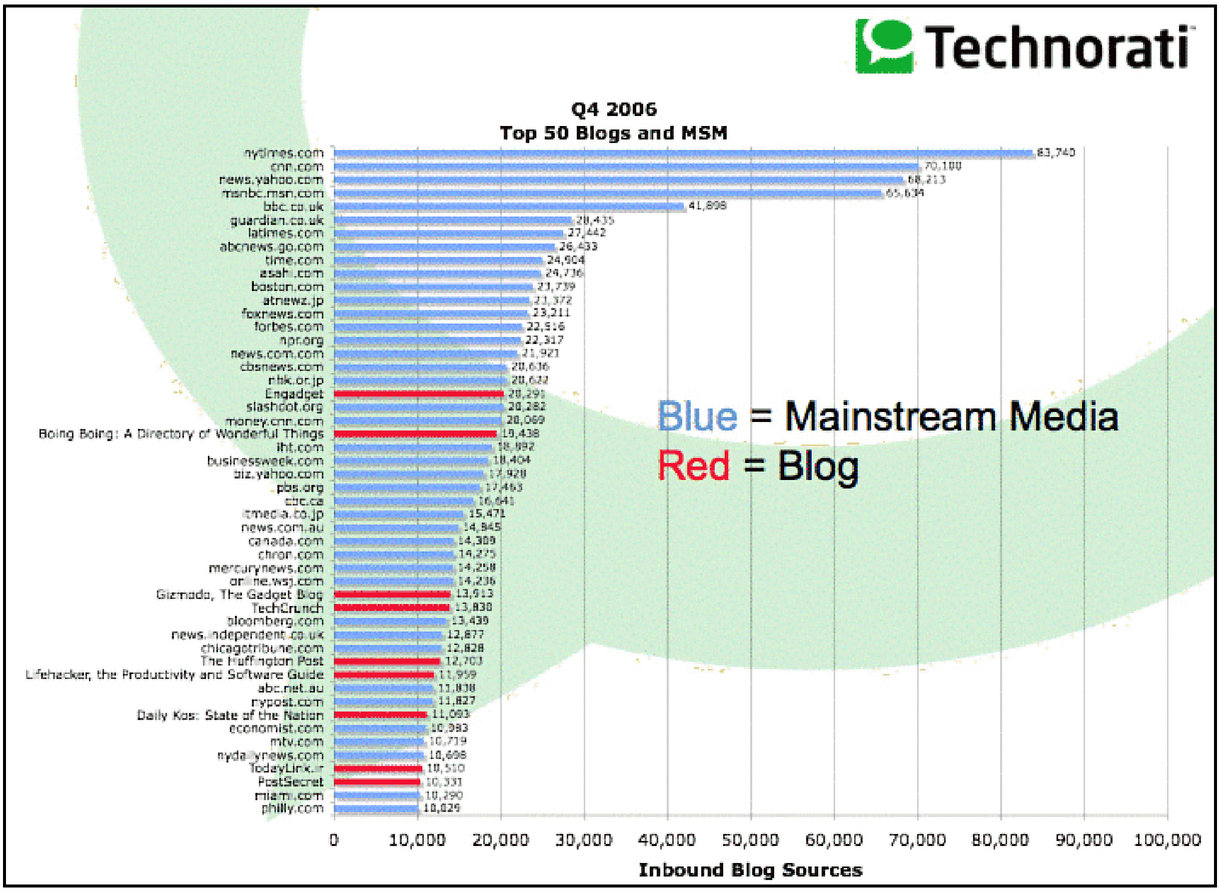

Figure 2-19: 47 of the top 50 blogs are related with mainstream media (Technorati Survey, as cited in Guterman, 2007, p. 17)

This number should have increased manifold by the time this research was brought to paper. In learning, Ken Smith (2004, para. 9) reasons the importance of quality linking in blogging as follows:

> "Instead of assigning students to go write, we should assign them to go read and then link to what interests them and write about why it does and what it means, not in order to make a connection or build social capital but because it is through quality linking that one first comes in contact with the essential acts of blogging: close reading and interpretation. Blogging, at base, is writing down what you think when you read others. If you keep at it, others will eventually write down what they think when they read you, and you'll enter a new realm of blogging, a new realm of human connection" (Smith, March 30, 2004, para. 9).

Tosh and Werdmuller (2004) considered that a blog can also be a personal portfolios folder maintaining past, present, and future tasks. Downes (2004b) viewed blogging as the mechanism to mesh life with workplace learning, or lifelong learning, because blogging as an activity evolves around individual style and embodies processes of reading, community sharing, discussions, and reflecting in a personalized space. Whether it brings life to learning, or brings learning to life, blogging by its linking mechanisms binds together isolated topics and areas across a variety of disciplines and people into a personalized or individualized virtual learning space.

Dan Mitchell blogs about the implications of weblogs and related tools in the context of learning objects, which will be the focus of chapter 2.4.2.2.3. According to his point of view weblog tools can provide the following:

- “They can easily be incorporated into web pages on the weblog site, either by embedding or by linking to the original object.
- The page containing the link or embedded object can contain descriptive material concerning the object.
- Plug-in mechanisms allow additional features such as easy inclusion of metadata.
- The page and the metadata are searchable.
- RSS (will be discussed later) can provide notification when a new object is posted” (Mitchell, 2004, section: Manila as Learning Object Repository [Con’t] , para. 4)

However, Alan Levine posted an opposite opinion on the same weblog-ed.com. He argues that storing learning objects is the function of a stable repository (e.g. Multimedia Educational Resource for Learning and Online Teaching [MERLOT]) and not a blog. A blog at its best can help to formulate and distribute learning objects, i.e. “the contexts, which is much more interesting than just the objects themselves” (Levine, 2004, section: Response 2, para. 2). The same stance will be pursued in this thesis as well.

Another advantage of blogs, rarely discussed, is that all entries by the owner and the comments of readers have permanent links. So the learner can use these to always go back to and find the original source, unlike the coming and going content on constantly changing websites.

2.4.2.2.4 Podcasting and RSS Feeds

In 2004, a MTV show host, Adam Curry popularized a hip new way of broadcasting personal or professional audio content over the Internet, and named it: “podcasting” (The Economist, April 22, 2006). Podcasting is another method of distributing any file type (usually audio and video) over the Internet for playback on mobile devices, like any MP3 player, iPod from Apple Inc. (which lent part of its brand name to podcasting, apparently without hesitation), smart phones, and personal computers. As an underlying technical concept the RSS feed mechanism is used to syndicate the content files (Hall, 2006; Stephens, 2007).

Quain (2004) reviews that “RSS” as abbreviation variously stood for: “Really Simple Syndication” or “Rich Site Summary”. RSS defines an environment to automatically capture the right information at the right time from a “RSS feeding” web site onto a mobile device or normal computer workplace with an appropriate “RSS reading” mechanism. In addition to the reading mechanism the receiving device has aggregation tools where all automatic downloads from different RSS feeds are presented in a fashion adopted for end-users, e.g. play list interfaces for audio and video content. It is popular for bloggers to use RSS sharing the latest entries' headlines, their full text, or multimedia files. Large news organizations, such as the New York Times, CNN and BBC, have adopted RSS, allowing other websites to incorporate their "syndicated" headline or short-summary feeds under various usage agreements. RSS is also used in websites and blogs syndication for the latest news or postings (Information Outlook, 2007). RSS is to be understood as a mechanism “pulling” content as files from the web onto a user’s target device, after the user has decided to do so and accordingly has subscribed to the service on his device.

In the context of learning, podcasting can be used for publishing anything from lecture notes, over audio files, to video files on the Internet. Then, scanned automatically by RSS reading, the content is brought down to the learner’s device. As opposed to the fluctuant and transient experience of “visiting a website” the content is stored in the file system of the learner’s device. As such it is more static. So it can be reused, organized and contextualized at the user’s choice at the workplace - and the content can be consumed in disconnected-mode. The biggest advantages of podcasting are being mobile and flexible. Disconnected mode allows consuming information at portable devices as playbacks without time and location constraints. As opposed to visiting a website the learner can subscribe to the RSS feed to automatically receive new and updated content (Stephens, 2007). Thus, podcasting delivers content (mostly as audio or video files) to an audience who listen or watch at their discretion when they want, how they want, and where they want, in a car, a plane, or a train (Shepherd, 2005). As an example for a dedicated learning environment, the Department of Business and Human Resource Education at the University of Paderborn is using audio podcasting for in depth and background student material in their “IWP on air[10]” offerings.

[10] Podcast offerings from the Department of Business and Human Resources Education at the University of Paderborn accessible from http://groups.upb.de/wipaed/podcasting/index.htm last viewed on June 30, 2007.

Obviously, the disconnected mode of podcasting bears value for busy knowledge workers, who often juggle work, family, and updating skills and knowledge. E-learning, in the past, carries much of the marks of web-browser-based learning. Meanwhile, podcasting adds an important extra dimension of mobile learning without the necessity of connecting to the web-browser. More and more organizations, from large ones like General Motors to small ones like local restaurants, are utilizing podcasting as a tactic for reinforcement, supplement, or follow-up sessions to improve organizational performance (Islam, 2007). Gronstedt (2007) states that podcasting technology pushes workplace learning to the individual knowledge worker who will take responsibility for their own information and skill updates. He denotes examples of EMC, a computer storage company, and IBM with 2,700 downloadable Podcast episodes. Both corporations employ podcasting to replace traditional conference calls or training sessions. Moreover, Gronstedt (2007) reflects a variety of tactics for podcasting in an enterprise environment. According to the EMC survey, the length of a Podcast episode should be around 15 minutes. And, the best place to host podcasts is on a blog to foster effective discussions and engagement in learning among a community of knowledge workers.

The Economist (April 22, 2006) states the low cost factor as the second reason for the swift and wide adoption of podcasting. For everyone, professional or amateur alike, to produce content only requires a microphone, a computer, and an Internet connection, and for video content a camera or screen capturing tool. Most of these are becoming household commodities in the industrialized world and developing countries, such as China. On the other hand, the acquisition of skills to consume content are outsourced from an organization's point of view and not part of the training budget. Podcasting is part of a mass phenomenon in the consumer world with all its radiations: The software being freely distributed in Web 2.0 fashion, the worldwide expert network disseminating the knowledge about how to use it being kids who might in turn teach their parents or grandparents – and the employee too shy or embarrassed to admit or ask their superiors for formal training because he/she is not capable of using podcasting at their workplace.

For the matter of workplace learning, the first advantage of podcasting is to streamline information in an on-demand fashion via RSS feed. For example, a saleswoman may learn the latest product updates after she has plugged the iPod or any media player for synchronization. Secondly, because podcasting is a standard format to render content, especially multimedia files, subscribers or learners can plug-and-play all Podcast episodes from a variety of podcasters without worrying about compatibility issues. Last but not least, the mobility of taking learning to-go liberates learners from physical limitations as well as from being connected to the Internet. So, commuter trains to work are the places to consume Podcast content.

2.4.2.2.5 Summary

After all, Flickr, Wikipedia, personal blogs and podcasts are all grassroots, end-user driven applications. They opt for a community approach in sharing information, collaboratively generating knowledge, voicing individual opinions that were not heard before, and taking music, shows, learning events to any places at any time when the user feels comfortable.

In today's information intensive work environments, folksonomies, blogs, wikis, and podcasts offer powerful and vibrant alternatives of collaborative and individual learning experiences alongside classical and formal educational settings (Fiedler, 2004). Web 2.0 tools are slowly entering the corporate world. Riding on the bandwagon of Web 2.0, McAfee (2006) of Harvard Business School declares the era of "Enterprise 2.0" has finally arrived. This is an era which is more effective in assembling and sharing tacit knowledge than the previous ones, which relied mostly on push-technologies such as e-mails, on corporate portals, or on non-interactive websites. He picks six technical components that make up the core of the Enterprise 2.0 technology platform:

- keyword-based search as opposed to flipping web pages,
- links among information and knowledge built by individual knowledge workers instead of a group of experts,
- shared content authoring,
- tagging based on common, understandable language,
- contextual extensions as in Amazon's suggestion of "customers who bought this item also bought…" and
- signals, like RSS feed, to alert users with updated content.

The center point of Enterprise 2.0 is bottom-up collaboration and collective intelligence.

Nevertheless, collaboration is not new. The most widely deployed collaboration platform in corporate environments, IBM Lotus Notes Domino, has been on the market since 1989 (IBM Developer Works Lotus, Web team, 2005). Yet, most consumers and researchers in educational settings so far hardly take advantage of Lotus Notes' sharing architecture and functions which are essentially constructed following the concept of bottom-up collaboration.

The slow recognition of the core collaboration functionalities of Lotus Notes technology may prove Christensen's (2000, p. 67) observation that technology innovation valued in emerging markets is hardly comprehended in the mainstream ones. Like many innovative information and communication technologies, Lotus Notes was invented in an era, at the end of the 20th century, which was marked on the one hand by centralized corporate computing approaches based on mainframe technology. And on the other hand in the office, at the workplace, it was marked by the deployment of one-dimensional tools which brought about an easy and intuitive evolution not demanding radical paradigm shifts in the organization. In the foreground of this evolution were tools which helped to enhance production of office papers such as Microsoft Word, or Microsoft PowerPoint which first helped the production of transparent slides used on overhead-projectors and later replaced them by direct projection with data-projectors, or (Microsoft) Excel for paper-based spreadsheets designed around a single-user fashion. All these office tools were not and are not collaboration centered from their architectural approach. Only after personal computers and their usage on the Internet have become household commodities being employed for collaborative applications in a mass fashion on consumer markets, the promises Lotus Notes has made already more than a decade earlier as a new paradigm for communication centered and collaborative virtual workplaces were welcomed and widely accepted.

After all, learning is essentially a social activity. People learn best via interacting with one another (Cross, 2006). As information technology becomes more ubiquitous in all spectrums of life, tools like wikis, blogs, and podcasts and IT-middleware platforms like Lotus Notes Domino are forming a genre of social collaboration software of their own. At their core lies the idea to facilitate generating, editing, and sharing learning content and knowledge collaboratively. While merging learning into the workplace context, the conceptual foundation, basic technologies and IT-tools now are predefined by this trend of decentralized collaboration in both the learning and the workplace arena.

2.4.3 From Content-Centric to Context-Driven Learning in Workplace

The first generation of e-learning development at the workplace has been centered on a content-driven model for formal learning and training in a classroom setting. This approach has generated several problems. According to The Conference Board of Canada's study (2001), in 2001 employers ranked the lack of appropriate content as a top barrier for successfully starting e-learning. Employers face three substantial challenges: First, they have difficulties to find the right content on the market. Second, when the desired content is available, it is often designed for delivery models in a classroom learning setting. Thirdly, how to reuse content is the basic issue in workplace e-learning, but is not a decisive part of e-learning approaches so far. Employers do not have the knowledge and skills to transform given content which is designed for traditional learning methods for reuse or repurposing (p. 13). Consequently, The Conference Board of Canada pinpoints the following success factors related to content challenges in workplace e-learning:

1. Outsource - sourcing non-proprietary content externally, such as communication skills and technical skills.
2. Content Creation - involving employees in proprietary or process-specific content development.
3. Integration - integrating e-learning with knowledge management, performance management and communication systems.
4. Modular Design – designing shorter, more modular, just-in-time, and need-to-know frameworks as learning will become more integrated with work.

A study conducted by Bersin & Associates (2005) in June 2004 confirms the content outsourcing trend marked by The Conference Board of Canada. Bersin & Associates find that among 320 survey respondents from the corporate training and human resources sector, the number of outsourcing content is reaching 68 percent. Additionally, as shown in Figure 2-20, the study also points to a fast growing area in outsourcing content development efforts.

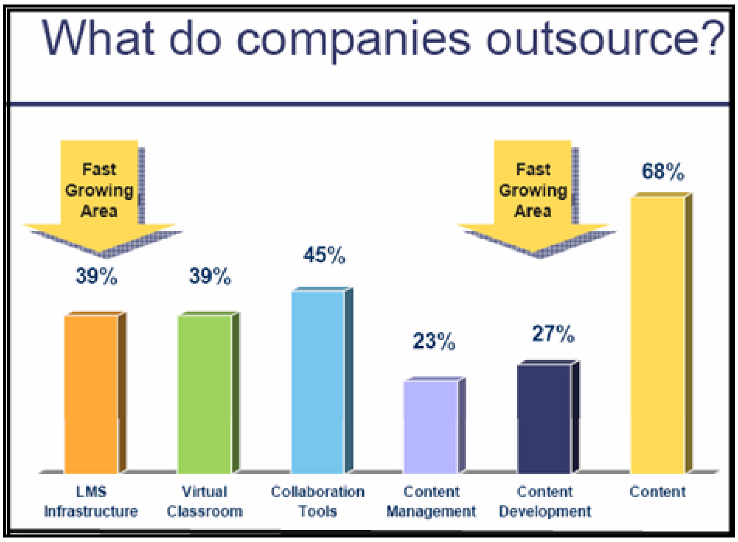

Figure 2-20: Outsourcing trend in e-learning (Bersin & Associates, 2005, p. 29).

Nevertheless, another survey conducted earlier in the same year opposes the content outsourcing trend in the corporate training professions. In January and February 2004, Kim, Bonk, and Zeng (2005) survey 239 individuals who were either engaged in e-learning activities or possess knowledge about the e-learning industry. About 30 percent of the respondents assert that their organizations are focusing on creating content as shown in Figure 2-21 (section: Findings from the Survey Study, para. 4).

Figure 2-21: Forecast of organizational focuses on e-learning (Kim, Bonk & Zeng, 2005).

The different survey demographics state a stark contrast of the outcomes. The Bersin & Associates' focus group is solely based on professional training managers in corporate training and the development sector. On the other hand, Kim, Bonk, and Zeng study a more mixed population group of training executives, managers, instructional designers, performance technologists, and trainers/instructors (2005, para. 3) who work either in for-profit or nonprofit organizations. Both surveys direct toward e-learning development in the workplace setting of North America. The corporate sector, i.e. for-profit organizations, is clearly most cost-conscious in saving development expenses by outsourcing standard content and development efforts to vendors.

One more interesting point is that from Figure 2-20 Bersin & Associates' survey indicates that the least outsourced area is the content management system, which is an important component of an organization's knowledge management system. Again, the topic comes back to the point of managing knowledge/content in the workplace context. Knowledge/content management is not an entity to be outsourced. This, because it is not only about explicit content, but also about dynamic context information, which determines how to cope with noise, data, information, knowledge and wisdom at the daily workplace. By studying medical students learning in a virtual environment, Paul (2006) validated that an e-learning solution only depending on content did not help the medical students in their clinical actions. The reason was that it provided generalized explicit knowledge at the time when contextualized tacit knowledge was needed. A medical textbook, no matter how it is organized or written, cannot predict all patients' individual conditions in specific settings. This is a classical case study displaying that content rendered as static printed text will not apply to the dynamically changing contexts in real world scenarios.

In the setting of on-demand learning, Bersin & Associates (2005) outline a basic contextual measurement of content. Often, at the workplace during a work process, when e.g. a physician, a consultant, a manager or an engineer encounters a problem, they cannot or don't have the time to take a course or a week-long training program helping to resolve the problem. Rather, more often they need a reference, whether it is a person, a website, or a list of paragraphs from a whitepaper, which directs them to the right solution of the problem in their working context. Then, they go back to their ongoing job tasks. "This learning on-demand model appeals to the way human beings use the Internet and we are finding that the explosive growth of online books and references supports this demand" (p. 30). Bersin & Associates present a two-dimensional model to categorize content by contextual usage of time and performance problem, as depicted in Figure 2-22.

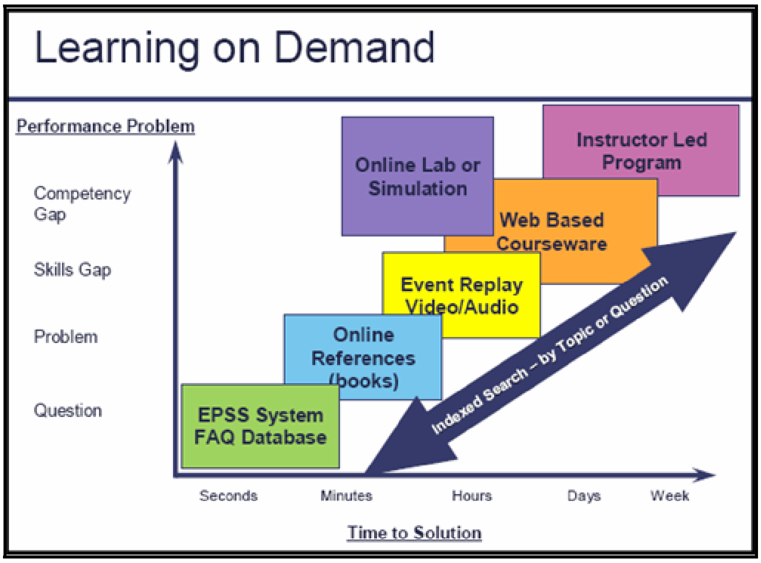

Figure 2-22: Content map of "Learning on Demand" (Bersin & Associates, 2005, p. 46)

In this model, content is classified against the two contextual measurements *Performance Problem*, i.e. knowledge gap, and *Time to Solution*, i.e. countable availability of time of a person. The bigger the performance problem is, the longer it will take to tackle it. However, this model is too simple or too general to apply to the multi-dimensional, multi-contextual world. For instance, it does not consider different learning needs based on different competency levels of individual knowledge worker in an organization. When all the content is structured as an instructor-led program, it is a waste of time for an experienced sales manager who only wants to learn the most recent updated product information.

Davenport (2006), editor of the *Training and Development Magazine* of the American Society for Training and Development, reports some experts' opinion on the future trend and development of workplace learning solutions. He reflects that the academic model of classroom-based learning won't fit the on-demand learning needs at the workplace anymore. The next generation of workplace learning will be context-driven informal learning in which the employees are active generators as well as participants of self-directed learning embedded into his/her work process. Technology enables this learning-by-doing process, the start of which each time is initiated by the individual knowledge workers themselves. Furthermore, professionals in the field of corporate learning and development have jumped on the idea of embodying the concept of small digital learning objects into their corporate learning strategies. Additionally, organizations shall look into new technologies and tools for supporting workplace learning, such as wikis, blogs, folksonomy, social network systems, RSS, or podcasts.

Besides learner involvement in content generation and learning integration with knowledge management systems, The Conference Board of Canada also advises modular design of learning which is delivered in a just-in-time fashion at the workplace. This recommendation has echoed the movement of the *learning objects* design approach to learning resources. Hodgins (2002) first coined the term "learning object", referring to constructing granular, reusable, and sharable learning resources instead of the classical instructional design model of bundled content.

At the first glance, the concept of modularizing learning content offers promises for on-demand learning with its appeals of

- being small – just the right quantity,
- being reusable – saving time and resources, and
- being sharable – suitable for collaboration at the knowledge intensive workplace.

However, the idea of small and modular design of learning resources poses a series of questions in a real world application. For example, what is the meaning of being a *small* object in digital context? Is reusability predictable so that it can serve as a guideline for correct pre-construction in content design? Is it worthwhile and cost-efficient to customize future learning resources and redesign existing learning content in smaller units? What about intellectual property rights issues when it comes to reusing and sharing learning resources across organizations? The next chapter of this thesis, chapter 3 will be entirely devoted to discuss and search answers for questions evoked by the idea of learning objects.

2.5 Summary

Networked communication and computers have changed the nature of work and organizational structures. The rising of Web 2.0 technologies and their progression in the private sector enable the on-going changes in the workplace arena from a hierarchical organizational structure to a networked working environment. In this new workplace milieu knowledge workers collaboratively share information and knowledge in a bottom-up fashion.

In the knowledge-intensive society pulled by information and communication technologies, competitive advantages and business agility on a global scale are measured by the speed of transforming data and information to knowledge and finally to products and services being paid for. Therefore, continuous learning, updating skills and knowledge throughout the complete working life is the only way to stay competitive as an individual as well as an organization in a global changing environment. The evolution of just-in-time, on-demand learning caters to these increasing learning needs at the workplace.

Learning on-demand at the workplace promises an enormous competitive edge for the corporation. It enables "its workforce to have the knowledge - both human and digital - that they need, when they need it, the way they best understand it, in the amount they require. It's about time. It's about performance support," explains Jonathon Levy, a senior learning strategist with the Monitor Group (as cited in Davenport, 2006, p. 41). Additionally, workplace learning on-demand implies that the knowledge worker directs his/her own learning processes while the learning outcomes derive from collaborative activities among colleagues and learning resources.

Therefore, the design framework for workplace learning on-demand entails a different approach from the traditional centralized, instructor-led learning model. The idea of learning objects has been appealing to the needs of modular design of content at the workplace for knowledge workers, albeit it imposes numerous questions and challenges in real world applications. The following chapter, chapter 3 of this study will focus on these issues and challenges of learning objects.

3 Learning Objects – Challenges to a Modular Design Approach for Information and Knowledge

> ***The role of context is simply too great in learning, and the expectation that any educational resource could be reused without some contextual tweaking was either naive or stupid.***
>
> *(Wiley, 2006, weblog , January 9, 2006, para. 4)*

The concept and implementation of digital learning objects (LOs) has gone through a wild ride since its first appearance in the early 1990s. In theory, the idea of granular, reusable, and interoperable digital learning resources can save cost and enhance the efficiency of learning in the real world (Hodgins, 2002). Therefore,at the beginning, researchers and organizations in the learning and training fields have jumped on the bandwagon of developing granular, reusable, and sharable objects. Especially, in the workplace learning setting, a learning object is the most visible catalyst to design, develop, and deliver the right amount of learning resource for the right time.

3.1 Introduction

3.1.1 Learning Objects: The Enthusiasts …

Wayne Hodgins, an educational visionary, is accredited with coining the term "learning objects" in the early 1990s (Wiley, 2000a & 2000b; Jacobsen, 2001; Wagner, 2002a & 2002b; NGRAIN, 2004). According to Hodgins, the basic idea is centered on designing granular, "LEGO"-like (the toy) objects that can be easily reused in later contexts, as well as shared among different systems independent from their underlying IT-infrastructure. A great number of scholars and industry practitioners immediately realized the potential benefits offered by this new concept. They (Griffiths & Garcia, 2003; Koper, Pannekeet, Hendriks & Hummel, 2004; Laleuf & Spalter, 2001; Longmire, 2000a & 2000b; Metros, 2005; McGreal 2004; Polsani, 2003; Tittenberger & Jackimiek 2006; Wiley, 2000a & 2000b) argue that learning based on reusable objects will change the landscape of content creation, development and delivery. In addition, the vision of learning objects based systems proposes significant promises to enhance the efficiency of learning processes and human performance. Metros (2005) states that the idea of learning objects pull e-learning content developers out of the traditional book metaphor. Finally, the developers are "taking advantage of the inherent capabilities of technology to provide learner-centered, nonlinear, customizable, media-rich educational content" (Metros, 2005, p. 13).

In the setting of workplace learning, the approach of granular, reusable, and interoperable learning objects has a number of key benefits outlined by researchers (Hodgins, 2000a &200b; Shepherd, 2000, section: The point of objects; Longmire, 2000b; Mortimer, 2002, section: Promises, promises; Barritt & Alderman, 2004, pp. 18 - 19):

Benefits for an organization:

- Reduced cost. Searchable and reusable material reduces cost of reproduction and redundancy of the same content created elsewhere. Consequently, just from a technology point of view, the costs of managing and storing content across the organization are lower.
- Saved time. Profound and sufficient metadata information about the learning objects may ease search, updates, maintenance, and content management efforts and time.
- Increased sharing. The platform independent interoperability character of learning objects allows the same content shared across different divisions in an organization.
- Increased productivity with an integrated learning approach. Employees may enjoy just-in-time, just-enough, on-demand performance support when access to learning objects repositories is integrated into the workplace environment.

Benefits for the learner at the workplace:

- Granular on-demand approach. Learning objects can be used to deliver a just-in-time and just-right-amount approach to learning. Learners can efficiently retrieve self-contained learning objects in digestible chunks just when they need it, instead of searching through classical courses and books that are built on linear, not decomposable structures.
- Competency-based rather than course or training event.
- Personalized learning. For a long time, personalized learning has been desirable in the workplace environment, yet it was hindered by the linear-structured and one-fits-all book metaphor design. Learning objects open new ways to learning design which are more fitting to individual learning needs.
- Flexibility. Learning objects can be repurposed in different contexts. For example, the sales brochures may be reused in marketing and training sessions.

In addition to theoretical thinking, according to a survey published on the online magazine of the American Society for Training and Development, Barron (2002) accounts that a majority of 143 training professional perceive their organizations benefit substantially from learning objects based technologies. Figure 3-1 details the feedback on a list of advantages offered by learning objects based systems. The two highest ranked benefits are the ability to quickly modify existing content and the modular approach which allows efficient management of learning content.

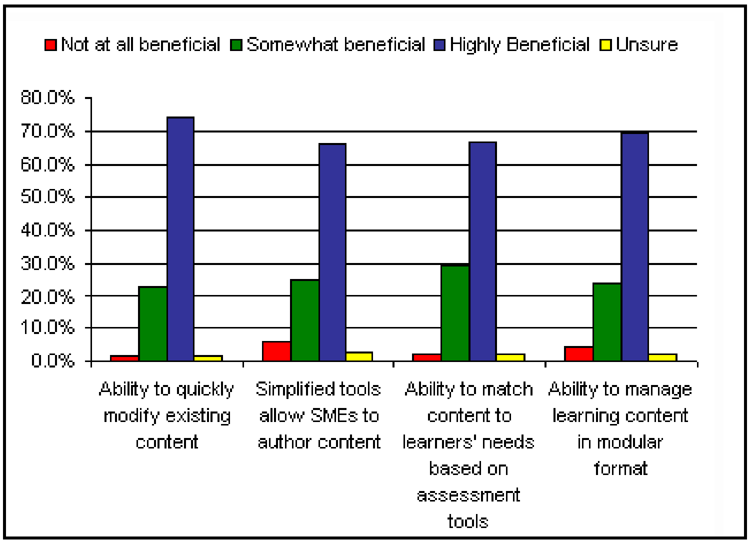

Figure 3-1: Benefits of learning objects based systems (Barron, 2002, section: Interest in LO capabilities)

The survey also shows that there are over 22% among the 143 respondents already using technologies based on learning objects in 2002, and more than 56% are either planning or evaluating this approach as depicted in Figure 3-2.

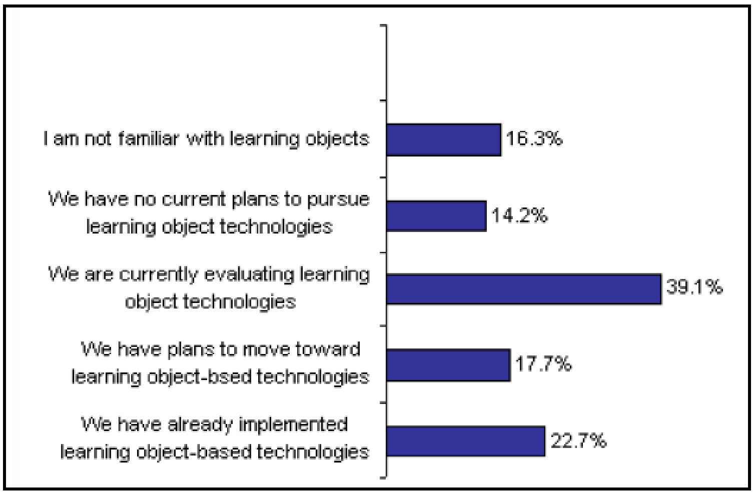

Figure 3-2: Adoption of learning objects based technologies (Barron, 2002, section: Interest in LO capabilities)

Last, but not the least, the survey also reveals that more than one third of the respondents opt for positioning the learning objects approach as part of their knowledge management initiatives. The linkage between learning and knowledge management is evident by some scholars' claim to change the label "learning objects" to "knowledge objects" (Merrill, 1999; Koper, 2003). The rhetoric war for defining LOs will be further discussed in chapter 3.2 of this thesis.

3.1.2 … and the Skeptics

Advocates of learning objects are encouraged by its granular, reusable, interoperable evolutional characters. At the same time, there is a school of skeptics who doubt the envisaged virtues of learning objects, especially whether they either make sense, or can be achieved, in reality.

Particularly, among the field practitioners, the doubts are laudable. "Reusable learning objects are incredibly over-hyped," expresses John Hartnett, president and chief executive officer of BlueMissile, a Minneapolis-based web-based training developer (as cited in Mortimer, 2002, section: Dissonant voices, para. 2-3). "Reusability itself is a flawed concept", according to Hartnett's experience, "Anyone who has the power and budget to generate their own training will do so … so they don't have to use what someone else built." In addition, Hartnett believes the interoperability issue of learning objects is another myth. Information system integration is more complex than simply setting up industry-specific specifications, such as the Sharable Content Object Reference Model (SCORM) led by the defense department of the United States. There are more sharp critics on the SCORM development. Thor Anderson, director of developer support at the Instructional Management System Global Learning Consortium (IMS) in Burlington, Massachusetts, says that the implementation of SCORM may produce pedagogical and instructional sewage because SCORM does not include quality benchmarks of learning objects (as cited in Welsch, 2002, section: Pedagogical sewage). Moreover, from his working experience on e-learning projects at Cisco Systems, Lahanas states that SCORM has failed on creating simple implementations for resource saving adoption (as cited in Welsch, 2002, section: Technical challenges).

On the academic side, after the first period of excitement, lately many researchers have questioned the ideas of learning objects basically on two fronts. First, because no consensus on the basic understanding of the label *learning objects* has been reached. Many have doubted the conceptual soundness of this learning objects approach (Sfard, 1998, Parrish, 2004). Metros (2005) sharply points out that the same scholars who honed the promises of learning objects are now predicting its end. However, she adds that the artificial label “learning object” is out of fashion, yet the transition to building granular and sharable learning is evident.

Second, driven by the well-heated development of learning object standards and specifications, many questions have been raised on whether they are relevant to the cycle of learning and instructional design. Many argue that due to the lack of integration of pedagogies and instructional design theories in learning object standards and specifications further development will produce disintegrated learning material and processes (Bannan-Ritland, Dabbagh & Murphy, 2002, Wiley, 2003; Friesen, 2003).

More educators have also added that the concept of learning objects is exactly against the traditional principle of well-designed instructional materials. It is difficult to keep a logical content and instructional flow among disintegrated small objects when they are used out of their original context. David Merrill, a well-known instructional design expert from the Utah State University's Department of Instructional Technology, strongly objects to the idea of learning objects: "You can't chop things up and expect them to make sense." (as cited in Welsh, 2002, section: Pedagogical sewage, para. 4). This is a particular challenge with existing learning content. Tompsett (2005) adds that re-configuration and re-integration of existing learning content into a new course is not well researched and far more complex than many assume present and before. There is a great need in research focusing on the issues of re-configuring and re-integrating learning objects, rather than initial creation. Dahl (2006) also doubts whether the resources poured into the devolvement of learning objects would ever pay off. With the power and pervasiveness of blogging on the web, skeptical voices can be raised and heard aloud immediately. In Dahl’s blog, by linking into other learning technology researchers’ blogs, many other critical voices can be found, again, including those who used to be the strong supporters of learning objects and the development of learning object standards:

> Feldstein (2006) states: “I believe the term "learning object" has become harmful. It hides the same old, bad lecture model behind a sexy buzz phrase.”
>
> Ip (2006) contests the value of learning technology standards and specifications, such as SCORM, to the learning community: “Can anyone show me some concrete proof that any learning technology standard has made a difference in learning? Will be greatly appreciated”

> Parkin (2005) concludes that the single focus on content will not lead to the success of the sharable learning objects approach because "While content is obviously essential, context and process are more important to learning".
>
> Wiley (2006) reproaches the definition of learning objects by accepting all definitions: "… because no one can agree about what a learning object is (although I enjoyed reading that a urinal apparently qualifies)".

Clearly, after over 10 years of ups-and-downs, and back-and-forth discussion, papers, and slide shows, and prototyping, people are frustrated by no tangible application of learning objects in use, following its initial promises of being granular, reusable, and interoperable across systems and learning context.

3.1.3 Summary

After more than a decade of discussions and practice, the early promises of the learning objects approach have not been fulfilled. Certainly, the idea of learning objects carries many challenges from its birth. But the mere idea shall not take the full blame for its failures. Rather the misled interpretations and conventional developments based on the idea traps innovative learning applications.

David Wiley, one of the well-known and active advocates of integrating the learning objects approach into instructional design (Wiley, 2000a & 2000b), wrote in his weblog:

> "There have been lots of articles around the blogosphere of late ringing the death bell for learning objects. It's hard to tell if they're right or not, because no one can agree about what a learning object is … And perhaps that very statement is all that needs to be made"(David Wiley's blog[11], Jan. 9, 2006, para.1).

The following will present assertions about learning objects from a variety of schools of learning objects advocates. Then, challenges of learning objects will be analyzed. And finally, samples of state-of-the-art learning object repository applications are reviewed. The past and present are examined for the answer of the future.

3.2 Definition - in the Eyes of Beholders

Although, as often declared, apparently there are no two people in one room who might agree on a more precise definition of "learning objects", there is one very general and thus

[11] Weblog posted by David Wiley on January 9, 2006 on http://opencontent.org/blog/archives/230

universally accepted interpretation of learning objects. This is formulated by the Learning Technology Standards Committee (LTSC) of the Institute of Electrical and Electronics Engineers (IEEE). Since 1997, IEEE has set up LTSC[12] to develop as well as maintain the Learning Object Metadata (IEEE LOM) standard. In 2002, in the final publication of the standard, LTSC claims: “For this standard, a learning object is defined as any entity - digital or non-digital - that may be used for learning, education or training.” (IEEE LOM, 2002, p. 5).

Based on this definition, the scope of learning objects in IEEE LOM covers virtually all materializations, whether they are paper-based or digital data, information, and knowledge that may be used in learning. Adding more complexity, “software tools, and persons, organizations, or events referenced during technology supported learning” are also scooped up by IEEE LOM into the breadth of learning objects (IEEE LTSC[13], section: Working Group Information, Announcements & News). It is understandable that, as a standard committee, LTSC aimed at a broader landscape leaving an open space for wider adoption of its standard. Nevertheless, many scholars oppose such a broad definition of learning objects.

3.2.1 Voices from Individuals

The different explanations of researchers, on what exactly learning objects are, have been contributing to the confusion on the subject. For example, Littlejohn (2003), Mayes (2003) and Koper (2003) prefer "online resources” or “learning resources" instead of learning objects. Gibbons, Nelson and Richards (2000) have tried to define learning objects as instructional objects following classical instruction design theories. As an instructional design expert, David Merrill says: "No one seems to know what a learning object is in the first place … One of the absurd definitions I heard was, 'as small as a drop, as wide as the ocean.'" (as cited in Welsch, 2002, section: Pedagogical sewage).

One active figure of learning object advocates is David Wiley, cited before, from Utah State University. Wiley (2000b) has been working extensively on the subject of learning objects by questioning the usefulness of IEEE LTSC’s definition as it is too broad to be practical. He refines the IEEE LTSC definition of learning objects to “any digital resource that can be reused to support learning … [this definition] includes anything that can be delivered across the network on demand, be it large or small” (p. 7).

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[12] IEEE LTSC website: http://ieeeltsc.org/
[13] See more explaination about the IEEE LOM from IEEE LTSC website: http://ltsc.ieee.org/wg12/index.html

Wiley's definition includes anything that can be delivered and accessed across the digital network, large or small. Small digital resources include digital images or photos, live data feeds (like stock tickers), live or prerecorded video or audio snippets, small bits of text, animations, and smaller web-delivered applications, like a Java calculator. Larger digital resources include entire web pages that combine text, images and other media or applications to deliver complete experiences, such as a complete instructional event (Wiley 2000b).

Metros (2005) disagrees with David Wiley's version. In Metros' view a learning object must mediate learning, and "to be considered a learning object, the digital resource must include or link to (1) a learning objective, (2) a practice activity, and (3) an assessment." To Metros and many others, anything titled with "learning", must contain specific instructional elements or instructionally defined learning sequences (L'Allier, 1998). Obviously, Metros and L'Allier stand by the sacredness of *learning*, e.g. as presented in the instructional form of the classroom setting. Their theory implies learning objects must be a structured endeavor with instructional learning models embedded. Thus, the content format oriented listing "digital resources comprise simulations, movie clips, audio files, photos, illustrations, maps, quizzes, text documents, and much more" is not sufficient to qualify learning objects in Metros and L'Allier's opinion. Following this interpretation, people reading blogs, chatting with a subject expert online, or exchanging ideas with colleagues, don't learn, or do they? Surely, they do "learn", in their preferred sequence, format, and activity setup for gaining new knowledge.

Just to make the picture even cloudier, instead of learning objects some researchers prefer the term "knowledge objects" (Merrill, 1999 & 2000; Koper, 2003). Nevertheless, the agreed point is that both are object-based, as well as reusable and sharable. Whether it is "learning" or "knowledge" depends on the viewing angle. From the classical academic teaching and learning point of view, learning is a predefined process based - amongst others - on pedagogy and instructional design theories. For example, such a process may include an objective, activity, and an assessment. Looking further and wider, a knowledge object is a broader version of a learning object. According to Koper (2003): "Knowledge objects are learning objects that contain information for people to learn from or to use while supporting the learning activities of others" (p. 47). Merrill (1999 & 2000) brings learning objects into the wider framework of a knowledge object approach that consists of a number of components and is embedded in an algorithmic system. Components are instructional strategies pertaining to presentation, practices and learner guidance. These are linked to knowledge objects of various kinds as other components, like entities, activities, properties and processes. The combination of both components allows learners to choose among a range of instructional strategies with reusable content. Within this cognitive instructional design model, learners are not actively engaged in generating learning content, nor do they influence the processes. Everything is pre-packaged.

From the classical instructional design point of view, Wiley (2000a & 2000b), Downes (2000) and Douglas (2001) have tried to extend the approach of object-oriented software - as well known, profoundly researched and widely used - into the arena of designing learning objects as well. However, experienced object-oriented software engineers have argued that reusability is not a default attribute of an object-oriented software component. Rumbaugh, Blaha, Premerlani, Eddy & Lorensen (1991, p.8) continue that reusing objects is a process of careful planning and investment in a wider area of domain generalizations instead of an automatic outcome of formal system specifications.

3.2.2 Academic Institutions

Some academic institutions have chosen to voice their opinion about learning objects on paper, others in practice. In order to implement learning objects, many academic institutions adapt a working description of learning objects. An example of this is from the Wisconsin Online Resource Center (WORC) [14], Wisconsin, US (section: Learning Objects Defined):

- "Learning objects are web-based, self-contained, small chunks of learning.
- Learning objects are small enough to be embedded in a learning activity, lesson, unit or course.
- Learning objects are flexible, portable, and adaptable, and can be used in multiple learning environments and across disciplines".

The properties of a learning object are:

- "The most basic building block of a lesson or activity
- Searchable
- Usable in any learning environment
- Able to be grouped or to stand alone
- Transportable from course to course and program to program"

---

[14] Retrieved May 2, 2006 from the Learning Objects Defined section of the Wisc-Online website: http://www.wisc-online.com/about.asp#defined

WORC's examples of learning objects are assessments, animations, simulations, case studies, interactions, drill and practice, and templates.

The learning objects description from the WORC is as vague as IEEE LOM's by using words like "small", "the most basic", "chunks", etc. The difference between the two is that WORC's LOs are restricted to "web-based" digital entities, which follow the classical content aggregation model of "lesson", "unit" or "course". According to WORC, two types of digital resources are excluded as learning objects: the ones that are not structured in "course" format or as a "learning activity", and those that are available only in the Intranet environment of an organization. Technically, for now, the "web-based" only learning objects can not be fully "portable" because web connectivity has not been a de-facto infrastructure or commodity available anytime across the globe. WORC's interpretation of LOs does not take the aspect of context-specific learning into consideration as it regards the LOs are "usable in any learning environment" and "transportable from course to course and program to program". Collis & Strijker (2004) and Strijker & Collis (2006) have clearly pointed to the difficulties of transfering learning objects among universities to corporate or military environment because the stark contextual differences in each environment (see chapter 3.4.3 for detail).

The Center for International Education[15] (2007) at the University Wisconsin – Milwaukee (UW-Milwaukee) adopts WORC's definition into a more pragmatic one for implementation:

- LOs are a new way of thinking about learning content - traditionally, content comes in a several hour chunk. Learning objects are much smaller units of learning, typically ranging from 2 minutes to 15 minutes.
- LOs are self-contained – each learning object can be taken independently.
- LOs are reusable – a single learning object may be used in multiple contexts for multiple purposes.
- LOs can be aggregated – learning objects can be grouped into larger collections of content, including traditional course structures.
- LOs are tagged with metadata – every learning object has descriptive information allowing it to be easily found by a search.

The UW-Milwaukee's version is more a guideline towards the implementation of learning objects than a definition. It has a time restriction of "2 minutes to 15 minutes" in length, but

[15] More information on WORC: http://www.uwm.edu/Dept/CIE/AOP/LO_what.html

lacking further justification of the time. Polsani (2004) wonders whether such a time measurement refers to the actual duration of working on a learning object, or a required learning time as questioned, or both. Nevertheless, the significance of context and the metadata tagging have been added into the UW-Milwaukee's interpretation of learning objects. Both are essential building blocks in the subsequent constructive parts of this thesis.

Although WORC and UW-Milwaukee belong to the same organization within the University of Wisconsin System, WORC's unspecified "small chunks of learning" will have problems in connecting to UW-Milwaukee's "2 minutes to 15 minutes" objects.

Above is a typical example that different academic institutions, even if they are from the same organizational system, interpret the term "learning objects" quite differently when it comes to real world applications. The definition or guidelines for learning objects often seem compliant to the context of an organization's agenda.

3.2.3 Industry Practitioners

Macromedia Inc., as a widely accepted tool provider for e-learning, takes the view that learning objects are based on learning objectives. As denoted in the Figure 3-3, a learning object in Macromedia's understanding is a set of instructional elements focused on one single learning objective. A LO may consist of elements like raw media, practice, simulation, collaborative interaction, assessment, and educational resources, etc. This combined unit is surrounded by metadata information (Heins and Himes, 2002).

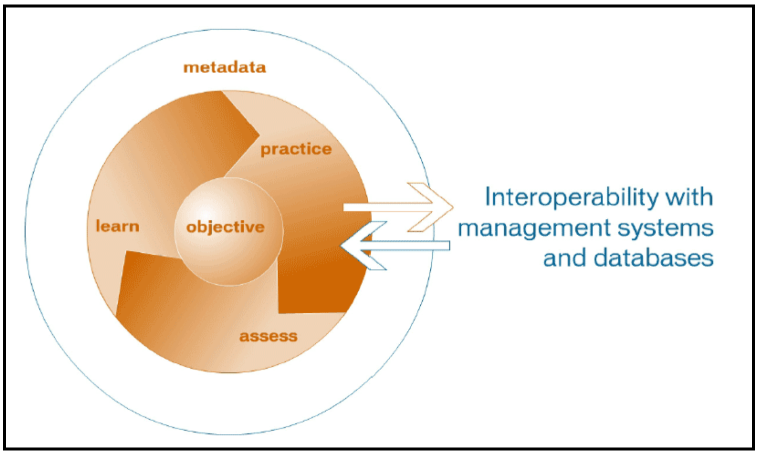

Figure 3-3: Macromedia's structure of learning objects (Gallenson, J. Heins & T. Heins, 2002, p. 2)

Macromedia rides on the bandwagon of learning objects to promote the use of its products or tools for building LOs, such as the Flash Communication Server MX, the ColdFusion MX server application and Flash Player (Gallenson, Heins and Heins, 2002).

Cisco Systems Inc. is the most referenced and the earliest industry practitioner of LO design, for its learning content for employee training and the underlying infrastructure (Barron, 2000; Shepherd, 2002; Maddocks, 2002; Britt, 2004; McGreal, 2004). In Cisco's white paper *Reusable Learning Objects Strategy* (2001), it states that many terminologies have been used in the knowledge management world to describe the concept of reusable, granular, interoperable objects stored in a database, such as component, nugget, chunk, object, unit, and asset.

Adding more on the interpretations of learning objects concept, Cisco has introduced new terminologies: *reusable information object* (RIOs) and *reusable learning objects* (RLOs). According to Cisco (2001):

> An RLO is created by combining an overview, summary, assessment, and five to nine (7 ± 2) RIOs ... an RLO is based on a single objective, derived from a specific job task. Each RIO is built upon an objective that supports the RLO objective. Each RIO is built upon a single objective, content items, practice items, and assessment items (p. 7).

A graphical representation is depicted in Figure 3-4.

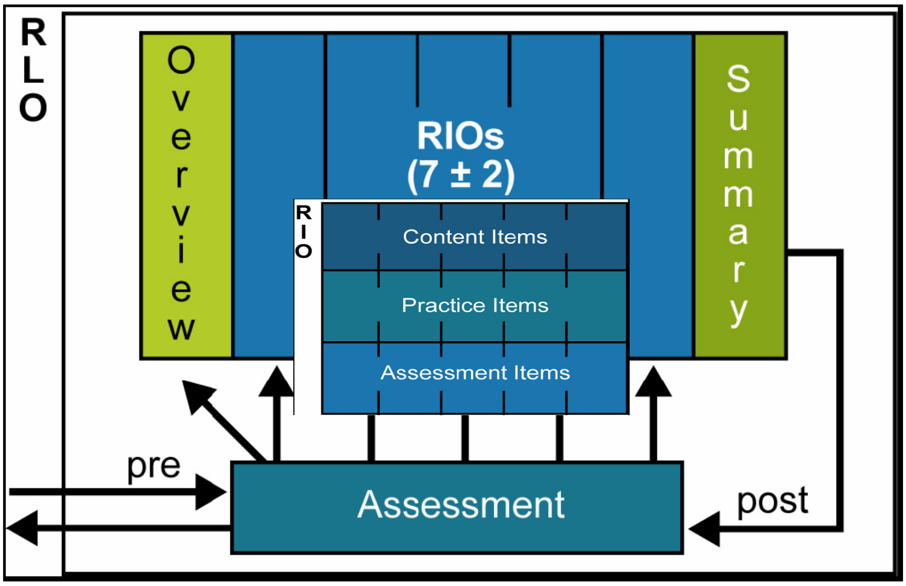

Figure 3-4: Construction of Cisco's Reusable Learning Objects (RLOs) and Reusable Information Objects (RIOs) (Cisco, 2001, p. 7)

Some years later, Chuck Barritt who has led the reusable learning object project at Cisco, quotes that Cisco's learning object consists of "a single learning or performance objective that is built from a collection of assets that provide static or interactive content and instructional proactive activities" (Barritt & Alderman, 2004, p. 7). Additionally, the learning or performance objectives can be tested in a pre-post assessment scheme evaluating the learning success.

Apparently, Cisco's definition is an instructional-designer-oriented concept stemming from the classical education approach to teaching and learning. Cisco's learning objects are aggregated by pre-defined learning objectives, content & activities, and assessments. This classical instructional design approach is dedicated for mass training or learning purposes, but not for an individualized learning model. It sets learning in a pre-sequenced and hierarchical container for learning subjects from which individual learners are either forced to customize or drill down to data, information and knowledge fitting his/her specific learning needs (Barritt & Alderman, 2004, p. 199). In addition, according to Cisco's RLO notion, the label "reusable" implies that reusability is a default attribute of LOs. However, from the textbook-like packaging and lesson-like delivery in Cisco's approach, reusability is rather limited to the convenience of training instructors, but not for the needs of the individual learner.

3.2.4 Summary

Organizations, industry adopters, and individual researchers are struggling to synchronize a common understanding of the term and the scope of "learning objects". Metros (2005) reckons that such a disagreement on defining the label "learning object" is one of the biggest obstacles for its application and technical adoption. Consequently, potential adopters of the LO-concept were confused when the experts kept saying that a learning object could be "as small as a grain of sand or as large as an ocean" (as cited in Metros, 2005, p. 12).

Nevertheless, despite the vacancy of a homogeneous understanding of the term, some organizations are taking huge steps to lead the learning objects concept into practical application, such as Cisco, Macromedia and the Wisconsin Online Resource Center. These practitioners have to redefine a working classification from IEEE's all too general LOM definition in order to fit into their individual organizational objectives and agenda (Finke, 2004). Their experiences have contributed to the maturity of the learning objects concept.

After all, it is the essence of the LO-concept that dictates the popularity of designing learning content, which is a concept of granular and sharable elements that can be used and reused in supporting learning. Reviewing different interpretations of learning objects by researchers and institutions, there are two schools of opinion. One school tends to see learning as the gray, fussy zone between classical instruction and knowledge management. In this school, all resources can be classified as learning objects to support potential learning events, in concordance with the definition in the IEEE LOM standard. The second school adheres to the roots of traditional learning and training methodologies, as in the views of L'Allier, Cisco, and the WORC. In this second school, the understanding of learning objects is dominated by the cornerstones of traditional learning like courses, classes, or lessons with sequences of objectives, activities, and assessments. Both schools have their place derived from different learning environments and contexts.

The author of this thesis is anchoring the subsequent modeling and prototyping on the LO-interpretation from the first school, i.e. a broader understanding of learning objects as digital resources to facilitate learning and knowledge creation. The focus of this research is in the virtual workplace setting where learning is a continuous event and activity connected to everyday job tasks. The on-demand learning needs of an individual employee cannot all be predicted or pre-packaged by a limited number of experts or instructors. Here, learning is highly individual and contextual, driven by demands of organizational processes at the workplace. Therefore, learning objects are understood as any digital entity that can be used to facilitate learning processes on an informal basis as well, established by discovering and internalizing of information and knowledge at the workplace in the collaborative contexts of ever changing teams.

Additionally, the learning objects approach should not be regarded as the Holy Grail or the final solution for challenges in the e-learning arena. Barritt and Alderman (2004) suggest that each institution shall exam their organizational goals, and plan development and delivery steps in detail before strategically taking on learning objects.

In conclusion, Parrish (2004) concludes that it is better to treat learning objects as an essential idea for an object-oriented content design strategy rather than wasting time, words, energy on pondering the artificial label of "learning objects". As time goes by, the innovative practices and experiences will guide and re-define the meaning of the label.

3.2.5 In Search of a Metaphor

A colorful interpretation of learning objects also leads to metaphoric rhetoric. H. Wayne Hodgins originated the term "learning object" by observing his children playing with LEGO bricks (Hodgins, 2002). He portrays the digital learning content as pin-sized, standardized objects that can be "assembled into literally any shape, size, and function" (p. 76). He continues that these objects can be reused directly or re-assembled for different purposes. Later, because of the overly simple metaphor of the LEGO bricks, Hodgins offers another analogy from the construction or building industry to justify the complexity among content elements. Nevertheless, it is his first metaphor of the LEGO bricks that attracted the most attention during learning objects discussions.

Figure 3-5: LEGO - from pieces to a theme "City Skylines" [16]

As shown in Figure 3-5, precisely because of its simplicity and its intuitiveness, the idea of creating, assembling, and then delivering pre-packaged LEGO-like digital content is both an attractive and a highly criticized metaphor by many researchers. Liber (2005), Santally, Govinda & Senteni (2004), and Tittenberger & Jackimiek (2006) have questioned the relevance of using LEGO representing learning objects. First, LEGO, as a toy in the form of tangible physical objects is designed to be modular from the very beginning. For most existing learning resources it makes a difference whether they are digital or non-digital. To re-design or break up existing learning content to a modular format or fragments (e.g. a chapter, a paragraph, a single graphic, a sentence that supports learning objectives) is neither feasible, nor practical. This cost of breaking learning resources into pin-sized objects will be revisited later in chapter 3.4.1. Another challenge is how to maintain the integrity and logical flow of the original resources – LEGO pieces can be assembled together by one simple sticking mechanism in whatever order. Moreover, whether this effort may improve content creation and delivering processes for effective learning is still in question.

Second, LEGO consists of static physical objects. Unlike information or content, each LEGO piece cannot be updated or modified. Learning content, on the contrary, must be updated, re-organized, and re-structured according to different learning contexts, i.e. settings and target groups. Furthermore, in an organization the process of reusing or repurposing learning content or learning resources involves version control, access right management, issues in intellectual property rights, etc.

Third, normal LEGO pieces have no sequences between one and another except some special parts representing a unique feature of an entity, such as a house roof, a car, or a figure. But

[16] http://www.lego.com/

anything qualified as good learning material must obtain a logical flow either designed by instructors/facilitators, or chosen by the individual learner.

In addition, Wiley (1999), Parrish (2004), and the learning objects group (2003) have also sharply criticized the LEGO metaphor as it hinders instructional design methods. Wiley (1999) points out that the LEGO metaphor may lead to a collection of learning objects which have no classical instructional usage. In Wiley's view an "atom-molecule" analogy has more value than the LEGO metaphor.

> "Atomic bonding is a fairly precise science, and although the theories that explain it are well understood (albeit probabilistically) at the macro-level of neutrons, protons and electrons, they are understood less well at the levels of the smaller bits. While the smaller bits are an area of curiosity and investigation, this does not prevent fruitful work from occurring at the macro-level. Similarly, instructional design theories function probabilistically at a high level, while less is understood about the exact details of the smaller instructional bits … It should be obvious at this point that a person without understanding of instructional design has no more hope of successfully combining learning objects into instruction than a person without an understanding of chemistry has of successfully forming a crystal" (Wiley, 2000b, p. 20).

As a trained instructional designer and researcher, Wiley has viewed designing learning objects as a sacred scientific task by and reserved to instructional designers. As compared to LEGO which is so simple to be played by kids, Wiley's proposal of the atom-molecule metaphor is not something so trivial for everyone. Taking a more scientific look at the nature of atoms and their combination, the atom metaphor is better at stressing the complexity of content combination, but "it still suggests a limited set of rules and algorithms for combination, which may not reflect the dynamic, open-ended nature of knowledge." (Parrish, 2004, p. 61). Parrish throws in another metaphor – film montage. But he neglects amongst others that one of the key features of learning objects implementation is reuse. But in reality, we do not go to a cinema to see a film made by reusing old movie montages. Parrish's proposal of the film montage metaphor has most likely to be valued against his own argument of "over simplifying human knowledge and communication by using a physical metaphor" (p. 61).

After reviewing the quest for a proper learning objects metaphor, two key scholars from the learning objects community have dominated the scene – Wiley and Hodgins. David Wiley stresses the complications of content combination, the knowledge of instructional design methods and the important role of instructional designers. Wiley's opinion is instructor-centric, following the traditional classroom instructional design and delivery methods. Meanwhile, Wayne Hodgins envisions standardized learning resources that may be open to more users to easily assemble learning on-the-fly. Not only the trained instructional designers can assemble learning content, but also the individual learners, children or the child at heart, can learn by assembling learning as they like on-demand.

After all, people are still trapped in finding a physical metaphor representing the virtual entities in a networked virtual sphere. With the absence of a proper metaphor, this thesis is concentrated on taking learning objects as a catalyst in enabling and engaging learners to create their own learning content collections and processes for just-in-time learning needs at a virtual workplace environment.

3.3 Granularity or Aggregation Model

Reusability is the main objective of the learning objects approach, but not a default attribute of learning objects. As the only valid learning objects definition even IEEE LTSC does not name reusability as the built-in character of a learning object. To enable increased reuse of learning materials it is necessary to have a granularity model, to model the influence of context and to follow technology standards. The following will first delineate the issues in finding a granularity model in LOs design.

In the physical world, the term *granular* literarily means small in size. In the physical world, it is possible to granulize goods relative to the object's length, width, height etc. In the context of e-learning measuring digital resources in the virtual sphere - data, information or knowledge - is fundamentally different from the physical world.

In the learning objects community many researchers view that granularity obviously is not only about the size of an individual learning resource, i.e. expressed by digital bytes. But what is more important are schemes of disaggregation and aggregation of resources, or the methods of sequencing chunks of learning resources in a way that easy reuse is possible in multiple learning contexts (Wiley, 2000a; Wiley, Gibbons & Recker; 2000; South & Monson, 2000; Koper, 2003; Wiley, 2003). As a consequence that the definition of learning objects itself is widely disputed, the granularity issue - small-sized versus aggregated, large-sized objects - cannot be precisely resolved either (Merill, 1999; Wiley, 2000a & 2000b). "Small" is a vague but preferred word used by many in the discussion of granularity. Besides the use in WORC's classification, Quinn (2000) reasons: "If the objects are *small* enough, and instructional experiences are composed of these objects, then different learners can have different instructional experiences" (section: Granularity, para. 3). Wiley states in his atom metaphor for learning objects: "an atom is a small 'thing' that can be combined and recombined with other atoms to form larger 'things'" (2000b, p. 17).

On the other hand, researchers like Quinn & Hobbs (2000), Hodgins (2002), Ducan (2003), Olivier & Liber (2003), M. Thorpe Kubiak & K. Thorpe (2003) have alleged that the more abstract a learning object is the more it holds increased flexibility for reuse in different learning contexts. However, how far can instructors disaggregate packaged learning materials? To a single paragraph, a single chapter, a single paragraph as long as it consists of one single learning objective? Alternatively, can an entire course be considered as one learning object? In addition, will aggregation by pulling resources or content from different contexts make sense for learning?

Fernandes, Madhour, Miniaoui & Forte (2005) express that to facilitate reuse there is a need to define the adequate level of granularity which the learning items may be segmented into. Currently, there are three approaches on classifying granularity levels of learning objects.

3.3.1 Granularity Based on Text Book Sequencing

The first school originates from traditional instructional design practices. For example, the classical structure of an instructional book is often used as a metaphor for granularity levels (Ducan, 2003). Given the fact that much learning material is still locked into text-based printed books, it is most natural to granulize by disassembling content from a book for future reuse, e.g. to a single graphic, a paragraph or by chapters, illustrated in Figure 3-6.

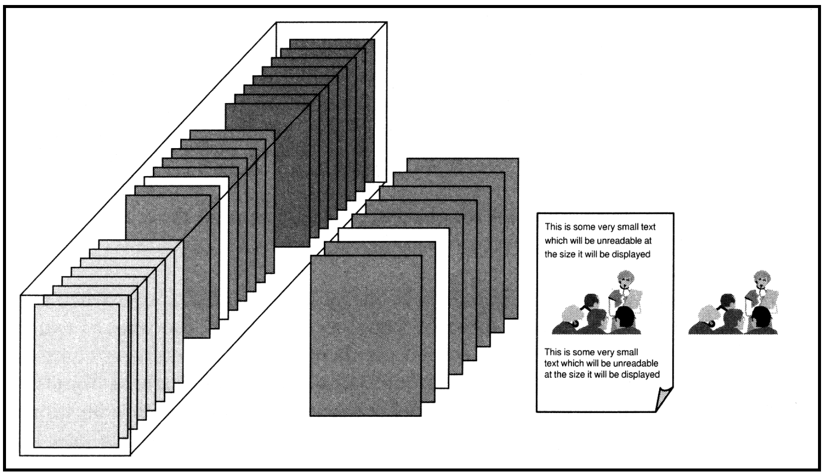

Figure 3-6: Disassembling a book into chapters, pages, paragraphs, etc. (Duncan, 2003, p. 14)

This approach sounds logical. But in practice the workload or cost involved in disassembling content of all published books is neither affordable, nor it is apparently desirable. Taking the authors by their word: Even recent published prominent books focusing on learning objects are neither available in the granular size which is championed by their authors, nor in digital format, namely *Reusing Online Resources – A sustainable approach to e-learning* (Littlejohn ed., 2003), or *Creating a Reusable Learning objects Strategy: Leveraging information and learning in a knowledge economy* (Barritt & Alderman, 2004). David Wiley who edited and published the online book *The Instructional Use of Learning objects* (2000b) has achieved granulation of content only to the level of a chapter, but not more.

Drawn from the same line of instructional design background, another aggregation model is based on observing how instructors create content of courses. Reigeluth & Nelson analyze the process of instructional design (1997). Usually, instructors will first disassemble relevant materials from available bundled learning objects. Then, they re-assemble selected materials on different sequence patterns based on particular educational contexts and objectives. In the learning objects arena, ideally, instead of the two steps 1) disassemble and 2) re-assemble, instructors will directly jump to the second step by taking already disassembled material and put it together for their new intended learning purpose.

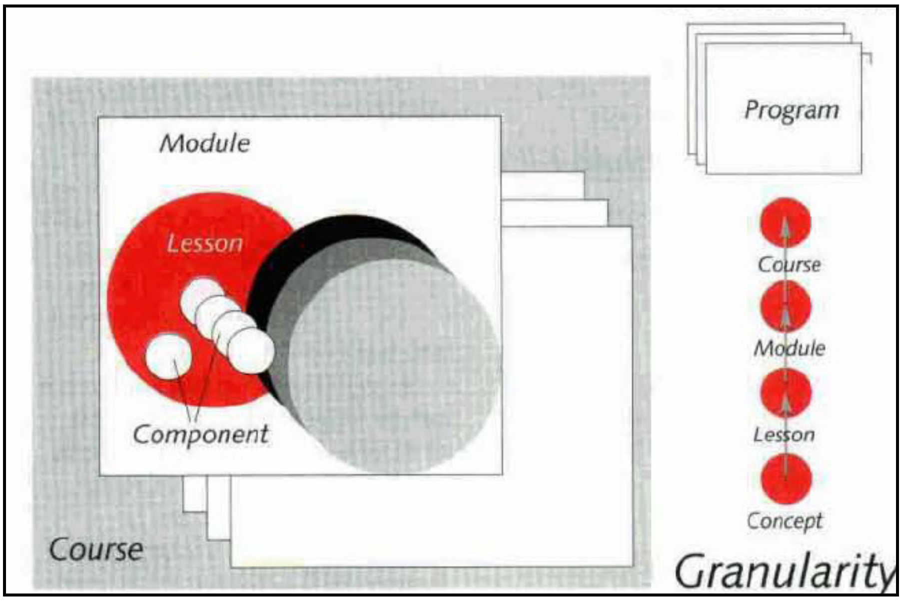

Figure 3-7: Traditional course-based granularity (McGreal & Roberts, 2001, p. 27)

Depicted in Figure 3-7, instructors will search needed resources from the smallest learning objects, which can be a concept, a photo, or a video clip. Then, they aggregate them to lessons, modules, courses, and finally a full learning program (e.g. a certificate program, a degree program, a corporate training unit). When a set of the smallest components is combined (e.g. into a lesson) this becomes the first level objects with respect to granularity. Consecutively, the next level module is aggregated by several lessons. The learning objects become less granular as levels move upward. Thus, a program becomes the least granular object of all.

Duval & Hodgins (2003) denote another aggregation model that defines not only the granularity levels of learning resources, but also assigns another meaning to the label "learning object". As depicted in Figure 3-8 there are five levels of granularity in their "Learningactivity Content Model". The aggregation is starting with "Raw Data Media Elements", i.e. text, animation, graphic, etc., then "Information Objects", i.e. a process, a concept, a summary, etc., then "Application Objects" such as, amongst others, "Learning Objects", i.e. a reference, a marketing brochure, support documents, etc., then "Aggregate Assemblies" and finally "Collections". Obviously, this is a linear hierarchical aggregation model from data to information to objects to units of learning. In this model a learning object is restricted to have only one learning objective articulated by data and information from the levels below.

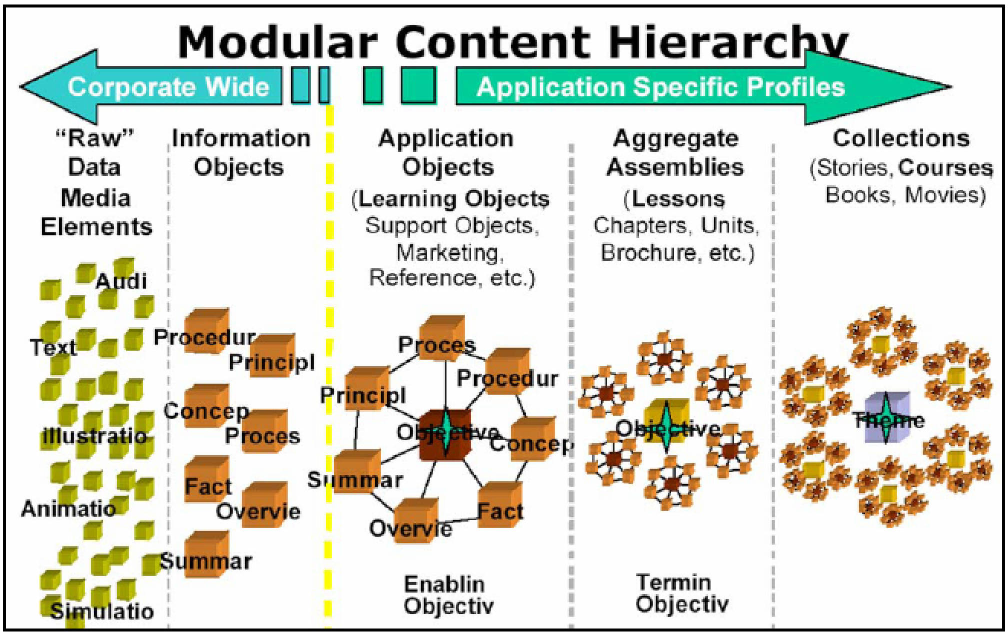

Figure 3-8: Learningactivity Content Model
(Duval & Hodgins, 2003, section: Research Issue 1 - A Learning Object Taxonomy)

Evolving from this Learningactivity Content Model Wagner (2002b) suggests in her "Content Ecosystem" that the reusability level decreases as the learning material is assembled from simple "Content Assets" as raw media to an aggregated collection in a specific "Learning Environment" (see Figure 3-9). The raw media have the maximum reusability but least educational value. The learning environment sits at the other side of the spectrum, of being the least reusable learning resource but being highest in educational value.

Looking at Wagner's content model, two interesting aspects have to be pointed out. The learning objects are positioned right in the middle of the reusability spectrum, and they are the transitional point between e-learning and knowledge management.

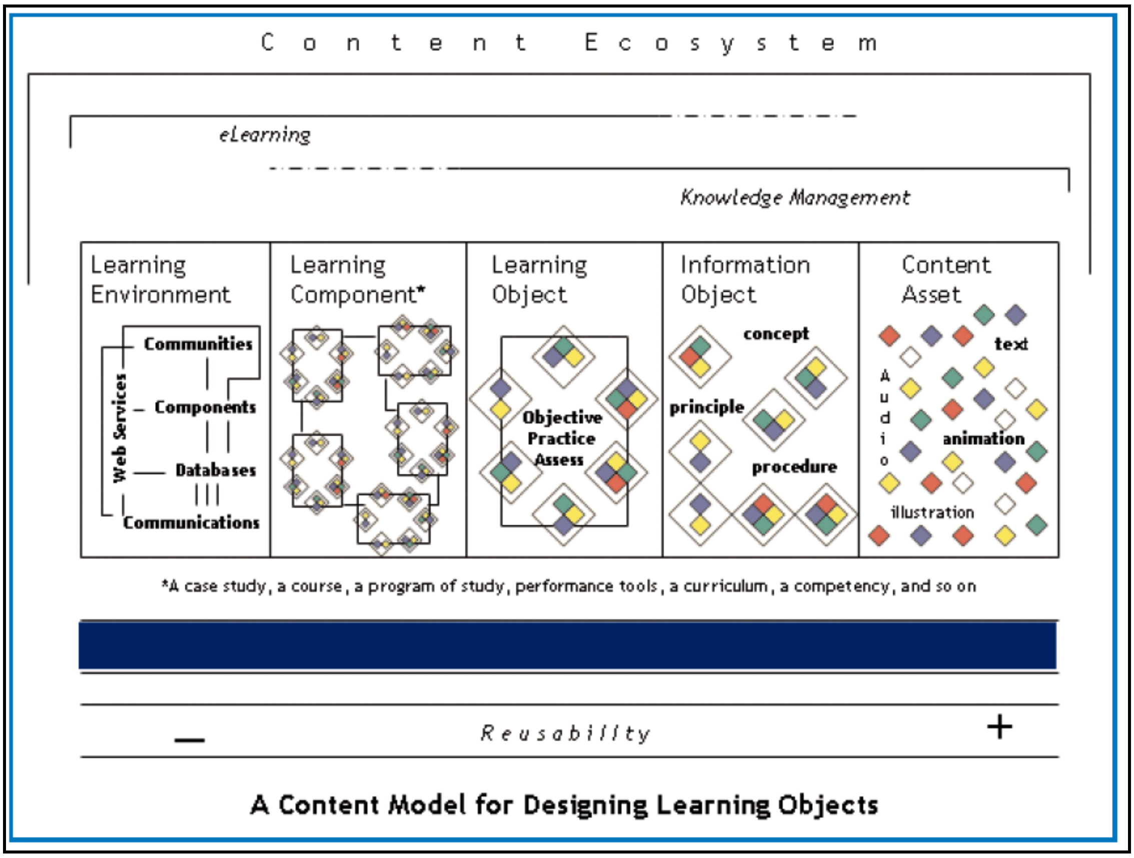

Figure 3-9: Spectrum of reusability of content (Wagner, 2002b, p. 5)

When it comes to the relation between learning objects reusability and educational value, South & Monson (2000) suggest a balanced view between granularity levels and educational usage. Accordingly, Figure 3-10 indicates that it is important for the learning objects adopters to find an optimal level of granularity to avoid the two extremes of the highest and the least aggregated learning materials.

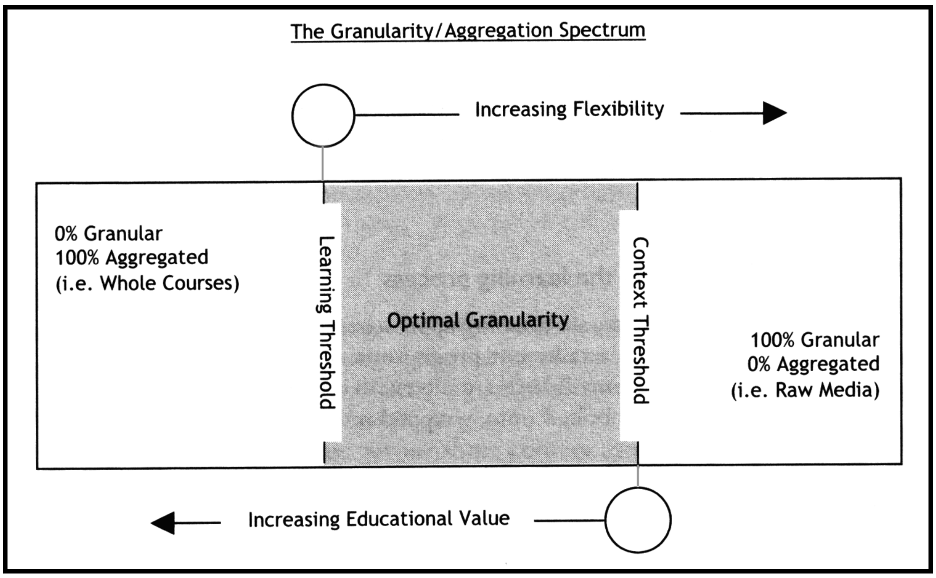

Figure 3-10: "The Granularity/Aggregation Spectrum" from South & Monson (2000) (Adapted by M. Thorpe, Kubiak & K. Thorpe, 2003, p. 113)

In addition, M. Thorpe, Kubiak & K. Thorpe (2003) emphasize that learning content creation is not a linear collection of pieces of learning materials, or a patch-work of disintegrated stand-alone, small learning materials. People need to have an overall plan to plug-in individual pieces of data and objects. The model of classifying granularity following the traditional course concept is the most straightforward and commonly practiced concept. Standardization committees, i.e. IEEE LTCS[12], and specification organizations, i.e. IMS[17] and ADL[18], have all relied on this linear content aggregation model which is reflected in the IEEE LOM standard and the SCORM specification respectively. In industry, this model is also implemented by Cisco. In Cisco's case, they encapsulate 7+/- reusable information objects, units of concepts, facts, principles, processes, and procedures, into one reusable learning object (Cisco, 2001). Cisco's model based on reusable information objects (RIO) with reusable learning objects (RLO) resembles the 'lessons-within-course' structure or 'chapters-within-book' format, though Barritt & Alderman (2004) claim that each RIO and RLO commits to a single objective. However, due to the linear hierarchical structure among RIOs and RLOs which are registered on a learning management system (LMS), learners cannot go straight to RIO materials. They must go through the whole hierarchical structure of the RLO in order to find the material they need at a reusable information level (Barritt & Alderman, 2004, pp. 198-199). This denotes a structure gap for reusing resources in an on-demand application and decreases efficiency.

3.3.2 Granularity Based on Content Domain

South and Monson (2000) state the granularity level of learning objects should be based on the number of domain(s) involved in the object itself. In their words the concept of learning objects "has the greatest potential for reuse when they center on a single, core concept" (p. 18). David Wiley (2000a & 2000b) follows this notion and further articulates the inverse relationship between reusability of a learning object and its size. In Wiley's view, the more objectives are involved in a learning object the less are the chances of it being reused in multiple contexts. Specifically, a digital image of Da Vinci's painting *Mona Lisa* can be reused in a multitude of learning contexts, such as: in a drawing course, a history class about the renaissance period, a women's study, in a book reading session related to the book "The Da Vinci Code", and much more. At the same time, a digitized book collecting many paintings of the renaissance period would be less reused in different contexts compared to this

[17] IMS website: http://www.imsglobal.org/
[18] ADL website: http://www.adlnet.gov/

one image. Therefore, by synthesizing instructional design models from Reigeluth's "Elaboration Theory", van Merriënboer's "Four-component Instructional Design" model, Gibbons and his colleagues' "Work Model Synthesis" approach, and the Domain Theory by Bunderson, Newby & Wiley (as cited in Wiley, 2000a, pp. 26-27), Wiley (2002a & 2000b) identifies a framework that maps relations among a single content domain, learning objectives and related activities to support the learning objective. However, Polsani (2003) criticizes the excessive influence of instructional design theories on pre-sequenced or pre-structured learning objects. He sees that instructional design theories have a tactical impact in overall development of learning objects, but are not the starting point.

Earle (2002) warns about a misguided development deriving from a content-domain-based granularity approach for learning objects. This domain-based structure implies wrongly that learning consists of sequential movements from lower chunks of learning to more complex ones, according to a predefined segmented knowledge hierarchy. Such a view of disaggregating knowledge into separate segments repeats the perception that the most granulized learning resource has the highest reusability. Earle disagrees with this view of thinking knowledge is linear and a decomposable entity. The study from Marton, Dallalba & Beaty, colleagues at the Open University of the United Kingdom, has supported Earle's opinion (as cited in Earle, 2002. p. 22). This study, based on interviews, has classified six stages of learning. It found out that the first three lower stages of learning fit the idea of linear aggregation and sequencing in collecting, reproducing and using bits of information. However, when moving up to advanced skill and knowledge acquisition, predefined pieces of information won't serve the other higher stages of learning needs. Additionally, Dowling expresses objections to present learners only a decomposed and fragmented concept of any content domain because this procedure blocks learners' involvement and practices on the higher levels of skills and knowledge (as cited in Earle, 2002. p. 22).

3.3.3 Granularity Based on a Multi-Layered Model

The last school of learning object granularity is towards a multi-dimensional thinking instead of a single dimension, such as content accumulation or content domain scope. Wiley, Gibbons & Recker (2000) ground a six-layered design model of a learning object, which derives from the design of a building – site, structure, skin, services, space plan, and content (e.g. furniture). Gibbons and his associates have proposed the following list of instructional design layers for a learning object:

1. Model
2. Problem
3. Strategy
4. Message
5. Representation
6. Media-Logic

According to this model, each layer should be expressed independently from the other to the greatest possible extent. Gibbons and his associates state that a single learning object consists of compressed layers. Unfortunately, there is no further explanation of each layer, or practical implementation of this theoretical model. It also leaves the question "what elements of the model, message, instructional strategy, representation, and media-logic layers are compressed within this learning object?" (Wiley, Gibbons & Recker, 2000, p. 5). However, such a multi-layered view is a conceptual move to position granularity as a result of combined factors influenced by multiple aspects in learning. Granularity shall not solely emphasize only one issue, like e.g. content (Earle, 2002).

3.3.4 Summary

Researchers have bet that the granularity issue will be solved by practical experience and better authoring tools. For instance, Jacobsen (2001) claims that "object granularity will be largely solved as best practices emerge" (section: XML everywhere, para. 3). Wiley, Gibbons and Recker (2000) would also like to witness the emergence of authoring tools and methodologies that carry on their work of the multi-layered view of granularity.

The three granularity approaches for LOs outlined above have two similarities: they are based on a physical metaphor and content-driven design. People often run into the pitfall of transferring physical experience or metaphors to the virtual e-world of digital assets and communication. Certainly, some lessons-learned from the physical world may be carried over to the e-world, but with caution. When learning is a lifelong endeavor, updating information and knowledge accordingly is a continuum and dynamic process, which is rather different from a world defined by static physical entities (e.g. LEGO, a text book, a particle of physical being, the construction of a building, etc.). Secondly, the consequence of following the physical metaphor drives developers to break up content as small and abstract as possible, like in LEGO or following a book design format. The content-driven or content-breaking approaches to learning resources did not produce many real world applications for efficient and effective learning so far. This is because fruitful learning comes from both content and context. During the past years of LO development people have mainly looked at the content side, while trying to minimize the influence of context. This is for the convenience of instructional designers, but not for the learners. Especially, in workplace learning, context plays a key role in effective learning outcomes. It is unthinkable to show a salesman only product information without letting him/her know related context information, such as product characteristics as compared to other products in the same segment, target consumer group, the newest information about competitors, experiences from others, etc. Therefore, the next chapter 3.4 will emphasize the role of context in learning and knowledge construction.

3.4 Context Information

3.4.1 The Influence of Context in Reusing Learning Objects

The promise of increased reusability of learning objects has driven all the excitement and effort towards the learning objects vision. Reusability is the biggest challenge of LOs design because meaningful content often depends on a complex set of context information (Parrish, 2004; Nurmi & Jaakkola, 2006a & 2006b).

At the beginning, people hailed the idea of reusing the smaller bites of information and/or content that is built once, then, reused infinitely in different learning context (Hodgins, 2002). The early understanding of reusability implies being able to copy-and-paste the same learning objects to multiple teaching situations and learning contexts. Technically this implies that the reused objects may function across different technology platforms or systems of different organizations. The technical interpretation of reusing is resolved mainly via efforts in technology standards and specifications (detailed in thesis chapter 3.5).

From the learning perspective, some researchers have simply used the term *reusable learning objects* instead of learning objects, assuming anything they built would be reused in later learning events and contexts (Cisco, 2001; Leeder, Davies, Hall & Wharrad, 2002; Polsani, 2003; Littlejohn, et al., 2003). The roots of implying reusability as a de facto attribute of learning objects again reside in representing learning via a physical metaphor. Building LEGO or building blocks type of learning has dictated that the developers break-up the content from its original contexts, even more, from the original pedagogic design (Polsani, 2003; Campbell, 2003; Barritt & Alderman, 2004). Others, however, have realized the importance of context. Thus, Koper (2003) and McCormick (2003) propose to surround small content objects with the original context and pedagogy models. As in defining a granularity model, the first generation design concept and approaches for learning objects are content-centric, albeit people realize the importance of context cannot be neglected.

After some years of hype, more and more researchers are now focusing on the role of context and how it influences individual learning. From the software design perspective, Gunn, Woodgate & O'Grady (2005) point out that the architecture and user interface for designing learning objects shall be more open and flexible, adapting to individual learning contexts and needs for a wide area of repurposing. Theoretically speaking, higher levels of learning are processes of knowledge construction which involve learners' contribution and interaction for building up their own knowledge for a specific context (Jonassen & Land, 2000). The underlying pattern of the first generation of LO development is based on cognitive learning theories, positioning the learner as a passive entity receiving prepackaged learning via a computer (Parrish, 2004). To facilitate the future trend of learner-centric knowledge construction in lifelong learning, the next generation of LO design shall cater to individual learner's contexts as well as enable a learner's contribution in creating learning resources.

Boyle (2006) states that the second generation of learning objects design is context-driven, in order to maximize reusability. It is a shift from content-centric design in the first generation of LOs. According to Boyle, pedagogy is essentially "about the design of contexts to enable learners to achieve learning goals and objectives" (2006, p. 1). From the instructional design point of view, Boyle treats the learning objects as "acute micro-contexts" and "the design of these contexts involves pedagogical choices in the selection and organization of activity and content to facilitate the learning process" (p. 1). These micro-contexts can be "fitted into the larger macro-contexts for a full and effective model for pedagogical design." (p. 8).

From a broader perspective of interpreting content, Schryen (2001) defines social and cultural barriers in the process of achieving reusability of software objects/components within and across organizations (see Figure 3-11).

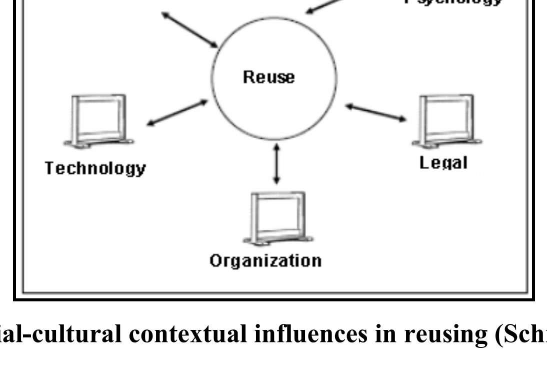

Figure 3-11: Social-cultural contextual influences in reusing (Schryen, 2001, p. 11)

Transferring them to the subject of learning objects implies taking into consideration influences like:

- Financial barrier – how much the learning objects cost and how much return of investment will a reusing endeavor bring to the organizations.
- Psychological barrier – learners' motivation and the goal of their learning. Whether it is time and task dependent in the workplace environment where reusing may save significant resources, or in the academic education arena where learning is accredited mostly by originality.
- Organizational Support – how the management from the top of an organization's hierarchy supports the dedicated development of reusable objects.
- Technical barrier – the software, system, and the level of the learner's technical literacy can greatly influence the success of reusing learning objects which are developed outside of the organization.
- Intellectual property rights issues in crossing different organizations.

3.4.2 The Context and Content Paradox

When pursuing reusability in the approach of learning objects, context often refers to everything that influences the process and delivery of content, namely, pedagogical choices, learners' knowledge levels, language, time, location, etc. The early debate of learning objects reusability is centered on the paradox in the relation between content and context. As discussed above, the pedagogy-and-technology-neutral approach has been the focus of the first generation LOs. Polsani (2003) and Koper (2003) claim that the separation of content from context will increase reusability of learning objects. The more abstract a learning object is e.g. separated from instructional design methodologies, the more chances it has to be reused in different learning situations. Another interpretation of the same sort is from Naeve (2001) who claims that there are differences between designing a course and building a resource component with respect to content and context. He reckons that as a sound instructional plan, the instructional designer often brings learning content together with contexts of the target group, prerequisites, time, culture issues, etc. When constructing a resource though, i.e. an information component within a knowledge framework, people may separate the content from the context in order to maximize content reusability.

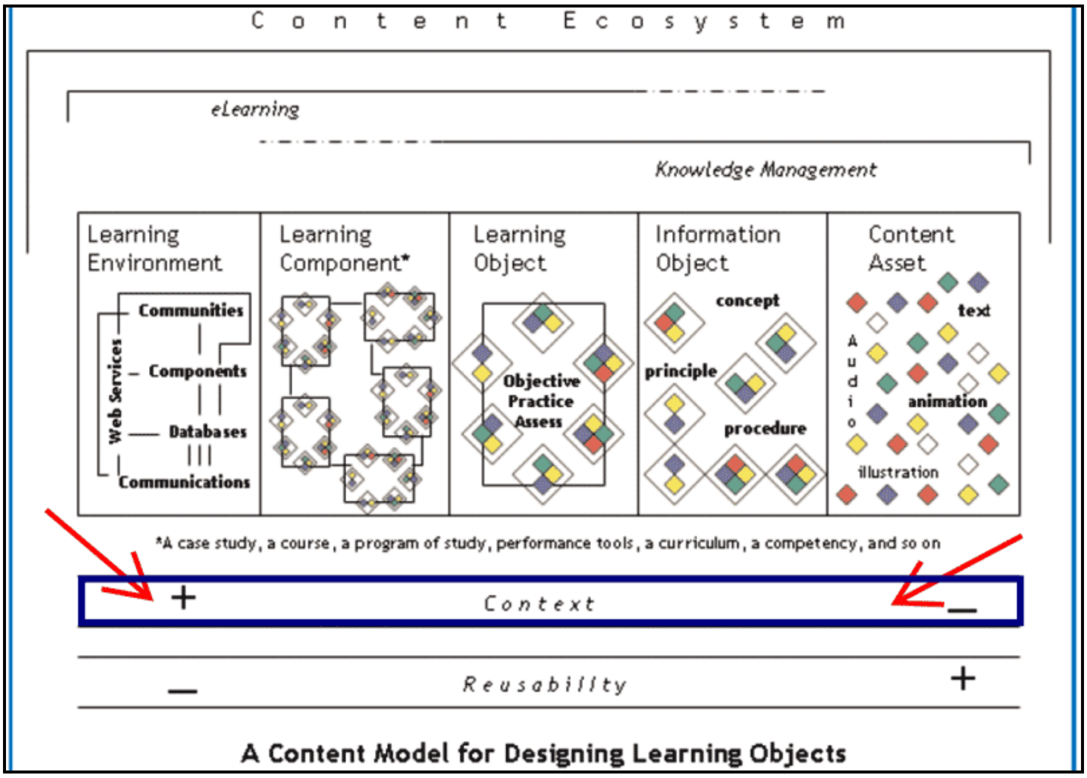

Figure 3-12: Content-context paradox for reusability (Wagner, 2002b, p. 5)

The content and context paradox is depicted by Wagner's model. This model has been presented in the discussion of granularity issues in this thesis in chapter 3.3.1 by omitting the context layer. When context is added, Wagner (2002) mirrors Naeve's assumption of context abstraction, which increases reusability in the case of knowledge construction. Figure 3-12 shows that the more context information is bound to content, the less reusability of content is reached. Learning objects in Wagner's view could be more reused when they are context-free. From an instructional design point of view, Wiley (2004) echoes the same view that increasing dimensions of pedagogical theories bundled with learning objects reduce their reusability (see Figure 3-13).

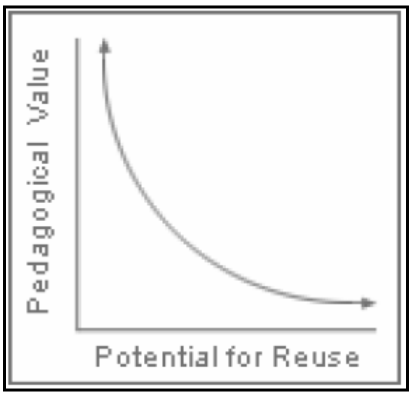

Figure 3-13: Inverse relationship between reusability and pedagogical effectiveness (Wiley, 2004, sction: The Reusability Paradox)

By a first look at Wagner's model, the relation among content, context and reusability seems to be logical, but it is simply too theoretical to be applied in real world scenarios. A reason is that creation of context-free learning content is not a practice for many instructors who "normally modify and adapt [learning] resources to fit specific teaching situations, disciplines, abilities of students and so on" (Littlejohn, 2003, p. 4). In other words, instructors often revise resources to fit their specific teaching and learning context. Second, context separation also involves cultural and political aspects. Nurmi and Jaakkola (2006a & 2006b) argue that the value of learning objects lies in the context of its use, and thus a design based on pedagogical independency is neither practical nor logical following the rules of sound instructional design.

From a broader aspect, Littlejohn, Jung and Broumley (2003) have noticed that content stays in the socio-cultural context where it has been created. For example, what has been created by UK instructors is based on requirements or environmental radiations of UK educational objectives and practices. When taking them to another country and another culture, they do not travel well. For example, in Korea instructors practice a mandatory curriculum established and sponsored federally. LOs with this social context cannot be widely reused in other countries with a different learning culture. Putting it simply, learning design without taking context into account may be a total waste of time and effort. In chapter 1, Lambe (2002), Nonaka and Konno (1998) all address the critical issue of context in influencing learning and knowledge creation.

Some time before, academics have sharply criticized the approach of separating learning content from its context in the early LOs development (Longmire, 2000; Wiley, 2000a & 2000b; Downes, 2003a, 2003b & 2004a; Campbell, 2003; Koper, 2003; Rehak & Mason, 2003; Metros, 2005; Liber, 2005). They insist that the contextual, especially, pedagogical layer, cannot be excluded when designing learning content in a classical instructional setting. As referenced above, David Wiley, the prominent advocate of LOs approach, says that it is foolish to think reusing learning resources is simply to copy the content directly into another context (weblog, January 9th, 2006).

In addition, academic institutions and specification groups have recognized the need of pedagogical context involvement in reusing learning content. The Open University of the Netherlands (OUNL) has been actively developing an educational modeling language to specify or standardize a variety of pedagogical frameworks and a range of learning contexts. According to Rawlings, van Rosmalen, Koper, Rodríguez-Artacho & Lefrere (2002) an educational modeling language is "a semantic rich information model and binding, describing the content and process within ‘units of learning’ from a pedagogical perspective in order to support reuse and interoperability” (p. 8). Liber (2005) states that OUNL’s concept is appealing for educators, but it is still too early to predict its wide adoption due to a lack of user friendly tools. He adds that the IMS has invested tremendous efforts in making specifications that support traditional pedagogical contexts, which were ignored by many content-centric standards and specifications.

From a bigger picture, the current trend in e-learning is going towards an individualized and collaborative learning for a life time. With this in sight, researchers have been stressing the need on knowledge construction where context plays an equal and key role as compared to content (Dillenbourg, Baker, Blaye & O’Malley, 1996; Duffy & Cunningham, 1996).

Again, the heart of constructivists is learner-centric. Longmire (2000) articulates more in detail than others about the advantage of providing context information to learners, and more important, empowering learners by engaging them in information contextualization processes. In his view, learning content without context is meaningless, confusing, and misguiding learners. Context information offers clues for learners of original usage and references as well as orientation for future applications.

As shown, the debate on the role of context in the second generation of LO design is clearly an important focus. Hereafter, questions arise on how much context information is needed and how to design context and content in ways that reusability is leveraged.

3.4.3 Organizational Context – One Aspect of Learning Context

To understand the nature of different learning environments is a necessary condition for a successful LO implementation strategy. Collis & Strijker (2003 & 2004) consider learning environments as learning context. The social, cultural and goal differences in university, military, or corporate contexts influence design and development of LOs greatly. Rehak & Mason (2003) and Liber (2005) doubt whether the idea of learning objects is applicable in traditional educational environments, like schools, colleges and universities. They assert that the lack of pedagogical context in learning object standards and in the development of specifications would not convince educators in traditional teaching environments to take the approach of content-centric learning objects seriously. From their research work, Collis & Strijker find that learning objects in the academic environment is the least applicable field to design and deliver learning (2003 & 2004). In the universities where professors have much influence on choosing and deciding what, why, when, where, and how learning resources shall be consumed, reusing learning objects often would be restricted re-purposing or re-modifying their own materials, but not materials from others. Nevertheless, there are other learning environments which may greatly benefit from the learning objects approach, namely, in workplace training and informal workplace learning, the key components of lifelong learning. In the knowledge intensive economy, training and informal learning is a recurring event at the workplace in both for-profit and nonprofit organizations. Whether the employee is a professor, a consultant, a doctor, a computer engineer, or a soldier, he/she is often required or forced to update skills and knowledge constantly in workplace contexts. Therefore, taking advantage of modular design of learning materials is an appealing concept for learning the right amount of information at the right time at the workplace.

Collis & Strijker (2001, 2003 & 2004) study aspects that influence the application of learning objects in three different environments: the university, the corporate and the military settings. The outcomes are summarized in Table 3-1.

Learning Settings	University	Corporate	Military
Stability of Learning objects	Dynamic	Relatively static in training and dynamic in knowledge updates	Relatively static in training and dynamic in knowledge updates
Instructor's role on teaching	Very influential	Limited influence	Restricted influence
Involvement of Information Technology	Supportive	Blended in	Parallel to classical classroom training
Content ownership	Individual ownership	company-specific materials are owned by the company	Copyright restricted and classified

Table 3-1: Comparison of learning objects usage in three learning settings (adapted from Strijker, 2004)

According to Collis & Strijker (2003 & 2004), in universities learning objects are often updated and revised to reflect the ongoing development of the underlying subject domain in traditional instructor-let classes. Instructors/professors have more freedom on deciding what to be used, where, and how the learning objects are taught. More often, individual instructors own the instructional material – learning objects with claims of intellectual property rights. For learning content delivery, an e-learning format is more used to support the traditional classroom teaching.

In the corporate settings, learning objects are often designed to meet business objectives and employees' competence levels. Here on-demand, on-the-fly assemblies of materials are desired to adapt to competition and business needs within a limited time frame. Therefore, the individual designer or instructor has limited influence on choosing resources. They are either decided by a management team or the individual learner. Rehak and Mason denote that the phenomenon and many scenarios of reusing learning objects have originated from workplace learning and training in corporate settings (2003, pp. 22-23). Moreover, Collis & Strijker (2003 & 2004) also point out that a learner not only has to discover learning objects. But more important is to find out people and communities who provide learning support and valuable complementary knowledge. Communication plays a bigger role compared to any pre-defined learning process. Putting learning objects in a Podcast environment is handy and useful. Instructor-led, self-paced and informal learning are all blended into the corporate learning environment where the instructor's role is more and more transformed to facilitate learning. Regarding the ownership of learning objects, in the business environment company-specific materials are corporate assets. Sharing within the company is common, but obviously not with other competitors.

In the military environment, because of its command-and-control hierarchy, learning content is highly structured, stable, and slow to change. When it comes to the selection of learning objects, instructors have little or no say. Access to learning objects is highly secured and based on hierarchical access control. Meanwhile, the classical instructor-led training model is pursued parallel to the use of computer-based training technologies. Obviously, military learning content is often top secret; reuse is only desirable inside the organization.

The reflections above have shown that applying learning objects is often restricted by specific learning settings. A general design model and the idea of sharing learning objects across a variety of different learning settings are utopian and not very realistic.

In this thesis, the design of modular learning materials is set against the daily workplace setting, excluding the military environment. The author of this research views knowledge workers in both for-profit organizations (e.g. in commercial businesses) and in nonprofit organizations (e.g. in universities) as being equally under pressure to update knowledge and skills on a continuous basis whilst working.

3.4.4 Design Tactics for Context

Some researchers have outlined tactics in integrating context parameters in LOs design. However, two design principles have to be kept in mind. Firstly, there is an optimal contextual point. As in the question of level of granularity, there is also a middle point indicating a kind of "optimal" amount for context information. Wiley (2000b) puts it:

> "Learning objects should be internally contextualized to a certain degree – a degree that promotes their contextualization (combination) with a closed set of other learning

objects, while simultaneously preventing their combination with other learning objects" (p19).

Secondly, context information input is a teamed, collaborative effort. When the goal of learning objects is to provide reusability by multiple users in multiple contexts, it is natural to start from the very first step by engaging teams of experts or learners from multiple contexts to contextualize the content, e.g. by tagging mechanisms. M. Thorpe, Kubiak & K. Thorpe (2003) claim that the content creators would be the best candidates for delivering context information. Recker and Wiley (2001) add a concept of "non-authoritative" context information that provides referencing information about past usages for new users.

Certainly, technology, institutional objectives, policy, and individual needs influence quality, quantity and structure for input of context information. Learning object advocates like especially Longmire (2000, pp. 29 – 30) and others (like e.g. M. Thorpe, Kubiak & K. Thorpe, 2003, pp. 114-115; Koper, Pannekeet, Hendriks & Hummel, 2004, pp. 26-28; Green, Jones, Pearson & Gkatzidou, 2006, pp. 117-129; Gkatzidou, Pearson, Green & Jones, 2006, pp. 2928-2933) have subscribed to different tactics for contextualization. Their ideas are based on treating context information as separate objects that may also be reused or repurposed:

- *Context wrappers.* Instead of "internally contextualized" as mentioned by Wiley (2000b, p. 19), "wrap-around" tactics are put forward which separate context information from the content part of learning objects with the goal to increase the reusability of learning objects. These tactics offers a contextual layer to the user on top of the content. For instance, in a corporate environment, an object is about a new product with different contextual wrappers from marketing, training, or customer service departments. By applying the appropriate parameters for department contextualization, people from marketing will only be guided by corresponding context information sets/context wrappers for marketing without getting distracted by context information for training, sales, customer services, etc.
- *Adding context links to objects.* Another option of the context-wrapper approach is to add links to the learning object which point to outside layers of context. Context and content are associated with each other, but not mended together. The difference from being a simple wrapper is that context links are objects in their own right. Developers can update the linked but independent contexts, and when applicable, the same context objects may be reused and linked for multiple objects as well.

- *Pattern/Template Design.* This type of design is useful in performance-based or competency-based learning models to define reusable learning patterns related to learners' individual profiles. In addition, pattern/template design can be applied to recurrent activities with a predefined set of contextual parameters, such as travel reimbursements, protocols for quarterly reports, setting up budget plans, being involved in certain project phases, etc. Learners can use these templates if they need so, to be attached to or to „book" content fitting the underlying pattern.

These conceptual design methods are bringing new light into balancing the world between content and context. But little has been utilized in real world applications so far.

These conceptual design methods shall be reflected against the well documented corporate usage of a learning object strategy at Cisco's (Barrit & Alderman, 2004). At Cisco, based on directive learning architectures, context information is built-in, wrapped within the lesson unit. A general introduction is required for each learning object at the start and a summary at the end of the lesson, providing major context information of the lesson. This approach is neither enhancing the reusability of learning objects in multiple learning environments, nor following earmarks of good instructional design because the context information is restricted to support the underlying pre-sequencing of classical instructional approaches. So the internal dependencies of larger learning objects are made to be reusable with little modifications or additional efforts, and the number of contexts in which they can be applied is small enough to not call for wide reuse. Nevertheless, Cisco apparently realizes shortcomings of their approach.

3.4.5 Summary

Context is the important attribute to learning objects. The initial emphasis on the separation of content from context neglected the important role of context in learning. Context information can act as sequencing parameters, valuable guidance for new learners, and glue for personalized learning. Last but not least, context can be a reusable object in its own right, identified as patterns or templates of usage. Although there are some innovative ideas about context design in relation to content for maximizing reusability, practical implementations and technology approaches are lacking.

3.5 Technical Interoperability of Learning Objects

Interoperability efforts in the learning objects sphere aim at generating a learning standard which enables compliant learning objects interoperable among different learning systems and software programs.

Like railway systems, electricity, cars and telecommunications, The Economist observes that after their start these technological evolutions and developments have all gone through later standardization processes to ensure interoperability among competitors (The Economist, Survey, May 10, 2003). It is better to stay united and grow together than fight a costly war by all means from all sides.

According to IEEE (1990), interoperability refers to "the ability of two or more systems or components to exchange information and to use the information that has been exchanged." The e-learning industry, evidently, following the development and maturity of the IT industry, is going from proprietary systems in the direction of open-standards, and later, to standards centered on customer needs, as shown in Figure 3-14.

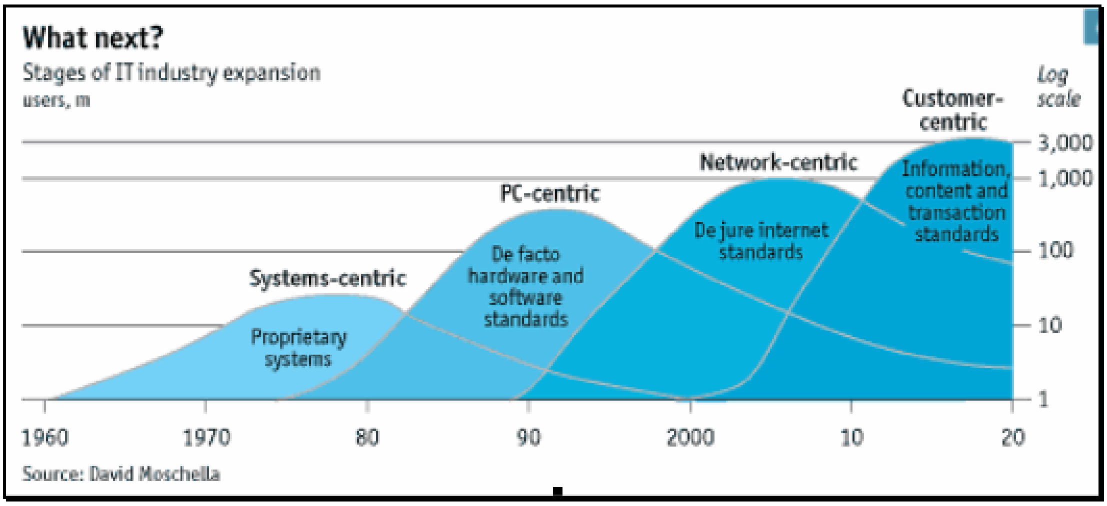

Figure 3-14: Stages of development in IT industry (The Economist, Survey, May 10, 2003)

Learning technology is also coming of age, technical standards becomes a focal point of learning objects development in both academic and corporate institutions. Standardizing metadata schemas, content aggregation protocols, and development processes have become main themes and centers of gravity pulling resources from e-learning content vendors and academia together. The effort is trying to operate standardized learning objects crossing a range of software, hardware, operating systems, learning management systems, or content management systems. Plenty of confusion remains in the fields of technical adoption of learning objects development, albeit much energy and millions of Dollars/Euros and years of development have been spent on developing learning object standards (Duval, 2004; Koppi & Lavitt, 2003, pp. 39-43; Jaakkola & Nurmi, 2004, p. 2; Parrish, 2004, pp. 59-60).

Before going further, it is important to understand the differences between two terms – *standards* and *specifications*. Information technology standards can only be generated by national governments and proved by international bodies, which are recognized by multiple national governments, i.e. the IEEE or the International Organization for Standardization (ISO). Hequet (2003), MASIE Center e-Learning CONSORTIUM (2003), Olivier and Liber (2003) all contribute clarification and insights about the current state of learning technology standard development.

Currently, the only learning objects standard is the IEEE Standard for Learning Object Metadata (LOM) (IEEE LOM, 2002). However, the Dublin Core Metadata Element Set (DCMES) (Dublin Core Metadata Initiative, 2003) is another standard endorsed by the ISO for a more open and general metadata approach on information and knowledge. IEEE LOM and the Dublin Core Metadata Initiative (DCMI) are competing as well as collaborating for learning technology standards. There are some overlapping metadata elements between basic standards of IEEE LOM and DCMES.

The notion “de facto” and “de jure” standards in Figure 3-14 (The Economist, Survey, May 10, 2003) reference non-rectified protocols. A de facto standard is a type of specification that is measured by market share of a leading system, software, protocol, or platform used by a large number of people, which may not necessarily relate to any standard. For instance, the PDF format is a de facto standard for electronic documents, the jpg and gif formats are de facto standards for digital images. IBM Lotus Notes Domino with more than 120 million users worldwide (Raven, 2006), is a de facto standard for workplace e-collaboration technology in the corporate sector.

Olivier & Liber (2003) explain that normally the government or government-related organizations set the guidelines and principles for de jure standards by their enterprise-wide usage. The Advanced Distributed Learning Network (ADLNet) sponsored by the US Department of Defense (DoD) is an example of organization that set the de jure standard for US-DoD.

Between the appearance of learning objects concepts and its later development, most energy spent on developing learning technology interoperability has gone into standardizing learning objects metadata standards and specifications. The front runners are the IEEE Learning Technology Standards Committee (LTSC) and the Dublin Core Metadata Initiative (DCMI) for standard development. The Instructional Management Systems (IMS) Global Learning Consortium, the Aviation Industry Computer-based Training Committee (AICC), and the Advanced Distributed Learning (ADL) Initiative are for specifications.

The following will discuss issues in metadata functions, issues in standard adoption processes, specification development and its implications from a none-technical perspective.

3.5.1 Metadata Functions

Metadata is universally understood as data about data. Granularity mechanisms and context information are manifested in virtual space via metadata tagging. In any learning objects repositories, or by and large, any content and knowledge management systems, metadata play a key role in enabling users to retrieve, capture, and connect resources. In other words, the design and implementation of a set of metadata elements is the first step of a challenging road to the pinnacle of a sharable, reusable and adaptable learning objects world.

There is no need to repeat the importance of metadata which has been stressed by many (Wiley, 2000a & 2000b; Robson, 2002a; Duval & Hogdins, 2004; Friesen, 2004a & 2004b). Rather the author of this thesis will focus on the implementation of learning objects metadata. Some academic researchers (McGreal, 2001; Olivier & Liber, 2003) compare learning objects metadata to library catalogue cards which describe the content of related books, articles, or journals. Meanwhile, Robson (2002a & 2002b), Hodgins (2002) and Barrit & Alderman (2004) are betting on a broader vision of a learning objects economy in which metadata are utilized not only as static descriptors, but also as linking mechanisms to product inventories, labels, or categorizations for customer-oriented services. The focus of this thesis follows the second vision. Today, the efficiency of online shopping experiences open our eyes on the functions and economics of metadata usage, whether it is purchasing books at amazon.com, clothes at Otto.de, medicine at Apotheke24.de, flights at Luftansa.com, or bidding on eBay.com. From their experience of designing the learning objects strategy for Cisco Systems and the Redwood Credit Union, Barritt & Alderman (2004) summarize four types of metadata functions used in corporations, as summarized in Table 3-2:

Metadata Functions	Minimum Examples / Requirement	Extended Examples / Requirement
Product Metadata	• Inventory number • Price • Product name • Simple description	References to: • Photos • Product reviews • Customer ratings • Product accessories • Related products
Customer Profile Metadata	• Payment method • Shipping address • Contact information	Demographic information: • Age • Gender • Income • Interest – potential buying trend, product categories
Interface Metadata	• Web-based customer portal	
System and Tool	• Systems & tools shall capture and store customer and product information	• May be capturing metadata automatically, with manually authoring and editing tools for both customers and sellers.

Table 3-2: Functions of metadata and systems in online retail industry (Barritt & Alderman, 2004, pp. 163-165)

Translating these functions and experience to learning, metadata systems and tools will largely stay the same in learning as in online shopping experience. Learning objects metadata will serve not only as the sole description of content title, subjects, author, dates, etc., but also comprise the learner's context, profiling learners' learning style, competency levels, usage domain, and so on. To summarize, the metadata shall not only be married to the associated content, but also leverage it to describe the context information about the learning settings and processes, and how a learning object is used or reused in knowledge gathering endeavors.

3.5.2 Metadata Standards

Metadata standardization is the first pragmatic step to interoperate learning objects across software platforms. At this stage, without any dispute, the two metadata standards widely accepted and populated in the e-learning content arena are, as mentioned: DCMES, the Dublin Core Metadata Element Set, Version 1.1 (Dublin Core Metadata Initiative, 2003), and IEEE LOM, the IEEE Learning Objects Metadata Standards - IEEE 1484.12.1-2002 (IEEE LOM, 2002).

First of all, the Dublin Core Metadata Set consists of 15 metadata elements with simple and straightforward descriptions. To name them all: title, author or creator, subject and keywords, description, publisher, other contributor, date, resource type, format, resources identifier, source, language, relation, coverage, and rights management. The Dublin Core Metadata Initiative takes a minimalist approach, focusing on "a broad range of purposes and business models" for digital resources standardization, which includes learning and education content

(The Dublin Core Metadata Initiative[19]). DCMI positions its set of metadata elements as the starting point of individual customization and expansion according to organizational context. Hence, simplicity is the core value of the Dublin Core Metadata Element Set, for minimizing the cost of generating metadata for organizations in order to achieve promotion of interoperability.

On the contrary, IEEE LOM is an extensive metadata classification scheme, particularly aimed at any resources that can be used to support learning. It has 78 elements spread in 9 categories, i.e. general, life cycle, meta-metadata, technical, educational, right, relation, annotation and classification. Figure 3-15 is an overview of the IEEE LOM metadata structure with specific data elements.

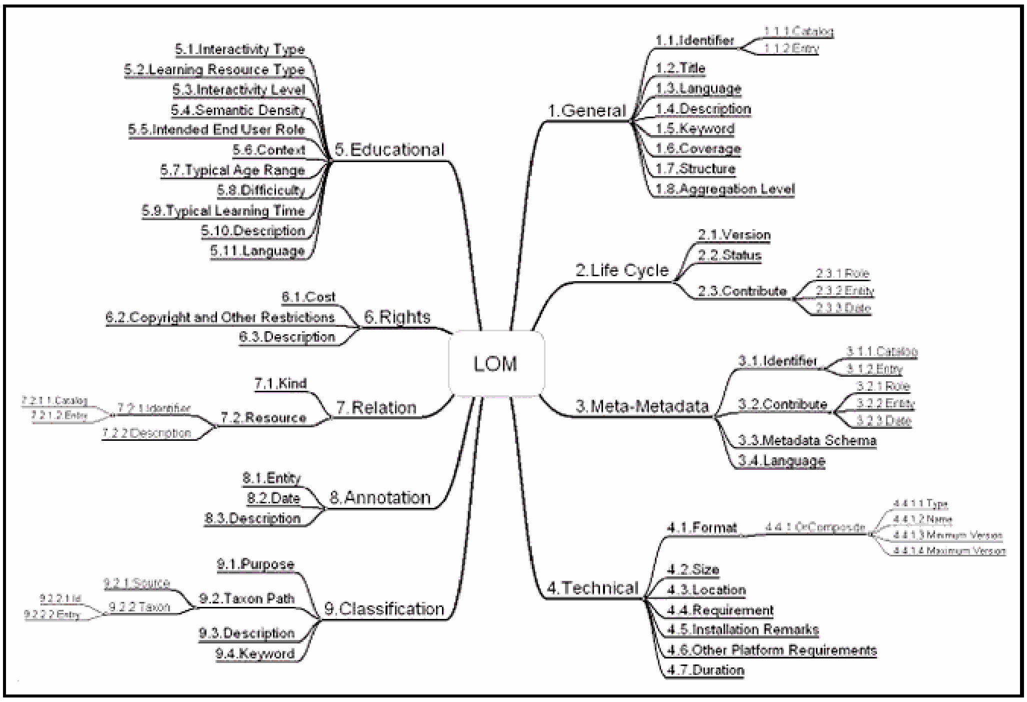

Figure 3-15: Elements and structure of the LOM conceptual data schema (IMS, 2004, section: 2.2 IEEE Metadata Elements and Structure [20])

To be noted, with careful study, one can map the overlapping metadata fields between IEEE LOM and the Dublin Core metadata standards. Table 3-3 shows that the 15 Dublin Core metadata elements are all included in IEEE LOM (IMS, 2001). In detail, 6 elements from the DC standard are in the general category of IEEE LOM, 4 in life-cycle, 2 in relation, 1 in educational, 1 in technical, and 1 in the rights category.

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[19] Dublin Core Metadata Initiative website: http://dublincore.org/
[20] http://www.imsglobal.org/metadata/mdv1p3pd/imsmd_bestv1p3pd.html

Dublin Core #	Dublin Core Name	Dublin Core Label	IEEE Learning Object Metadata
1	Title	TITLE	general.title
2	Author or Creator	CREATOR	lifecycle.contribute when lifecycle.contribute.role has a value of "Author".
3	Subject and Keywords	SUBJECT	general.keywords. For those wishing more specificity of Subject, a category of classification can be used with a purpose of "Subject". classification has elements for description, keywords, and taxonpath(s) that are specific for the purpose.
4	Description	DESCRIPTION	general.description
5	Publisher	PUBLISHER	lifecycle.contribute when lifecycle.contribute.role has a value of "Publisher".
6	Other Contributor	CONTRIBUTOR	lifecycle.contribute with the type of contribution specified in lifecycle.contribute.role. lifecycle.contribute can be repeated.
7	Date	DATE	lifecycle.contribute.date when lifecycle.contribute.role has a value of "Publisher".
8	Resource Type	TYPE	educational.learningresourcetype.
9	Format	FORMAT	technical.format
10	Resource Identifier	IDENTIFIER	general.catalogentry. greneral.identifier is currently a RESERVED term, as there is no specified method for creation of a GUID.
11	Source	SOURCE	relation.resource when the value of relation.kind is "IsBasedOn". This reduction is currently under consideration within the Dublin Core Community.
12	Language	LANGUAGE	general.language
13	Relation	RELATION	relation.kind, relation.resource
14	Coverage	COVERAGE	general.coverage
15	Rights Management	RIGHTS	rights.description

Table 3-3: Mapping of metadata elements between IEEE LOM and Dublin Core Metadata Elements Set (IMS, 2001, section: 5.2 Dublin Core element descriptions)

Many early adopters of metadata standards in the learning objects community often take elements from both standards in order to maximize interoperability with other LO repositories, or with content management systems. Although IEEE LOM is the only ratified and undisputed standard of learning objects development (Olivier and Liber, 2003), organizations are often shied away by the sheer number of its 78 metadata elements and the resources required in the compliant process. As long as there are no metadata tools and elegantly-designed interfaces to help authors and learners in tagging the required metadata elements, the IEEE LOM standard will not be the first choice for organizations (McNaught, 2003).

On the other hand, people are still attracted by the reusable and sharable aspects of learning objects. Over the years, people may gain valuable insights from early adopters' experiences and results. Here are snippets of lessons drawn from two organizational adopters of LOs approach to learning, and an international survey concerning the learning objects metadata issues. Experiences are summarized from a classical academic project, the iLumina digital library[21], hosted at the University of North Carolina at Wilmington, and from Cisco. At last, the findings from a two-year International LOM Survey will be reviewed as well. This survey, supported by CanCore Learning Resource Metadata Initiative from Canada, sheds light on future directions on the implementation of learning objects metadata standards (Friesen, 2004a & 2004b).

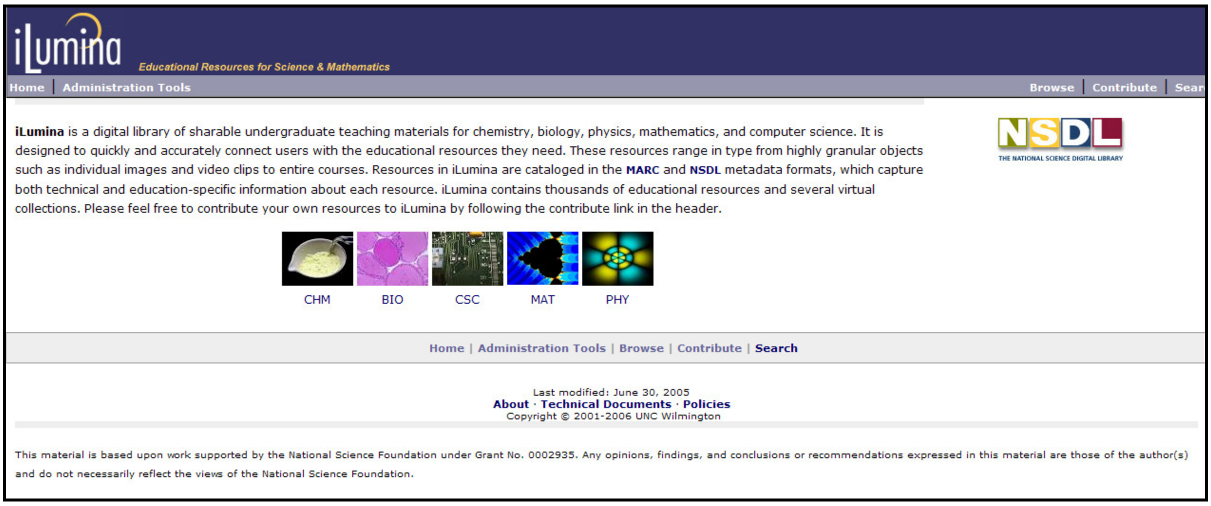

Figure 3-16: iLumina Digital Library (iLumina, 2005, section: Home)

First, it is necessary to clarify the settings of the three projects. Funded by the American Science Foundation, iLumina[22] is a web-browser-based digital library which contains learning objects that are "sharable undergraduate teaching materials for chemistry, biology, physics, mathematics, and computer science." (shown in Figure 3-16). iLumina mainly aims at content creators who are in the role of end-users of the digital library to browse and contribute digital content from single images to complete courses. The end-users fill out metadata information manually in a given form. The iLumina project members, Heath, McArthur, McClelland & Vetter (2005), state that many lessons have been learned during the five-year implementation process in compliance to the IEEE LOM, while simultaneously trying to import and export metadata from other databases adopting Dublin Core metadata elements. The background

[21] http://eww.ilumina-dlib.org
[22] iLuminia website: http://www.ilumina-dlib.org/index.asp.

information about the learning object project at Cisco has already been presented in chapter 3.2.3.

The two-year-long effort of "The International LOM Survey" analyzes feedbacks from a variety of learning objects initiatives, such as Canada's own CAREO project, the CELTS project from China, the European Union's ARIADNE project, Metalab from France, and the U.K. LTSN program. All these projects and programs have implemented the IEEE LOM standards. The records sizes vary from 75 to over 3000 (Friesen, 2004a). All three experiences have generated three key lessons:

- Lesson One – IEEE LOM is not cost efficient to adopt. In addition, organizations often add a set of metadata elements according to their particular settings. In the education context, the project team of the iLumina Digital Library has modified LOM vocabularies as well as implemented additional metadata elements, which are not in LOM (Heath, McArthur, McClelland & Vetter, 2005, pp. 71-72). In the corporate world, Cisco also adds company-specific metadata extensions, e.g. "product description, technology, and job task" (Barritt & Alderman, 2004, p189).
- Lesson Two – It is difficult and of questionable value to implement the LOM education elements. Specifically, in LOM, elements related to "an educational context or level are much less frequently used (e.g. Educational.Semantic Density, Educational.Context)" compared to other elements according to the CanCore's survey (Friesen, 2004a, p. 14). For an academic digital library project, Heath, McArthur, McClelland & Vetter also found little value in implementing the education metadata elements from LOM, which are not specified in the DC metadata element set (2005, p. 73). In Cisco, educational metadata extensions are applied which were recommended by another organization, the Customized Learning Experience Online (CLEO) for cooperating training purposes (Barritt & Alderman, 2004, pp. 169-172).
- Lesson Three – Unsynchronized vocabularies and the vacuum of a common taxonomy hampers interoperability among applications. Organizations often choose local and accustomed vocabularies in metadata descriptions according to their organizational context (Friesen, 2004a, pp. 4, 13). Consequently, learning resource interoperation and aggregation across organizational repositories is difficult to achieve (Heath, McArthur, McClelland & Vetter 2005, pp. 70-74). This view is also shared by Kabel, de Hoog & Wielinga (2003) whose empirical study stresses that the inconsistent labeling creates more problems than the promises of metadata standardization.

In addition, Friesen concludes that IEEE LOM's apparent inability to achieve interoperability is because it excessively relies on "costly, native-XML storage and processing [relational database] solutions" (2004a, p. 14).

Real-world applications and experiences prove to be more complex and variable than a learning object metadata model can standardize, though with 78 classified elements (Kabel, de Hoog & Wielinga, 2003). From the CanCore survey, the most frequently used LOM metadata elements, i.e. "classification purpose, title, format, (resource or object) Language, Lifecycle.Contribute.Role, Format, and Learning Resource Type" (Friesen, 2004a, p. 7) can be mapped to the much more intuitive metadata element set from DCMI. This makes people ask whether LOM is necessary or relevant when, ironically, LOM's educational elements are not implemented frequently across both the academic and industry sphere. The unconvincing implementation of LOM is criticized by the founding fathers of the learning objects concept. Hodgins & Duval (2004) say it is not the fault of the standard itself, rather it is the misguided "focus on the literal use of metadata, thus seeking to continue historical and current practices, rather than trying to design, experiment with and implement more innovative and effective ones" (section: Introduction, para. 2). They assert that different professions and disciplines shall define context-specific vocabularies, taxonomies, ontologies for interoperability within their community of practice.

With the education extension added into DCMES, Olivier and Liber (2003) assert that IEEE LOM is "explicitly created for learning purposes, while the Dublin Core is best at describing general information and knowledge that can be used for the purpose of learning" (p. 150). In another word, for a classical interpretation of learning as education and training, IEEE LOM may be applicable, but for knowledge management DCMES offers a broader perspective. Yet this argument contradicts IEEE's general definition of learning objects, which includes both digital and non-digital entities that can be used for supporting learning (IEEE LOM, 2002).

3.5.2.1 Cost of Implementing Learning Objects Standard

Another obstacle is the cost of generating, re-generating, re-versioning and capturing the learning objects standard (Feasey, 2002). In Figure 3-17 some pros-and-cons of adopting a learning objects strategy are listed. Two out of five categories are related to cost: the cost of re-tooling and re-training, and the cost of modifying existing content to ideal learning objects (Eduwork, 2001).

	PROS	CONS
Production Costs	By properly breaking content into learning objects, different parts can be maintained and updated separately. If a suitable learning object can be found, a new one does not need to be created. These are costs savers.	Changing to a learning object approach from a "self-contained system" approach involves retooling and retraining costs.
Flexibility	As more and more standards-based learning objects become available, increased choice will translate into more flexibility for designers.	Using standards-based learning objects restricts the scope of learner information that is accessible by content if total interoperability is maintained*.
Pedagogy	Learning objects fit nicely into many ISD theories. Instructional templates can be created with slots for specific types of learning objects. Learning objects may encourage designers to operate in more disciplined ways with a positive effect.	Restrictions on learner information available could restrict pedagogical approaches. Approaches using lengthy discursive material may not benefit from the use of learning objects.
End User Cost	The learning object approach prevents consumers from being locked in to specific systems. As standards take hold, the market for content will take on more of the properties of a typical consumer market with lower costs and increased choice.	The cost of converting existing content to a learning object approach may be significant
Industry Support	All leading system vendors and content producers are supporting SCORM and other standards that are based on or that complement a learning object approach.	Realistically, it is twelve to eighteen months between the time the vendor community adopts an approach and the time products that implement the approach are available.

Figure 3-17: Pros and cons of implementing learning objects (Eduwork[23], section: Pros and Cons of Learning Objects)

Barritt & Alderman (2004) also address the cost issue in the learning object project in Cisco. As shown in Figure 3-18, when implementing metadata, the associated cost benefit of metadata has its limit. The more metadata are implemented, the higher the costs of capturing and maintaining them. According to the individual organizational agenda, people must decide on an optimum amount of metadata elements that they can afford in application as well as later maintenance processes.

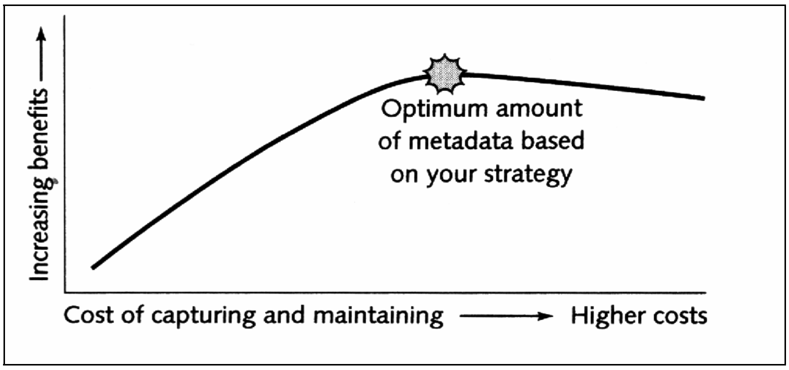

Figure 3-18: Cost vs. benefits of metadata (Barritt & Alderman, 2004, p. 188)

3.5.2.2 Summary

Experience from librarians and industry adopters of IEEE LOM reflect the first-hand knowledge of the challenges and labor involved for being LOM-compliant. Slaton and Abbate (2001) reckon that it is quite common that users reject technology standards because the adoption procedure requires re-defining existing relations or processes in organizations. Not all standards can foresee all users' preferences. Nonetheless, Duval and Hodgins (2004) argue

[23] http://www.eduworks.com/LOTT/Tutorial/prosandcons.html

that the current stagnant adoption of the learning objects metadata standard is due to people's literal use and misguided practices repeating the past wrong-doings in learning.

3.5.3 Specifications from Different Organizations

Again, there is one and only one recognized standard for learning objects, the IEEE Learning Objects Metadata Standards. The rest are either specifications or specific models. Specifications are at an early stage of developing standards before receiving recognition and approval from standard committees (e.g. IEEE). Farance (1999) points that the nature of the specification is experimental, incomplete and more rapidly evolving, hence it demands careful research before adoption.

Prominent bodies for learning technology specifications are represented by two industry committees in the aviation and military training field, AICC and ADL respectively. Additionally, the interoperability challenge of learning objects development has fostered the rise of two others, IMS and ARIADNE, consortia combining organizations from academia, industries and governments. Their background and activities are described below according to Sonwalkar (2002, p28-29), Fallon & Brown (2003, pp. 32-38), Olivier & Liber (2003, pp. 148-153), and Friesen (2005, p. 25):

- AICC – Aviation Industry Computer-based Training (CBT) Committee. AICC was founded in 1988 to provide interoperability standards for computer-managed instruction (CMI) systems, which are now more widely known as learning management systems or course management systems. AICC primarily caters to CMI systems developed for the aviation industry and related vendors, and provides AICC authorized guidelines and recommendations.

  AICC Specifications: CBT Guideline; CMI Guidelines for Interoperability between web-based courseware and learning management systems.

- ADL – Advanced Distributed Learning Initiative. ADL was formed by the White House Office of Science and Technology Policy in 1997 and received initial support from the U.S. Department of Defense (DoD). ADL has distinct operational responsibilities. ADL supports three Co-Labs focusing on developing the Sharable Content Objects Reference Model (SCORM). These labs are located in Alexandria, Virginia, in Orlando, Florida, and the Academic ADL Co-Lab at the University of Wisconsin-Madison, USA.

ADL Specifications: CAM Content Aggregation Model, RTE Run-Time Environment, SN Sequencing and Navigation; SCORM Sharable Content Object Reference Model. (ADL, 2006)

- IMS – IMS Global Learning Consortium. IMS was founded in 1997 and originally known as Instructional Management Systems (i.e. IMS). The consortium is active in providing open market-based standards relevant to learning technology, as well as specifications for content metadata. IMS collaborated with IEEE LTSC to propose metadata specifications to the IEEE P1484 committee. This work later became a draft for the Learning Objects Metadata Specification.

  IMS Specifications: Learning Objects Metadata Specification, Content Packaging Specification, Question and Test Interoperability Specification, Learner Profiles Specification, Simple Sequencing Specification, etc.

- ARIADNE Foundation – Alliance of Remote Instructional Authoring and Distribution Networks for Europe. Similar efforts like IMS's started at ARIADNE. Now, ARIADNE is working closely with IMS to produce learning objects metadata specifications.

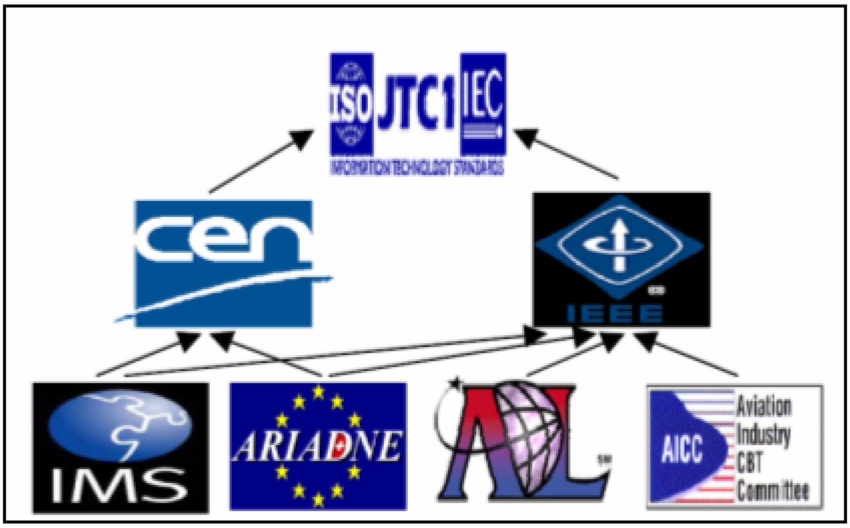

Figure 3-19: Process hierarchy for development of learning technology standards (Duval, 2004, p. 37)

Figure 3-19 depicts a hierarchical structure of the development process from a specification to a learning technology standard. IMS, ARIADNE, ADL, and AICC are on the same, the lowest level of developing, testing, and practice specifications. Then, they submit the specifications to the next level of standard committees, like the European Committee for Standardization ([CEN]) and/or IEEE. These submissions might be endorsed later by the

International Organization for Standardization ([ISO]), and/or the International Electrotechnical Commission ([IEC]).

Keep in mind that whether it is IMS or ADL, or AICC, their main concern is the overall learning technology interoperability. They are not specifically emphasizing the learning objects approach. Among all the organizations related with learning technology specifications, IMS and ADL are the most active ones producing specifications or models.

3.5.3.1 IMS Content Packaging

The IMS Global Learning Consortium, Inc. (IMS) aims at developing and promoting open specifications for facilitating online distributed learning activities, including learning objects applications or systems (IMS, 2007, section: About IMS). Friesen (2005) considers that IMS is a consortium formed by mostly English-speaking, American and British organizations, which has caused some concerns on multilingual and multicultural aspects which most specifications shall target.

IMS has currently been producing 17 different learning technology specifications, from metadata to content packaging to learning design, which are mainly web-based XML format specifications (IMS, 2007, section: Specifications). One specification that stands out is the IMS Content Packaging (IMS CP) specification pertaining to synchronizing processes of aggregating and disaggregating content objects among learning systems. Over the years, the IMS Content Packaging specification has gone through two stages: version 1.1x series, and the last major functional revision is the version 1.2, drafted in 2005 and planned for release in 2007 (IMS, 2007).

During the early years of setting up content interoperability, IMS Content Packaging version 1.1.x series has concentrated on packaging traditional instructional content, which is incorporated in SCORM® version 1.2 and SCORM® 2004.

In 2007, IMS is going to release the Content Packaging Specification version 1.2, the last major revision from IMS (2007, section: Content Packaging Specification). In version 1.2, besides continuing support of the classical approach to package instructional content, IMS provides a wider range of support and modifications of content interoperability among different learning or content management systems. In summary, the following are distinctive improvement of IMS CP version 1.2 (Ward, 2006):

- IMS CP version 1.2 allows reusing existing information structures.

- IMS CP version 1.2 supports not only exchanging physical files, but also the logical package.
- By relying on metadata description, IMS CP version 1.2 also caters to the growing demands on individualized information presentation, and different formats for rendering of the same content information.
- IMS Content Packaging specification relies heavily on metadata

The clarification of IMS Content Packaging specification was mainly introduced for the next referenced Sharable Content Object Reference Model, or SCORM, a highly visible model in the learning objects community of practice.

3.5.3.2 The Sharable Content Object Reference Model – SCORM

A reference model is a collection of profiles of specifications and standards that together enable the construction of applications (Reusable Learning, 2004). Apparently, apart from the IEEE LOM standard, the Sharable Content Object Reference Model, SCORM from ADL, is the most discussed *reference model* in the learning objects community (Duval, 2004). Because ADL is backed by the U.S. Department of Defense (DoD), SCORM's key objective is set on military training (ADL, 2007, section: About ADL). Olivier and Koper (2003, p. 149) name SCORM as the de jure standard in the military setting of the US DoD. Nevertheless, ADL influences strongly the interoperability development of learning objects and learning management systems, not the least due to its impressive budget and unmatchable purchasing power (Finke, 2004). However, ADL does collaborate with others (e.g. IMS) in setting up specifications.

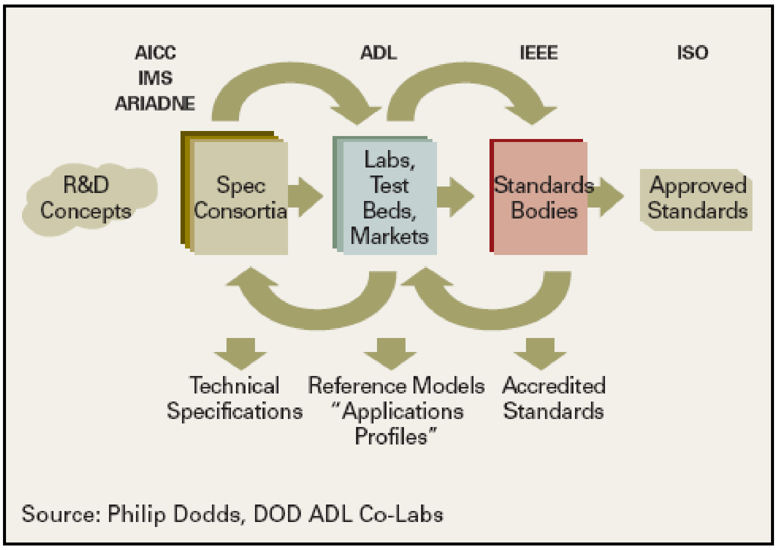

Figure 3-20: Collaborative development model for formal learning standards (as cited in Sonwalkar, 2002, p. 29)

Besides ADL's three Co-Labs, Figure 3-20 shows a more detailed structure between ADL and the rest of specification consortia. ADL is supposed to be the testing bed for AICC, IMS, and ARIADNE's concepts and specifications (as cited in Sonwalkar, 2002). With this in mind, SCORM inherits the CBI and CMI practiced by AICC, which are based on a single-learner, self-paced and self-directed learning model (Friesen, 2003). What originally was called *lessons* in the AICC specification, is called *sharable content objects* (SCOs) in SCORM.

There are four stages in the development of SCORM (ADL, 2007, section: SCORM Downloads/Products):

1. January 2000: SCORM® v1.0 was born as a simple version of the sharable content object approach.
2. January 2001: SCORM® v1.1 became the first production version, an XML format based on AICC specifications to describe content structure. Because of inadequate support for metadata as well as a missing robust packaging manifest version 1.1 is quickly cast off in favor of SCORM 1.2.
3. October 2001: SCORM® v1.2 gave the ability to package instructional material by using IMS Content Packaging specifications, and metadata for import and export was added. It also allowed optional detailed metadata tagging of content objects and assets described in the manifest. SCORM 1.2 lacks sequencing and some other desirable features. It is no longer maintained or supported by ADL.
4. January 2004: After three years of practicing and working together with other specification groups, such as IMS and AICC, SCORM® 2004, formally named as SCORM 1.3, becomes the latest version. It is based on the new IEEE Application Program Interface (API) for Content to Runtime Services Communication. The latest version of SCORM resolves several ambiguities of previous versions and includes the ability to specify adaptive sequencing of activities that use the content objects. Additionally, it includes the ability to share and use information about the success status for multiple learning objectives or competencies across content objects and across courses for the same learner within the same learning management system.

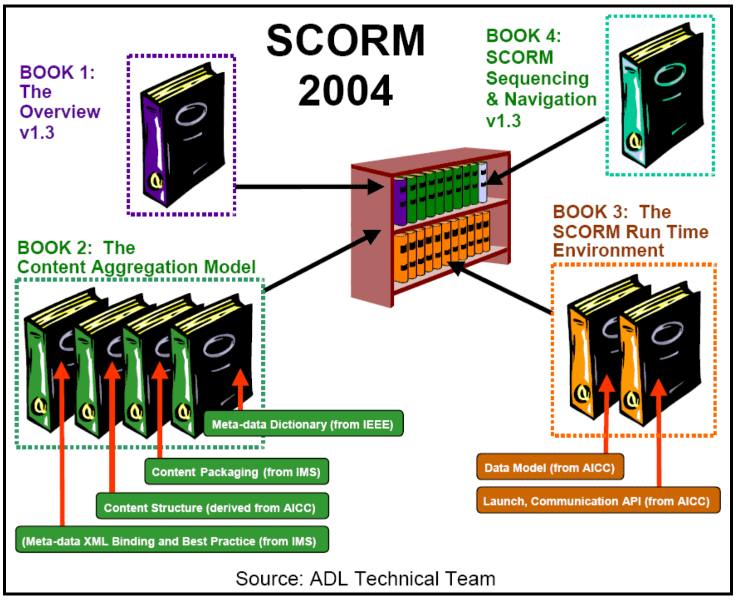

Figure 3-21: Four elements of SCORM
(as cited in Ellis, 2005c, section: A closer look at SCORM)

A complete SCORM is a collection of standards and specifications by synthesizing works done by AICC, IMS, and IEEE (ADL, 2004). One of ADL's contributions is to synchronize the language used for standards and specifications by a variety of learning technology organizations. As shown in Figure 3-21, Ellis (2005c) depicts clearly the four different sections (i.e. "Book 1" through "Book 4") of SCORM.

The first section of SCORM is an overview providing introduction of key concepts of SCORM, history, current and future status of ADL.

The second part presents a content aggregation model defining interoperability between systems that perform import, export, aggregate, and disaggregate content. This model consists of the following standard and specifications:

1. IEEE 1484.12.1-2002 Learning Object Metadata (IEEE LOM) as submitted by IMS.
2. A computer managed instruction (CMI) database schema from AICC.
3. Content packaging guidelines and XML binding and best practices from IMS Content.
4. Packaging version 1.1.3 and IMS Content Packaging XML Binding Version 1.1.3.

The third section of SCORM concerns the sequencing and navigation rules of learning objects, which is derived from the IMS Simple Sequencing Information and Behavior Model Version 1.0. The model formulates "how a SCORM conformant LMS interprets the sequencing rules expressed by a content developer along with the set of learner-initiated or system-initiated navigation events and their effects on the run-time environment" (ADL Technical Team, 2006, section: Sequencing and Navigation [SN], Version 1.0).

The fourth and last part, added in the ADL news release in 2004, focuses on the run-time environment. Run-time environment in SCORM refers to the interactions and activities hosted by underlying learning management systems (LMS). SCORM standardizes the communication between content and LMSs, as well as the data elements connecting the learner's experience with pre-defined launching processes of the content (Ellis, 2005c). This model derives from the IEEE Application Program Interface (API) 1484.11.2-2003, and IEEE 1484.11.1 Data Model for Content Object Communication (ADL, 2004).

To sum up, ADL SCORM presents models rooted in the classical computer-based training and learning scenario, essentially about a single-learner studying pre-packaged materials in a single virtual learning environment. In one word, SCORM is based on cognitive instructional design theory.

Again, ALD SCORM or any specification from IMS is all dominated by English-speaking industrialized countries, essentially North-America and U.K., including some European countries as well. When wide-area and cross-boarder interoperability is the vision, the current organizational scope has to be re-considered by recruiting a much more diverse membership from a variety of geographic, political and cultural regions.

More important, by its name, SCORM remains as a "reference" model focusing on content exchanges and transfers. Against the background of this thesis, SCORM is not applicable to learning scenarios fostering collaborative, just-in-time learning, in shared virtual workplace environments among more than one participant. This marks a shift from simply transferring pre-packaged content via pre-defined instructional settings to more emphasis on the learner's active role in his specific knowledge gathering environment (Koper, 2003). The other shortcoming of SCORM is that it is a solely web-based specification, which leaves many emerging media and system approaches suitable for learning in the dark, e.g. intranet, off-line, or mobile. In addition, many have also criticized the "pedagogical-neutral" approach of SCORM. Welsch (2002), Olivier & Liber (2003), Parrish (2004), and Liber (2005) doubt the effectiveness of SCORM's pedagogically neutral approach plainly because "specifications and applications that are truly pedagogically neutral cannot also be pedagogically relevant" (Friesen, 2003, section: Objection 2: Where is the Learning in E-Learning Standards, para. 9).

Last, but not least, Noble (1991), Friesen (2003) and Finke (2004) also question the relevance of ADL SCORM in other learning settings because SCORM is mainly targeted at the military and the settings of the military battle field. Likewise, as referenced in chapter 3.4.3., Collis & Strijker (2001, 2003 & 2004) and Strijker & Collis (2006) explicitly stress that different contextual settings entail a different approach to the design and development of sharable learning resources. Therefore, SCORM may not be the best choice for interoperability issues outside the battle-field.

3.5.4 Sharing and Intellectual Property Rights Management

In addition, the interoperability issue will be in jeopardy for interoperability across organizations, countries, and disciplines as long as the issues of intellectual property rights (IPR) and technical management of digital rights remain unsolved.

Intellectual property rights are the more thorny issues than the sheer technical aspects. The engineers working on improving Internet technology "will undoubtedly find themselves caught up in social, political and economic arguments. That is because while the Internet's existing architecture fosters innovation and promotes free speech", the Economist magazine reasons, "it also allows spam and illegal music downloads to flourish" (The Economist, March 11, 2006).

In the traditional academic environment, when engineering towards a wide-area content interoperating and sharing practice, many have doubts on its social and economical applicability. As Collis & Strijker (2003 & 2004) note the educational professions are often rewarded socially and economically by the uniqueness of their content. As long as there is a vacuum in protecting IPR, it only provides another reason to resist sharing or exchanging information and ideas online among traditional educational communities. Meanwhile, IPR issues can be simpler within the corporate setting because no one except the corporate institution has claims on corporate content or products.

Duncan and Ekmekcioglu (2003) turn to technical metadata to deal with the IPR issue of learning objects. They argue that learning objects should have at least the following information in their metadata description:

- A declaration of copyright ownership: who owns copyright, with contact information.
- A statement of condition of use. For example: free for educational purposes.
- Conditions of use including scope, time, geographical information, etc. Examples: geographically, sharing within the authors' country, or worldwide; can only be shared within a specific community of practice; only a portion of content can be repurposed. (Duncan & Ekmekcioglu, 2003, pp. 138-139)

Campbell (2003) points out that IEEE LOM addresses the IPR issues by asserting the *role* element (e.g. as author, editor, or publisher of the LOs), while the *relation* category can be used to define the relationship of one learning object to another. The Dublin Core Metadata Element Set has a set of specified values to described relations among learning objects: *is version of, is based on, is base for*, which is utilized by IEEE LOM (as cited in Campbell, p. 43). Metadata description of author, publisher, editor, contributor, and condition of usage is the first step to establish IPR in the LOs development. On the other hand, Campbell criticizes that IEEE LOM is lacking specifications for rights management. This makes it difficult to judge the LOs' adaptability, intended communities, or the acquisition process.

All rules can be written down on paper or via metadata virtually, albeit it won't prevent illegal learning resource downloads from the Internet, like in the music, movie, and software industries. Therefore, many have given up the total ownership of educational content. One reason of this trend is because technology, specifically Web 2.0, has fostered many institutions and individuals seeing the value of open content and further collaboration by sharing. For instance, the Massachusetts Institute of Technology's MIT OpenCourseWare, and the Multimedia Educational Resource for Learning and Online Teaching (MERLOT) are two leading projects towards open and free access to learning content and resources. Both projects will be reviewed in detail in thesis chapter 3.6.

In the enterprise learning environment, as mentioned before by Collis & Strijker (2004), there are two types of learning object, one of general information that may be outsourced to vendors who produce standard learning modules, and the other proprietary information which is owned by the company and shared among employees. Intellectual property rights issues in the corporate setting are more related to establishing a secured technology system rather than the question of personal ownership.

Technical standards and specifications cannot solve the sharing and interoperability alone. IPR is another pressing problem for wide-area sharing of learning content and resources across organizations, users, or across countries, albeit different industry sectors have rather different social, political, and economic concerns around this issue.

3.5.5 Summary

IEEE LOM, IMS specifications, and SCORM repeat the classical instructional design models, focusing on cognitive knowledge transmission with pre-defined learning content and processes. When regarding learning as a commodity that can be sold and purchased, there is no doubt in an urgent need to standardize production and delivery processes. After all, it is the content and learning technology vendors who gain the most from such content standardization. As in other trades, e.g. automobile, telecommunications, or utilities, all profit from standardized production and delivery conventions for the masses. In a networked knowledge-intensive society, learning and knowledge management is a dynamic, highly individual process requiring information and skills. With this in mind, the existing standards, specifications or models must relax their grip on defining too many rules or trying to pre-package everything in learning. Let the thousand flowers bloom.

3.6 State-of-the-Art of Learning Object Repositories

Because there is no precise definition of learning objects, the concept and structure of a collection of learning objects, the digital learning objects repository, is also mixed with different interpretations. As this irresolution is an inherited issue, the technical architecture, functionalities and features of a learning objects repository is in rhetoric debate with diverse structures as well (Friessen, 2001; Neven & Duval, 2002; Long, 2004). At least, the label, "learning objects repository" is a de facto name for such a virtual space to collect, retrieve, and create learning objects (Richards, McGreal & Friesen, 2003). However, when having the focus on interpreting learning objects as learning resources, Agre (2003) and Recker et al. (2005) prefer the label digital library as opposed to learning objects repository. Again, the name is not more important than its manifesto in applications.

Currently, there are two mostly quoted definitions of learning objects, IEEE LOM (2002) and David Wiley's (2000a & 2000b). Within the scope of both, any collections of digital resources that may be used to support learning qualifies as learning objects repositories. The types range from digital content repositories, learning content management systems to knowledge management systems. A simple search on Google easily produces over fifty publicly accessible learning objects/resource repositories. To name just two: the United Nations Educational, Scientific and Cultural Organization (UNESCO, 2006, section: Open Educational Resources) and the Center for International Education at the University of Wisconsin, Milwaukee (CIE, 2007, section: Learning Object Collections). These repositories are classified into two common categories: general or discipline-/subject-specific repositories. The UNESCO project also further divides subject-specific repositories by geographical coverage, i.e. regional, international, and international repositories.

The rest of this chapter will present four learning objects repositories as references and examples for state-of-the-art development approaches in the learning objects arena:

1. The Multimedia Educational Resources for Learning and Online Teaching (MERLOT[24]) as a bottom-up, general digital repository);
2. iLumina[25] as a government supported, subject-specific national repository;
3. MIT OpenCourseWare (MIT OCW[26]) as the first institutional-specific and openly accessible repository for instructional materials;
4. Apple Learning Interchange (ALI[27]) as an industry-supported application for learning resources.

All repositories are reviewed based on their May 2007 status from an end-user's point of view, while accessing the respective LOs repositories via a web-browser. The first three repositories are belonging to nonprofit organizations, and the forth one is sponsored by a for-profit business entity. Accessing them via web-browser gives an overall impression of the status of openly accessible repositories. With limited resources and IPR challenges, it is difficult to study learning objects repositories in corporate intranet environments.

3.6.1 MERLOT Learning Resource Repository

MERLOT, standing for Multimedia Educational Resources for Learning and Online Teaching, is a well-known repository in the literature with respect to learning objects repositories (Metros & Bennett, 2002; Neven & Duvan, 2002; Mohan & Greer, 2003; Cochrane, 2004; Abernethy, Treu, Piegari & Reichgelt, 2005; Ruiz, Mintzer & Leipzig, 2006). MERLOT is an initiative pioneering the idea of community sharing and rating digital learning resources for higher education. It provides free and open access to learning materials via web-browser. Founded in early 1997 by the California State University Center for Distributed Learning, MERLOT (MERLOT, 2007, section: History of MERLOT) has grown from a single university system to a multi-system and multi-disciplined consortium. Today, MERLOT is financially supported by twenty-three systems and institutional partners of higher education in the United States.

In web browsing mode, MERLOT's learning materials are organized according to the taxonomy for disciplines in higher education based on American standards. First, they are divided into seven general educational categories: arts, business, education, humanities, mathematics and statistics, science and technology, and social sciences. Then, each discipline

[24] MERLOT website: http://www.merlot.org/merlot/index.htm
[25] iLumina website: http://www.ilumina-dlib.org/
[26] MIT OCW website: http://ocw.mit.edu/index.html
[27] ALI website: http://edcommunity.apple.com/ali/

is further classified into specific subjects. As shown in Figure 3-22, the topic "security" is classified under "information technology", which in turn is classified under the discipline of "science and technology".

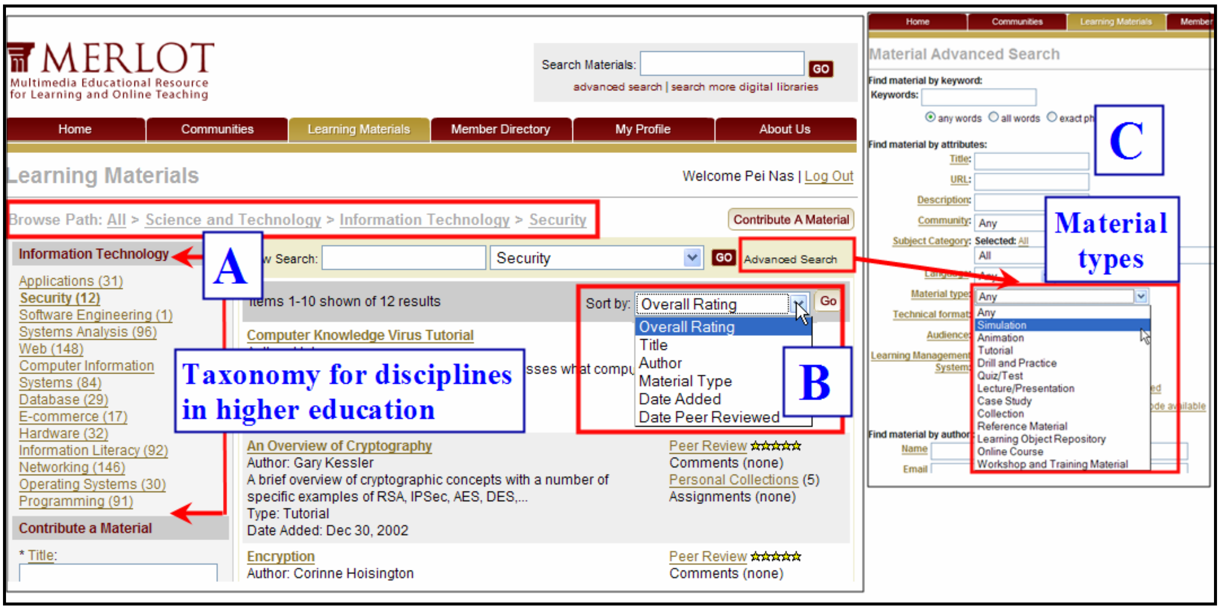

Figure 3-22: Example of different classification methods of MERLOT materials (MERLOT, Retrieved May 5, 2007)

The default sorting is by "overall rating", from the highest rated learning resources to the least rated ones, the rating carried out by a panel of experts from the MERLOT Editorial Boards. This is a cornerstone making MERLOT stand out from other learning material repositories. Each teaching and learning community (e.g. biology, faculty development, chemistry, etc.) has one editorial board comprised of elected editors, associate editors, and peer reviewers. This is a strategy taken by MERLOT to encourage quality contribution of learning materials. A user may also choose to sort material by title, author, type, entry date, or the date reviewed by peers as show in space B.

Another specialty in MERLOT is its own classification of material types. In Figure 3-22, space C, there are 12 different learning material types: simulation, animation, case study, drill and practice, lecture/presentations, tutorial, collection, quiz/test, reference material, learning object repository, online course, and workshop and training material. It is a loosely defined classification that is specific to MERLOT, which is based on how instructors group their teaching/training materials. From a learner's point of view, he/she may be confused by the scope of coverage among different material types, for example by differentiating between a collection and a learning objects repository, or between a lecture/presentation and workshop and training material, etc.

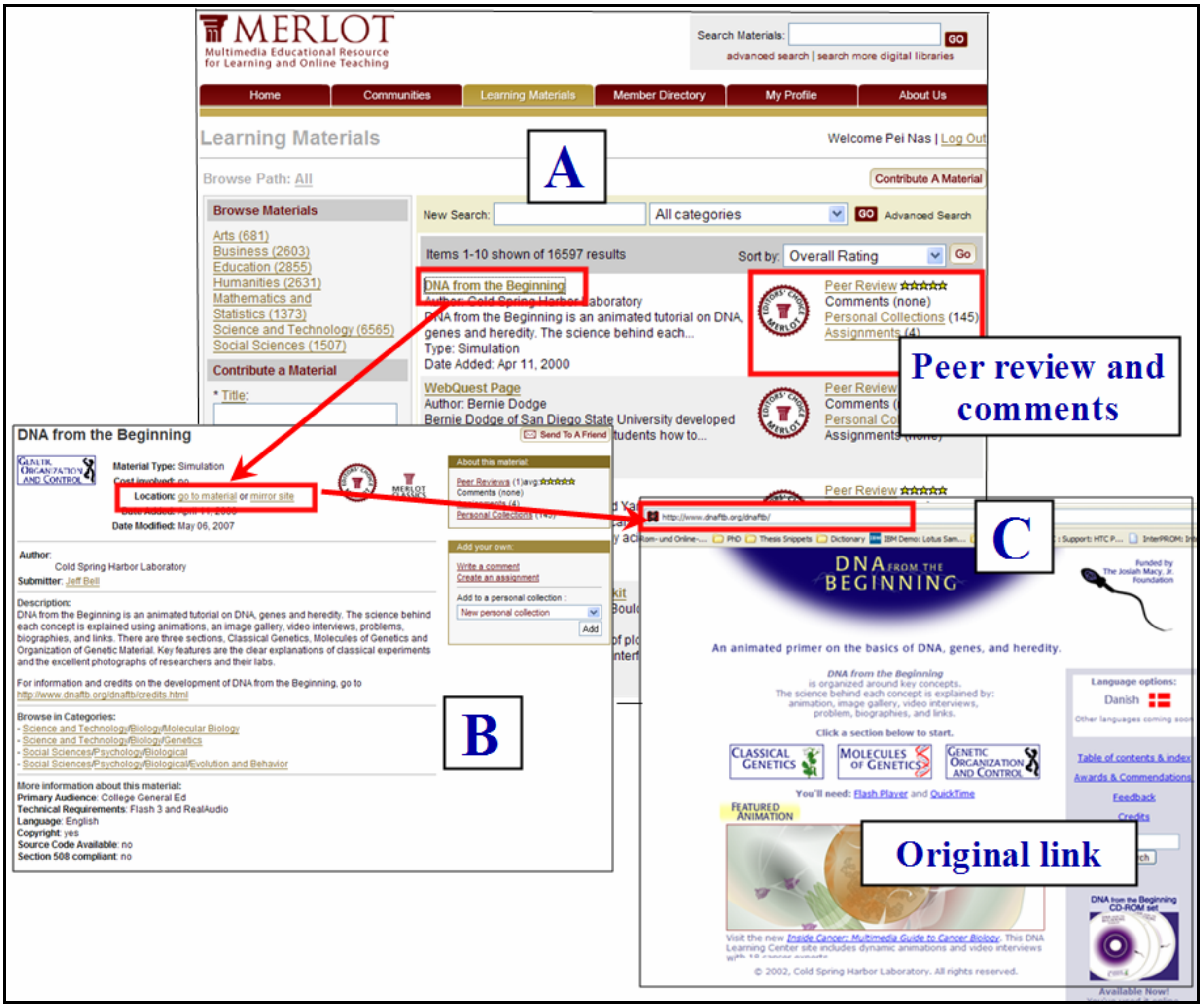

Figure 3-23: Web interface of MERLOT learning material repository (MERLOT, Retrieved May 5, 2007, section: Science and technology)

MERLOT's learning material repository primarily consists of hyper links to the sources, i.e. original websites. As of May, 2007, there are 16,597 links with static metadata description (MERLOT, 2007). MERLOT does not physically store any original data or information or media objects, rather metadata about the content, like description of the resources, reviews, and comment of the users, as depicted in space B of Figure 3-23. To access the original material, a user will have to get out of the web interface of the "MERLOT learning materials" collection in space A to the original website that contains the material. This is shown in the example of "Learning Materials/Science and Technology / DNA from the Beginning" in space C of Figure 3-23. On one side, this kind of architecture is saving the cost of maintaining the learning resources, but on the other, it has a high dependency on the stability and functionality of 16,597 or more links and servers that host the original materials.

Additionally, there is no place to structure relations among MERLOT's material objects. It offers different sorting and categorization for browsing purpose, but all learning material objects are independent from one another. This may originate from MERLOTs basic architecture model of not physically storing any data, information, or content, except hyper links. From this point of view, MERLOT functions as a digital library and reference system rather than as a learning content management system.

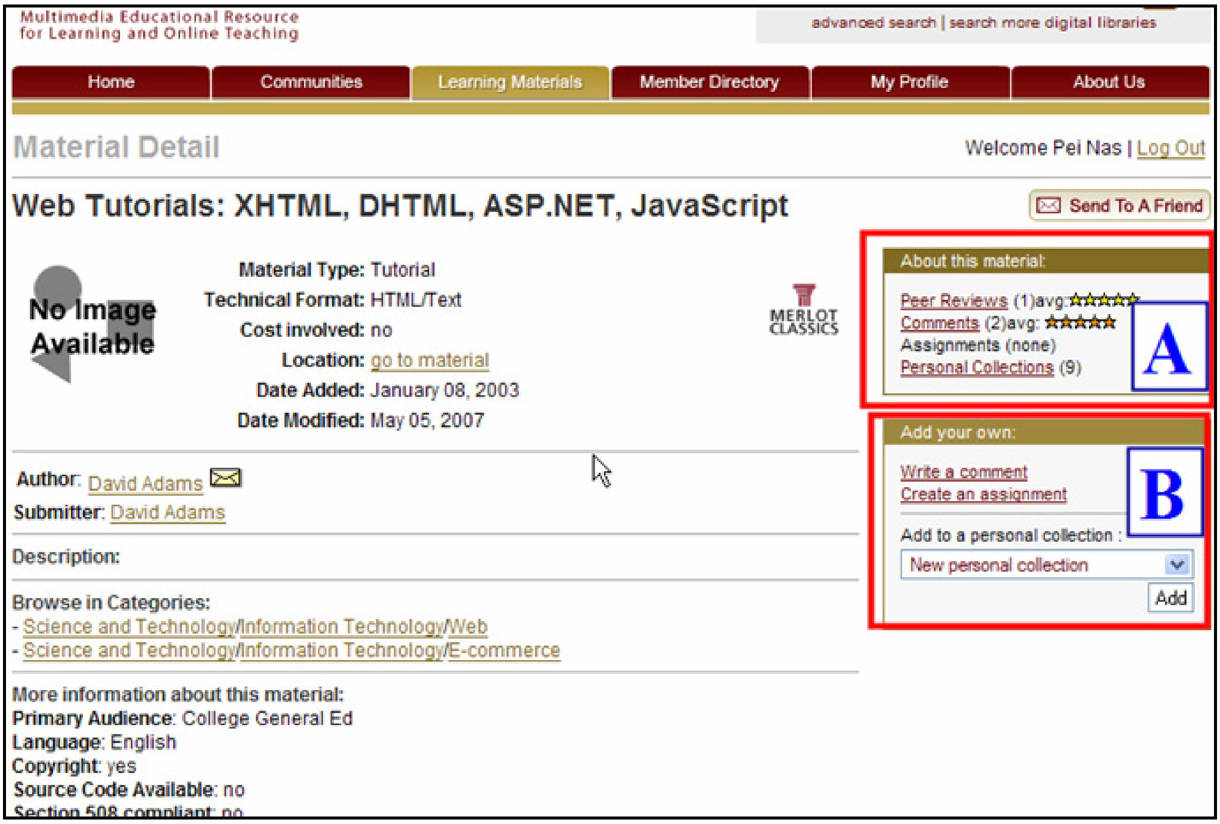

Figure 3-24: MERLOT context information place (MERLOT, Retrieved May 5, 2007)

As mentioned above, MERLOT's uniqueness comes from its context information (though to a limited amount of possible context parameters) attached to the learning materials. Specifically, it has embedded peer reviews, and three personalization features. Space A in Figure 3-24 shows a particular view about how many reviews have been done on "Web Tutorial: XHTML…" material, how many users have commented it, and how many users have put it into their own collection of learning materials. In space B, the individual web user may add a comment, create an assignment on this material object, or add it to his/her personal collection with MERLOT. Like many commercial e-business sites with customer rating and feedbacks, MERLOT also opens a space for contributing context information based on users/viewers' experiences (e.g. comments, related assignments) and expert opinions (e.g. peer review). This feature has been marveled at by many academic researchers (Metros & Bennett, 2002; Mohan & Greer, 2003; Ruiz, et al., 2006). However, in MERLOT, only elected experts, not everyone, can contribute with reviews on the learning material (but not all of the material reviewed). The rating is based on a scale from five to zero "stars" according to content quality, potential effectiveness as a teaching tool, and the ease of use for students and faculty.

According to Neven and Duval's survey five years ago (Neven & Duval, 2002), MERLOT has employed metadata from IEEE LOM's profile with a client-server approach for distributing learning materials via web-browsers. However, as evident by the categorization of material types, MERLOT applies metadata descriptions and vocabularies understood by average users, not the ones intended by IEEE LOM (2002) or SCORM (ADL, 2004). Without following the categorization of raw data, lessons, module, etc., underlying IEEE LOM or SCORM, MERLOT does not granularize learning materials by size or objectives. Last but not least, MERLOT content contributors may add learning material via a browser-based interface in 5 steps (shown in the blue box in Figure 3-25). There is no place to fill or structure aggregation levels of the object or to relate with other material objects. From a technology point of view, without physically storing materials and functions on managing existing materials, MERLOT is basically a repository for collecting hyper links and managing some metadata about the linked content.

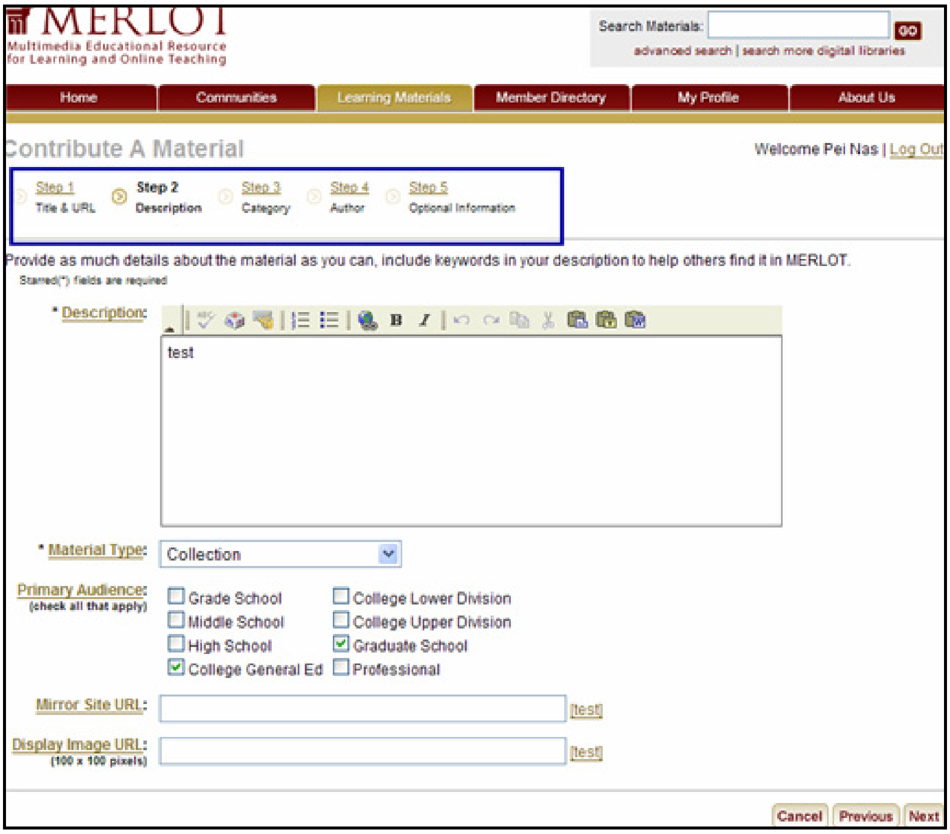

Figure 3-25: User-interface for material contribution in MERLOT (MERLOT, Retrieved May 5, 2007)

To sum up, MERLOT is a hyper-link collection for digital learning resources including some relevance tagging, mainly for higher educational users. It encourages free exchange of instructional materials in the academic communities. As an educational resource repository, MERLOT stands out via its ability to provide a certain level of context information about the learning resources, specifically, the quality of the learning material as perceived by users. However, for the user, MERLOT does not assure a 24/7 accessibility of the learning resources because it depends on external servers to provide all the materials it links to.

3.6.2 iLumina Digital Library

The second representative is the iLumina digital library that has been mentioned in chapter 3.5.2 of this thesis already. iLumina is a digital library for collecting resources of science and mathematics in higher education. It has a straightforward design of user interfaces for browsing, contributing, and searching learning materials. In the browsing environment, iLumina employs a three-level hierarchical taxonomy path: discipline, subject, and topic. As denoted in Figure 3-26, the result list is generated by selecting the discipline of “Computer Science”, then, the subject “Information Management”, and the topic “Digital Libraries”.

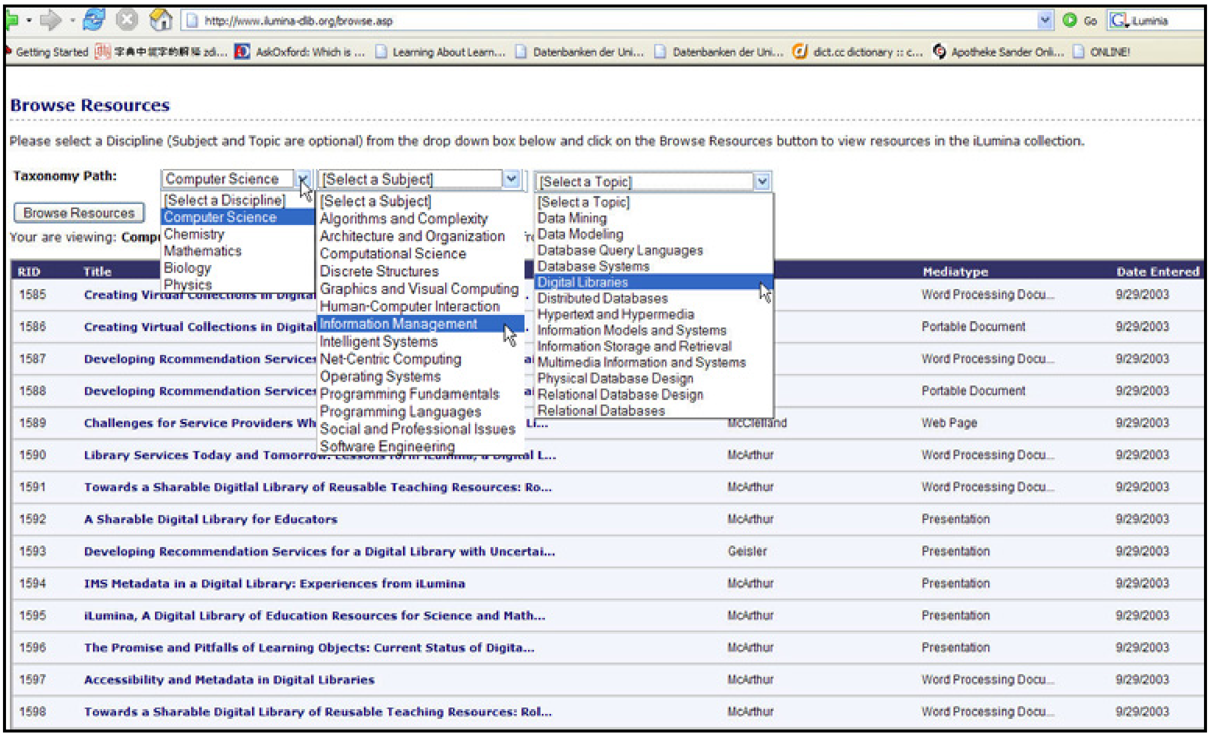

Figure 3-26: iLumina browsing interface (iLumina, Retrieved May 5, 2007)

As there is no registration or login required to perform either browsing or contributing materials, iLumina is an even more open learning material repository as MERLOT.

In the contributing material mode, users may submit learning materials by filling in six required metadata fields, as shown in Figure 3-27. These fields are rather lengthy, spreading over six sections. After some experimenting with the IEEE LOM metadata application

(Heath, McArthur, McClelland & Vetter, 2005), the current version of iLumina catalogs learning resources in two metadata formats. First, the Machine-Readable Cataloging (MARC[28]) metadata format that emerged from the U.S. Library of Congress-led initiative that began thirty years ago. The second metadata format utilized in iLumina is called the American National Science Digital Library (NSDL) metadata formats, which is a combination of the Dublin Core Metadata Element Set, plus, three IEEE LOM educational extensions that are recommended by the Dublin Core Education Working Group (Dushay, 2006). As the iLumina project team appears to be not convinced of the value of the three educational metadata elements, it applies only one, "educational. Interactivity level" element to its digital library. (Heath, McArthur, McClelland & Vetter, 2005, p. 73).

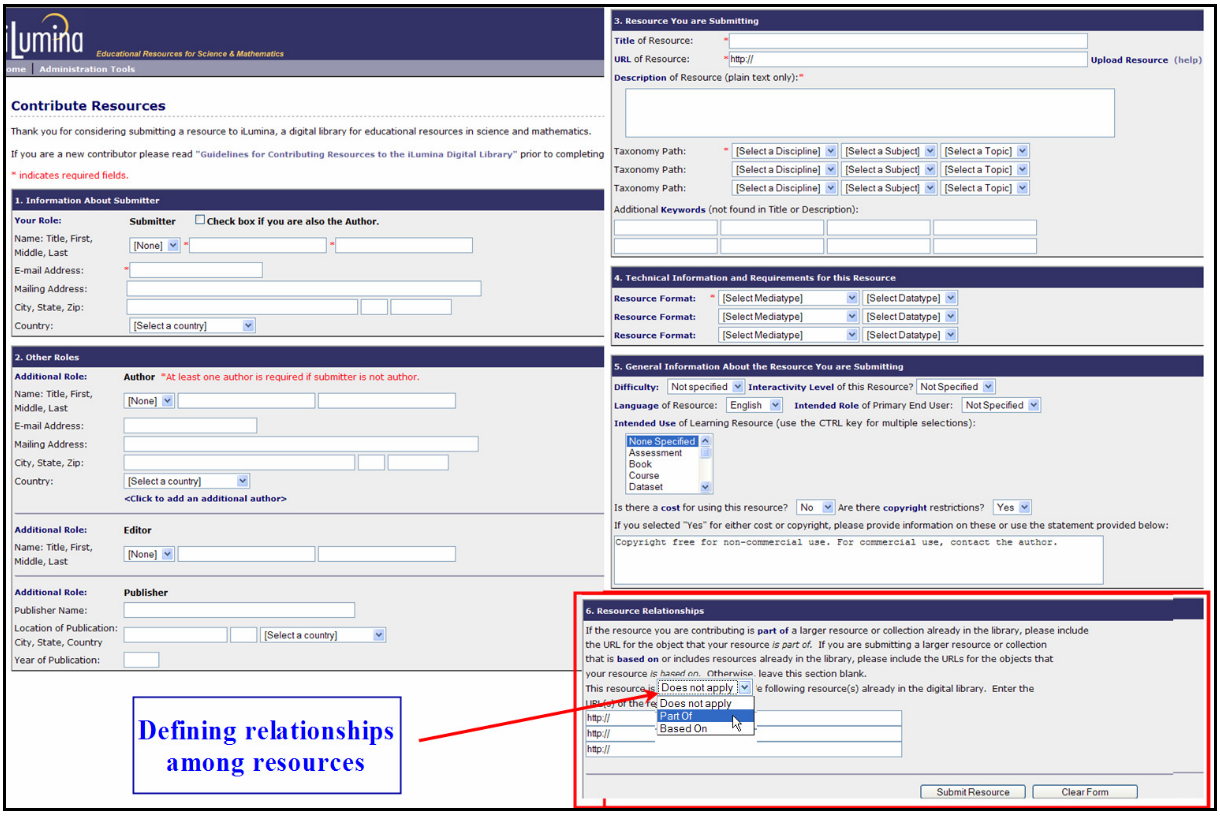

Figure 3-27: iLumina contributing forms (Retrieved May 5, 2007)

A unique feature of iLumina is that the learning resource contributor can define relationships among the new one and already existing ones, i.e. this resource "is part of" or "is based on" existing resource(s) in the library.

[28] See more information about MARC at: http://www.loc.gov/marc/

3.6.3 MIT OpenCourseWare

The Massachusetts Institute of technology OpenCourseWare (MIT OCW) initiative is the first world-class university openly and freely offering their instructional material online. MIT OCW (2007) has “1,550 courses published as of November 1, 2006” (section: About OCW). The course materials come from 34 departments and five schools at MIT, such as the highly regarded Sloan School of Management. Encouraged by educators, students, and self-learners around the world, the initiative commits to publish all MIT course material by the year 2008 (section: Our story).

Learning objects in the context of MIT OCW are digital course material and related resources. As a viewer, the general taxonomy path is by disciplines taught at MIT, degree levels (i.e. undergraduate, graduate, and a combination of the two), and the course titles. Aggregation of learning objects in MIT OCW is specified based on course, section, and resources level (MIT OCW, 2007, section: Technology).

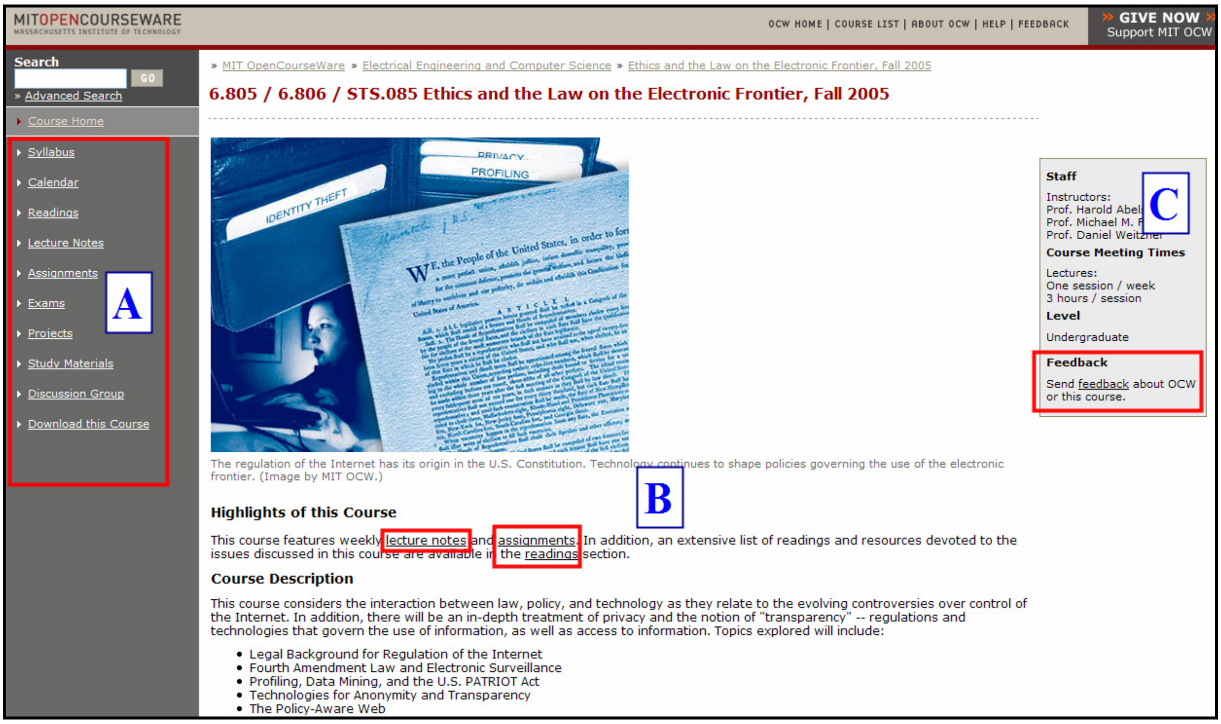

Figure 3-28: MIT OCW Course Home (MIT OCW, Retrieved May 27, 2007).

As pictured in space A of Figure 3-28, each course has a clear context information based on classical instructional design, i.e. syllabus of the course, course calendars, lecture notes, problem sets, assignment, assessments, etc. Its discussion section is outsourced to the Utah State University's Open Learning Support, a web-browser-based discussion tool. Space B gives an overview of the course that aggregates “lecture notes, assignments and readings”. In space C metadata information is presented, of the course instructors, meeting times/duration, and degree level. In addition, the viewer may give feedback on the courses.

Technically, MIT OCW employs current de facto standards for file storage. Most text files in MIT OCW are in pdf-format (Adobe), video files in rm-format (RealOne™ Player software), and audio files use mp3-format (for audio files played with QuickTime® Player, RealOne™ Player, or Microsoft Windows Media® Player).

The "Advanced Search" interface enables the end-user to elaborately narrow down their search criteria. The other repositories all utilize a drop-down menu that points to only one type of materials or selection option. Figure 3-29 exemplifies that users can search the topic of "information technology" "with the exact phrase" of "data mining", plus these courses must have "Syllabus", "Calendar" and "Readings" sections.

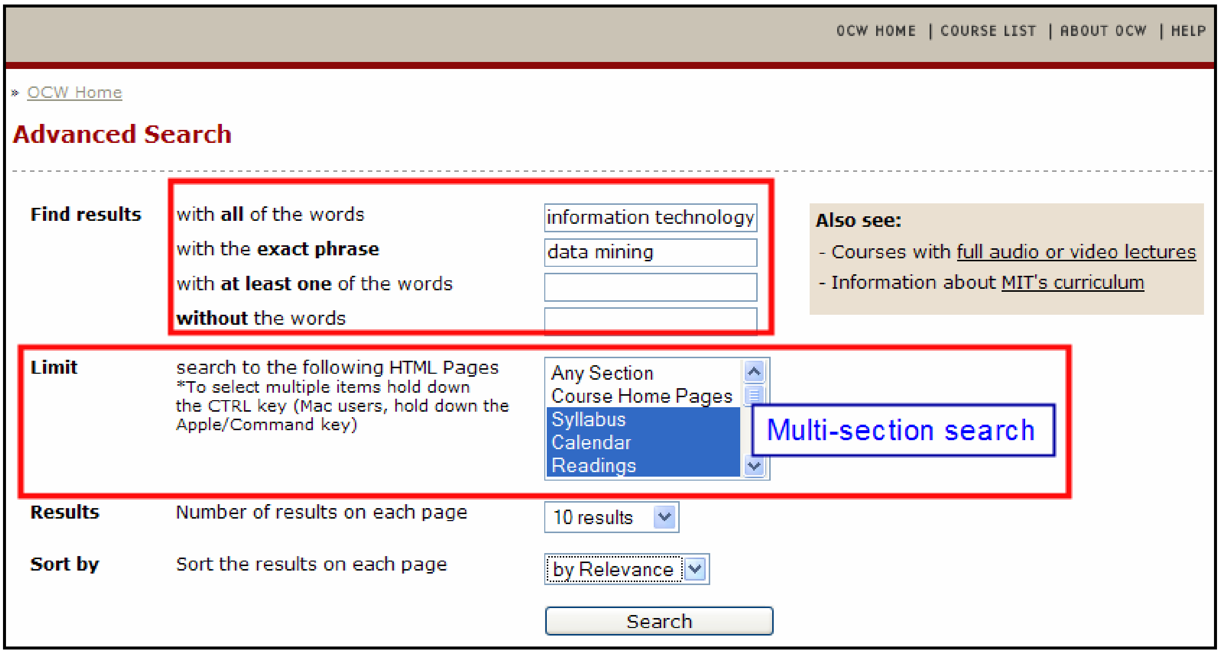

Figure 3-29: MIT OCW advanced search interface (MIT OCW, Retrieved May 27, 2006).

Following the Figure 3-29 searching criteria, MIT OCW has presented eleven search results as shown in Figure 3-30.

The result list distinguishes between different metadata offerings about the courses, e.g. "Calendar", "Readings" and "Syllabus". Figure 3-31 shows for the three different courses selected in Figure 3-30 the outcome. The "Calendar" metadata present a list of course sub-topics in a time-sequencing format according to session 1, 2, 3, etc. Accordingly "Readings" gives a bibliographical list of additional material to be studied, and "Syllabus" offers a structured summary about the course, including goals, information about the instructor, textbooks used, etc.

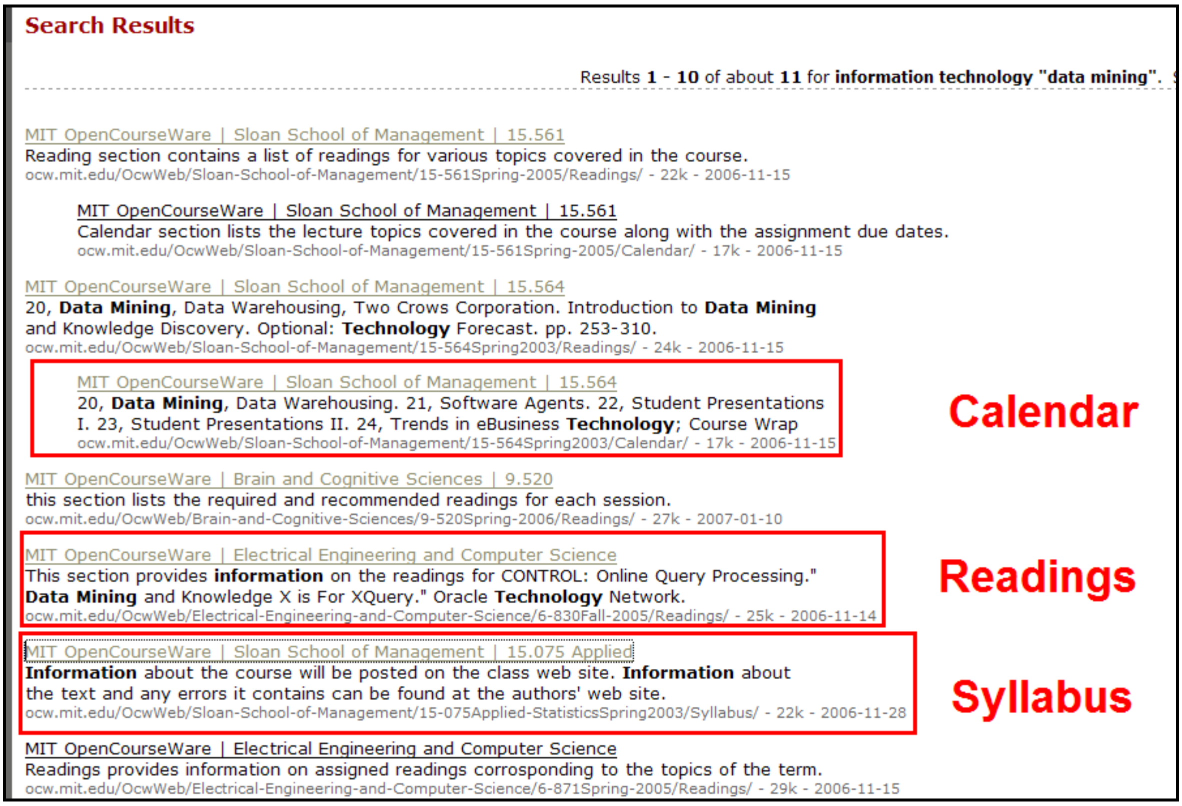

Figure 3-30: MIT OCW Search example "data mining" (MIT OCW, Retrieved May 27, 2007)

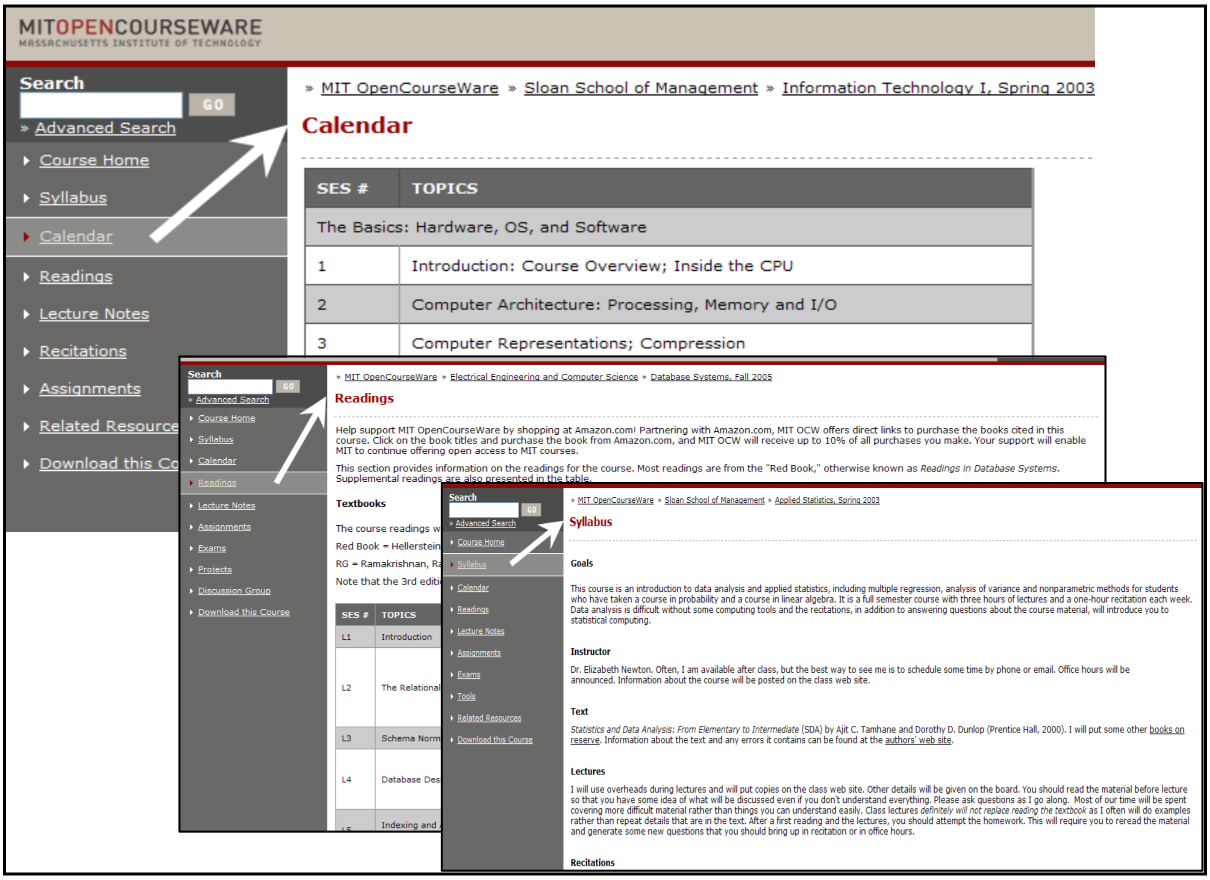

Figure 3-31: MIT OCW Search example: 3 course renderings for "data mining"
(MIT OCW, Retrieved May 27, 2007)

All course materials of MIT OCW are contributed solely by MIT faculty members, while non-MIT external users may view, download, and give feedback on the content. Another strategy taken by the MIT OCW initiative is that the OCW project team takes the responsibility to re-format course materials for faculty members, avoiding individual frustrations with technical and course design issues.

> “The OCW staff handled the reformatting and thorny copyright issues; all I had to do was essentially walk them through the material and hand over files for the syllabus and slides. Some time later the site was up. A colleague at Wharton noted ‘nice course site, particularly considering that you didn’t need to do it yourself." - MIT Sloan School Professor Steven Eppinger (as cited in MIT OCW, 2007, section: Our Story)

Experience from MIT OCW shows that supporting a high quality institutional content management system demands ample resources. The department running MIT OCW has nineteen employees as the core team. Financial support is provided from two foundations: the William and Flora Hewlett Foundation and the Andrew W. Mellon Foundation (MIT OCW website[29], section: About OCW), plus, generous donations from MIT alumni, such as, a $1 million donation from Jon Gruber (MIT OCW, 2007, section: Donating to MIT OCW). Although many may envy the manpower and financial resources owned by MIT OCW, it still grumbles about the high cost of producing media rich content like video course material: “The main concern is cost: While the technology for compressing and storing video is becoming more affordable, it is still not affordable, or feasible from a production standpoint…MIT OCW does not have that kind of storage capacity at this time.” (MIT OCW[30], 2005, Newsletter – 2. Section: MIT OCW's Approach to Video and Audio).

In one word, MIT OCW is an institution-specific digital course content repository. It targets primarily educators in higher education who may benefit from MIT course materials for a pedagogical jump-start. MIT OCW does not support individual learning processes or learners. Thus, it is not a content management system for online learning.

3.6.4 Apple Learning Interchange

Apple learning interchange (ALI) is a rich multimedia educational resource repository, mainly consisting of video and audio objects (ALI, 2007, section: About ALI). Because it is sponsored by Apple Inc., the default media player is naturally Apple’s QuickTime Player. In

[29] More about MIT OpenCourseWare at: http://ocw.mit.edu/OcwWeb/Global/AboutOCW/about-ocw.htm
[30] More about MIT OCW's approach to video and audio at: http://ocw.mit.edu/OcwWeb/Global/AboutOCW/newsletterjan05.htm#2

Apple learning interchange, most resources come formatted as media files. The main target audience of ALI is educators from primary to higher education. Following Apple Inc.'s trademark with respect to product innovation, ALI has also implemented innovative ideas and design features for sharing learning materials.

Figure 3-32: "Apple Learning Interchange" taxonomy (ALI, Retrieved May 27, 2007)

Normally, learning materials are generally classified by subject/disciplines as practiced by the previous three repositories, i.e. MERLOT, iLumnia, and MIT OCW. For collecting media rich resources, ALI has developed a specific taxonomy based on two dimensions: the media types rendering the material and "how directly the information delivered relates to educational practice" (ADL Co-Lab, 2003, p. 1). As shown in Figure 3-32, the box on the right hand side includes two general categories for media resources: "By Media" (types) and "By Collections" (an Apple specific vocabulary). Further, there are more drill-down classifications in each category, but they are not necessarily consistent. For example, there are more detailed classes under K-12 Education, while only two sub-categories under Higher Education. All the selection options for K-12 ("Teaching Ideas", "Leadership and Professional Development", "Learning Events", "Rethink, Global Awareness", and "Podcasts"), as well as for Higher Education ("Teaching, Learning & Research" and "Creative") are named after their prospective contextual application in educational practice rather than describing the actual content materials.

ALI is not compliant to any standard or specification, rather it serves their understanding of end-users' needs in building a learning community. In its latest version, ALI 2007, ALI has integrated online collaboration tools for the end-users to interact with people within the ALI community.

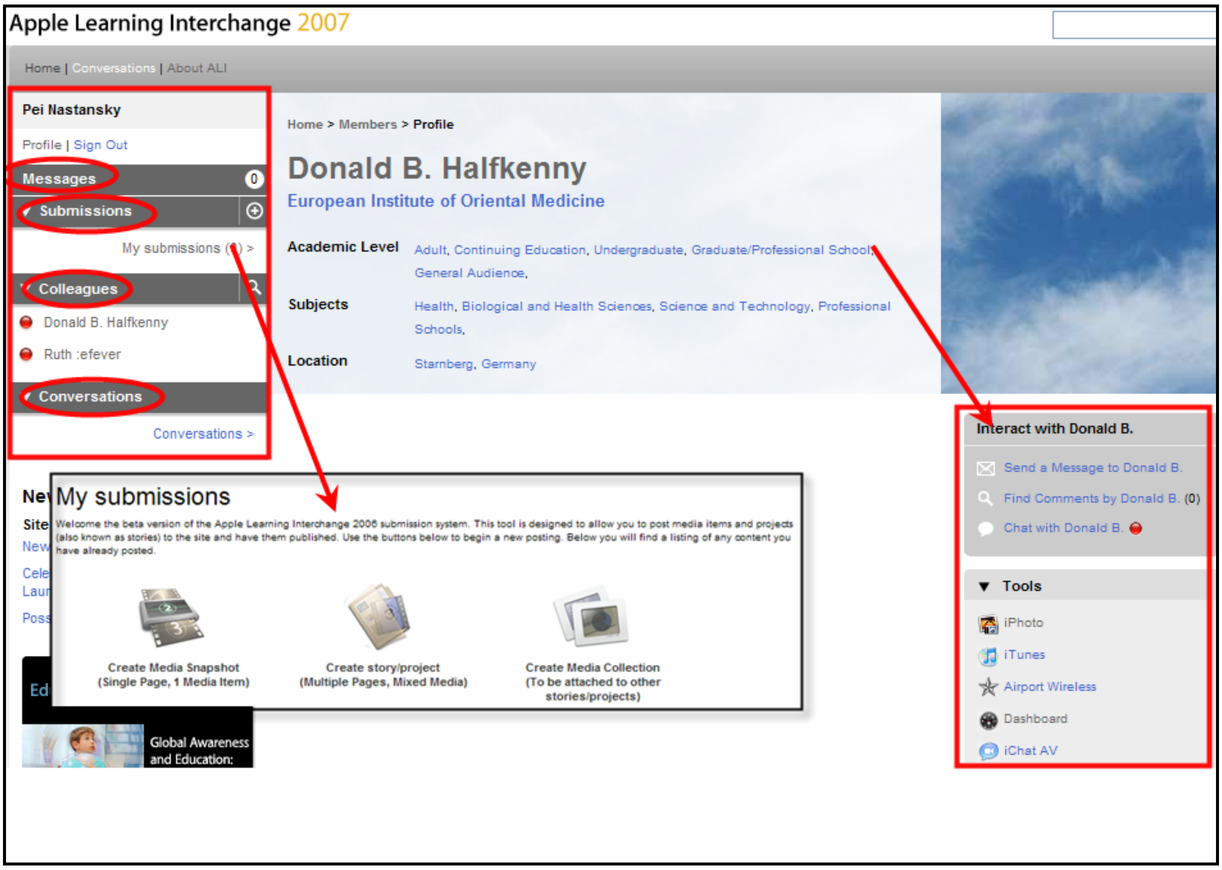

Figure 3-33: ALI online collaboration tools (ALI, Retrieved May 27, 2007).

From the box on the top-left of Figure 3-33, the author of this thesis can search and add people into her colleague list (i.e. there are two peers currently, one from Germany and the other from Beijing). The box on the right-hand side in Figure 3-33 highlights interactions among Pei and her colleagues. For example, Pei can send messages to her colleagues, or chat with them if they are available online, or even find any comments they have made in the ALI sphere. Additionally, the tools used by Pei's colleague are listed as well under "Tools", which adds more convenience to find experienced people for tips and tricks. Moreover, the end-user can also submit learning materials via a wizard interface with only three steps to follow.

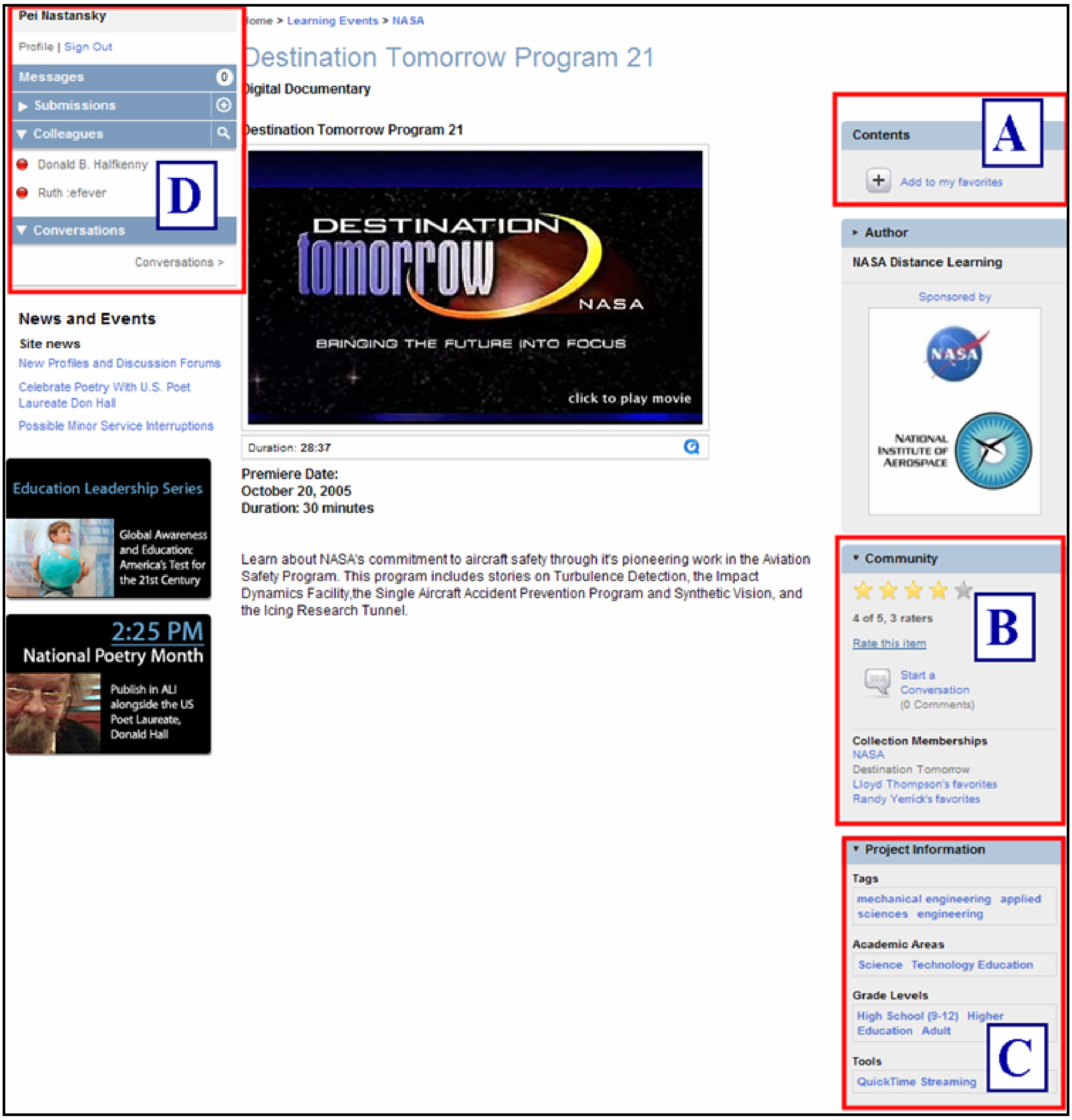

Figure 3-34: Context information within learning resources (ALI, Retrieved May 27, 2007)

In addition to collaborate with people in the ALI community, the end-user is also enabled to interact with learning materials. Area A in Figure 3-34 is the place for users adding desired information to a personal folder. Area B is a rating tool like in Amazon.com, and the end-user can start a forum to comment or discuss about the "Destination Tomorrow Program 21". Another unique feature of ALI is referenced in area C where context information and content metadata are tagged. For example, the context information revealed under “Tools” tells this specific material is built by the “QuickTime Streaming” tool, and it can be used by users fitting the “High School (9-12)”, “Higher Education” or “Adult” categories in the area of “Science Technology Education”. More important, all tags presented here are hyper links, which pull different aggregation results from different contexts.

However, the online collaboration tools in area D are not integrated with the interaction with materials on the right-hand side from A to C. For instance, Pei cannot discuss or converse with her colleague about the “Destination Tomorrow Program 21” directly in the interface place of Figure 3-34. In other words, the content and the context information is lost when the author clicks anything from the area D, albeit they are all presented next to the media resource.

Lastly, once again, the Apple Learning Interchange reinforces the trend to openly sharing content with free access. More important, ALI integrates collaboration and contextual elements in building repositories, which is not often seen in academic practices.

3.6.5 Summary

Following the learning objects repositories survey in 2002 conducted by Neven and Duvan (2002), Table 3-4 presents a summary on the four chosen repositories, covering three basic reviewing criteria:

- Design of learning object: metadata scheme, granularity, interoperability
- Design of repository: system architectural design
- Services or usability

Compared to the survey from Neven and Duvan in 2002, now, five years on, the landscape of learning objects repositories has changed little. From the system point of view, most repositories are relying on a web-browser as the main user interface. As for the design of learning objects, each repository is defining its own granular levels and aggregation structures for content, although most follow either IEEE LOM or the Dublin Core Metadata Element Set, or they are combining both metadata standards.

	Design of Learning Objects			**System Architecture**	**Services/ Functiona-lities**
	Metadata Scheme	**Granularity/ Aggregation levels**	**Interoperability/ technical standards**		
MERLOT	IEEE LOM	Single Linear Aggregation based on traditional educational taxonomy	Web-browser, XML de facto standards: MS Word, pdf, ppt, JPEG, etc.	• Client – Server • Stand-alone • Minimum security for browsing and contributing	• Community services • Search & editing • Rating • Federated search • RSS Feed
iLumina	Dublin Core related & domain specific	Single Linear Aggregation based on traditional educational taxonomy	Web-browser, XML de facto standards: MS Word, pdf, ppt, JPEG, etc.	• Client – Server • Stand-alone • Minimum security for browsing and contributing	• Community services • Search & limited editing
MIT OpenCourse Ware	IEEE LOM & SCORM Compliant	Single Linear Aggregation based on traditional educational taxonomy	Web-browser, XML de facto standards: MS Word, pdf, ppt, JPEG, etc.	• Client – Server • Stand-alone • Minimum security for browsing	• Community services • Feedback • RSS Feed
Apple Learning Interchange	Apple specific	Two-dimensional aggregation based on media types and content applications.	Web-browser, XML de facto standards: MS Word, pdf, rm, mp3, etc.	• Client – Server • Stand-alone • Minimum security for browsing and contributing	• Community Services • Rating • Rich Media • RSS Feed • Podcast enhanced

Table 3-4: Comparison of four learning objects repositories

Because of the unclearly defined nature of learning objects, the development of learning objects repositories takes various shades and directions by different organizations and institutions. The landscape is mixed, overshadowed by traditional instructional design methods, focusing on content granulation as to raw objects, lessons, modules, units of learning, etc. Context information about past and present experiences and application domains of the content are largely lacking, e.g. where, when, how, or why the object is used and reused, and who used it. Without a context information layer, reusing or repurposing learning materials is often implicitly taken for granted – as long as the materials are there, someone will reuse it, hopefully. From the system architecture point of view, all repositories are islands on different technology platforms without consideration of integration to people's workplace environments.

The trend is that content supply is increasing and content is freely accessible. Twenty years ago, people may have had difficulties to get hold of content. But today, the direction of opening and free access to information/content/knowledge appears to be the future, as revealed by the four examples of repositories. However, sheer quantity of content won't do the magic for effective and efficient learning. More and more organizations realize that collaboration and contextual factors play an equal role compared to putting up an open content repository, as shown by the ALI example.

Last but not least, the past design of learning object repositories is centered on passively collecting information. As denoted in Figure 3-35, Margaryan, Littlejohn & Nicol (2006) stress that the next generation design of learning objects repositories should engage peer-to-peer interaction for "knowledge construction, reconstruction, and reuse" (p. 2). This concept corresponds to the development of bottom-up collaboration technologies prevailing via Web 2.0.

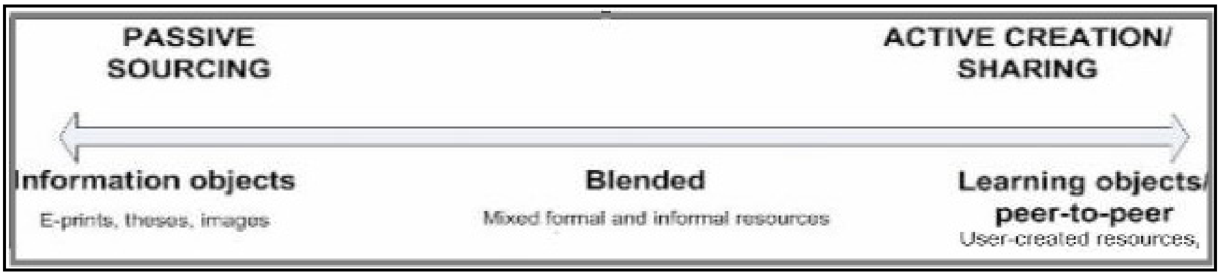

Figure 3-35: Extending to peer-to-peer interaction (Margaryan, Littlejohn & Nicol, 2006)

A glimpse of the future might be derived from the Apple Learning Interchange initiative. ALI has embedded community tools for fostering collaboration among peers. Furthermore, the metadata information is not limited to describing the content and the original context. It covers context information about the application environment of media materials, though the context information tagging process is not an open, bottom-up approach as in folksonomies and wikis.

3.7 Summary

Today, finding valuable content is no longer a critical issue. With the rapid evolution of information and communication technologies, prominent institutions like MIT are opting to open up their content for public use. Government-sponsored organizations are pushing forward the trend of open-access to valuable content in America and Great Britain. The Economist magazine reports (July 1, 2006) that the biggest sponsor for medical research in USA, the National Institute of Health, encourages its grants recipients to publish research findings in a free public digital archive. Similarly in Great Britain, the world second-biggest medical research charity, the Welcome Trust pressures its researchers to open up their results for free public access.

In e-learning, the idea of learning objects fits into this trend of accessing free-floating content on the Internet and organizational intranets. Nevertheless, the old content-centric paradigm still dictates the design and development of LOs.

As a prominent advocate of the learning objects approach to educational materials, Wiley (2006) announces in his blog[31] that he does not care whether the name "learning object" is alive or dead. His attention is on people's free will to share content via de facto standards. He wonders: "What if all the effort and money spent hyping and building technically interoperable content systems had gone into better understanding the process of localizing educational materials, and developing whatever new tools were necessary to support that process" (Wiley, 2006, section: RIP-ping on Learning Objects, para. 11).

Wiley's statement may provide a closing to the state-of-art development of learning objects. First, the debate of how to name the digital learning resource, whether they are called learning objects, nuggets, assets, or simply resources is not important. Examples of learning objects repositories/digital libraries/content management systems confirm the fact that different organizations have different understanding of learning objects.

The granularity approach of breaking-up content from its original context is proven to be costly and unrealistic. The issue of "localizing materials" is essentially centered on context information, describing the time, the location, the settings, the application domain, and the people who use, reuse, and repurpose the materials. With respect to the interoperability issue, most people are using de facto (industry) standards for rendering digital materials evolving from the overall development of information technology, like pdf, ppt, mp3, gif, the http protocol, etc.

From a bigger picture, Wilson (2001) expressed two broad trends currently in competition in distance education. One trend heads toward automation, standards, and control; the other towards an open system with a bottom-up, learner-centered knowledge construction process. During the last 10 years of battling among definitions, standards, specifications, the development of LOs has mainly concentrated on the direction of learning automation. Even on this front, learning objects implementers have failed, ending with a muted failure.

The modular approach of LOs to learning resources plays an important role in transforming the learning potential of the Internet. But Duval & Hodgins (2004) and Liber (2005) state that

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[31] Posted on January 29, 2006 on David Wiley's weblog: http://opencontent.org/blog/archives/230

there is no innovative model with effective technology to realize it. Moreover, Neven & Duval (2002) and Friesen (2004a & 2004b) point out that there is a huge vacuum in:

- Know-how experiences of utilizing information technology, rendering learning objects with rich, robust, and multi-dimensional contextual metadata information.
- User-friendly authoring tools to efficiently generate learning objects without programming skills.
- Tools that may gather information from other learning objects repositories.
- Knowledge to easily update learning objects by keeping the integrity of original objects.

In the remaining chapters of this thesis, the author will first take the learning objects approach as a catalyst for a modular design of learning resources. A multi-dimensional, contextual model will be then presented in order to maximize reusability. Later, the prototypical implementation of the model will be denoted, set in a real world workplace scenario.

4 From Learning Objects to Knowledge Nuggets and their Contextualization for Workplace Learning On-demand

4.1 Extending Learning Objects to Knowledge Nuggets

Although – as previously shown - there is no agreed definition, conceptual design, and technical implementation of learning objects across the e-learning industry, it hallmarks a modular thinking about structuring and aggregating digital resources which can be used and/or reused for learning. The concept of learning objects has given birth to e-learning technology standards like IEEE LOM. This standard is the result of bringing together collaborative efforts among academics and industry to develop learning content and technology interoperability, an endeavor and resources involved which have never been seen before in the e-learning history.

However, after some early hype, the topic of learning objects has also received a setback by sharp criticism due to the lack of practical applications and showcases of granular, reusable, and interoperable learning objects in addition to towering technical and other surrounding challenges (e.g. intellectual property rights, costs, politics, etc.) in the e-learning sector. The first generation of learning object implementations is largely defined by academic institutions, following a one dimensional, pre-defined learning paradigm: It means more or less putting the old wine - the traditional educational model - into the new bottle - the learning objects approach. This point of view also applies to industry practitioners, such as Cisco System's implementation, as discussed in chapter 3.2.3. This traditional approach is most appealing for instructional designers who may save resources to re-design content all the time over and over again. But these potential merits are not for the benefit of learners. Regardless of how many times the learning resources are reused or packaged into what proportions, all learners are exposed to the same learning processes (e.g. courses, modules, or chapters metaphor) in one pre-defined context by the learning designers/instructors/trainers. Little research has yet focused on a learner-driven implementation of the granular, interoperable, and reusable digital resources in multiple contexts, based on the rising trend of today's decentralized workplaces where learning and working are two parallel legs of one running organizational body.

Today, in order to stay agile and competitive, there is an increasing need to support as well as deliver on-demand learning at workplaces which is not restricted to the classical education and training model, often led by a teacher/trainer in a classroom setting or going online through pre-sequenced learning steps. This pertains to workplaces in both profit and nonprofit organizations. Learning on-demand is a just-in-time, self-directed, self-organized, and collaborative effort with peers and experts. It is to be achieved as an activity integrated with daily job tasks as reviewed in chapter 2.3.

To facilitate this kind of on-demand workplace learning need, learning technology must go beyond the traditional classroom setting and merge into the wider realm of organizational knowledge management, combining formal and informal learning processes (shown in chapter 2.4) in a workplace context. Therefore, in this research work, the term *knowledge nugget (K-nugget)* is used further on to replace the term "learning object".

Knowledge nuggets are digital resources - comprising context information and content materials in the form of digital assets - which can be used in facilitating workplace information and knowledge acquisition processes.

The convergence of learning and working positions "knowledge nuggets" is used as an umbrella term. This embraces not only all digital files, data, and information but also digital artifacts resulting from workplace collaboration, such as comments from peers, logged chat/instant messages, shared or co-edited documents, screen snapshots captured in business processes, recorded electronic conferences, etc. Knowledge nuggets represent a transition from a single-dimensional view of instructional learning/training to multi-dimensional support of formal and informal knowledge management processes in a workplace setting. The knowledge worker takes both roles at the workplace, as a lifelong learner as well as a daily job role, e.g. as manager, consultant, engineer, professor, assistant, etc.

Avoiding the term "learning objects" in the subsequent constructive parts of this thesis is also due to the usage of learning objects so far, which - as shown - right from the start is ambiguous, not precisely defined, and confusing. Additionally, by avoiding the term "object" a knowledge nugget distances itself from the notion of object-orientation in software development which easily but wrongly implies learning can be cognitively reused and automated by machines. This would neglect the importance of human interaction and collaboration in simultaneously pursuing learning and business processes. It has already been said that defining a "proper" name per se is not the focus of this research. Rather it is the concept and the guidelines for generating reusable digital resources which are the foremost important elements (Cisco, 2001, p. 4).

Accommodating the spectrum of informal workplace learning processes and on-demand learning needs, knowledge nuggets will be the preferred term referring to digital resources - used, reused, and shared among knowledge workers - which are driven by working contexts to fulfill learning needs in a just-in-time fashion. Furthermore, the following guidelines dictate the technical architecture of knowledge nuggets:

1. End-user-driven: knowledge workers generate, use, modify, and reuse the nuggets to facilitate their job tasks, transactions, and processes including embedded learning phases.
2. Context-driven: a knowledge nugget is granularly aggregated with respect to contexts, and not predominantly measured by content or restricted to physical characteristics of the digital resources (e.g. by bits, length, pages, file and media types, etc.).
3. Process-driven: knowledge nuggets are technically enabled for process-driven collaboration allowing the necessary associated context changes in a workplace environment.
4. Integrated solution: knowledge nuggets are embedded in a knowledge management environment and line of business solutions which are an integral part of the workplace platform technology being used in the organization.

This distinction of knowledge nuggets vs. learning objects does not mean that the notion of knowledge nuggets excludes some common advantageous characteristics highlighted in the discussion of learning objects. These are especially granularity, reusability, and technical interoperability. With respect to the constructive parts of this research these aspects will be applied in chapter 5 and reflected in chapter 6. However, in this thesis these characteristics are extended into a dynamic context-driven organizational process environment, complementing the first generation of content-driven design of reusable digital resources.

The subsequent parts of this chapter will explicate a conceptual foundation for knowledge nuggets, emphasizing the important role of context while pursuing several challenging issues in the reuse of knowledge nuggets.

4.2 Re-Thinking Granularity in the Context of Workplace Learning On-demand

Granularity is a critical challenge. After all, till this day, the mainstream of publicized approaches about granularity for reusability is circling around “content” with a single sequencing model following classes, or modules, or book chapters. Then, via technical standards, these objects may *automatically* connect to each other, hopefully, in a meaningful way in different teaching contexts. With this limited approach and thinking for years, the claim of the *Death of Learning Objects* on many educators’ blogs is not surprising (see chapter 3.1.3). The learning object, once most e-learning player's darling and many e-learning conference's divine topic, is now facing doom, only after some six years of existence (chapter 3.1.2). Apparently it faces the fate of other innovative ideas and thinking which have come up all too fast to be substantial enough to sustain.

Indeed, the current doom state of learning objects is originating from many of its mythical features imposed at birth.

Number one is being vague on how small a learning object has to be in order to be reused multiple times. There is no universal agreement on the exact definition or concept of "being small" because the world is made out of all too many different standards and shades. Content size is relative in both the digital and the physical world. For example, the basic content of a mathematical research paper or a chemical description may only consist of ten lines of formulas, but might have a similar information "importance" in the respective usage context as a two-hundred page report based on marketing surveys about consumer behavior in the mobile phone sector.

Figure 4-1: Sistine Madonna. Raphael, 1513-1514 (Old Master Gallery, Dresden, Germany)

Secondly, there is no one generalizing model of granulizing content in an abstract presentation that is meaningful to everyone coming from different sectors or contexts. According to IEEE (IEEE LOM, 2002, pp. 11- 15), a most frequently used example as the smallest and meaningful learning object is a digital image of *Mona Lisa* from Leonard Da Vinci. It is an overly simplified assumption. At the first look, it sounds correct. The picture of Mona Lisa is the smallest object possible for being meaningful in its own context – a woman's portrait by a renaissance master. This could lead to a vague and misleading impression that any complete image in its original context can be regarded as the smallest finite object.

No, not for all! Take Raphael's *Sistine Madonna*, regarded in the same category like Mona Lisa as a high renaissance master painting. As shown in Figure 4-1, at the very bottom the two little angels are famous by themselves, often picked out, used and reused in a multitude of different contexts, as individual entities separate to the whole picture. One part of the original image is decomposed from its original context, and reused in thousands of different ways.

Figure 4-2: Snippet of a religious course (Wake Forest University, North Carolina, USA [32])

For people learning renaissance art, the whole picture of Figure 4-1 would be the smallest and inseparable object. However, people, specialized in religious studies, angel and icon artwork, or making merchandise out of angel images, will treat Raphael's cherubs as the smallest objects as in Figure 4-2. And in Figure 4-3, the two angels, including repurposed and clearly recognizable abstractions from the famous origins, are reused in completely different contexts from their origin (surely not all for classical educational purposes). However, the whole picture as well as the two little angels are both the smallest learning objects in their own respective rights in the right context, sharing the same set of general metadata information when implementing the IEEE LOM standard. The key is that the little cherubs can be used with the whole picture or separately, but no one could have decided it before, even Raphael himself.

A core message after this straightforward example is that it is not possible to define one general principle of structuring, granulizing information and knowledge for later reuses or

[32] http://www.wfu.edu/~matthetl/sunrise/angels/angels.index.html 08.10.06

repurposing based on content of objects. Additionally, the above pragmatic comparison also shows another pitfall: reusability is not predictable.

Figure 4-3: Web Snippet of reusing Raphael's angels (Tim Spalding's website, with author's comments [33])

Raphael painted the masterpiece centered on one domain theme/objective/topic: Madonna ascending to paradise. He would have not expected his angels at the bottom (from a likely contemporary interpretation perceived as being bored and casually unimpressed by the action happening above them) as more eye-catching and acknowledged beyond the whole picture centuries later as a separate piece, serving other learning and/application objectives. At the same time, Saint Sixtus on the right, as well as Barbara on the left of the picture clearly surpass the two small angels by size, most probably aiming at a well-balanced composition of the whole picture. Nevertheless, the reusability of those chubby and in the context of the whole picture small angels ultimately evolved into their own identities by millions of viewers' affections. They are being unpredictably reused millions of times to support learning in art, religion, or the mythical effect of angels, and they are repurposed on T-shirts, cups, umbrellas for contemporary usage in commerce or life-style environments.

The fast transition from early hype to recent doom of learning objects is all educed by the metaphor of LEGO, or atoms as well, which has been employed in explaining learning objects (see chapter 3.2). The concept often follows a perception of "the smaller the better" for chances of reusability. Based on this thinking, taking the example of the well-documented learning objects implementation from Cisco, content models are born according to the number

[33] http://www.isidore-of-seville.com/angels/19.html

of application domains and objectives involved. Then, aggregation starts following a raw media concept from smaller to higher aggregation levels such as sections, lessons, modules, units, and finally, the ultimate accumulation into a curriculum

- Curriculum
    - Unit
        - Module
            - Lesson (RLO)
                - Section (RIO)

Figure 4-4: The RLO-RIO Hierarchy (Cisco, 2001, p. 8)

As discussed above, this model of classifying content with its implied content sequencing, repeats the traditional education and instruction design, leaving little control for the individual learner. Cisco follows this hierarchical way of granulating content so that the bigger objects encapsulate all the smaller ones on the levels below (Figure 4-4). Yet, Cisco's LO designer admits that this traditional instructional model requires tremendous resources - time, people and money – to be put into restructuring. As an outcome, because any restructured aggregation becomes too costly and sensitive, the resulting static approach does not offer individual learners the maximum accessibility and reusability of the smallest information or raw object (e.g. digitized simulation sequences, technical data, text) itself (Barritt & Alderman, 204, pp. 198-199). The model might be useful for classical instructors. But it is not fitting the needs of an individual learner with a specific project assignment in his company. This "learner" may not have the time to take a full course, but rather prefers to randomly access appropriate objects from different levels of the hierarchy with his/her prepared content to be studied in mind, content which depends on the actual required project context.

Mining the same vein of classical instructional design theories, targeted on instructors in education, David Wiley (2000a & 2000b, 2003 & 2004) (chapter 3.3.2) tried to find a general model pre-defining LO size by analyzing the complexity of the learning content domain and its related instructional activities involved. As a trained instructional designer, centered on content and a teacher's role, Wiley's model is derived from the traditional classroom setting by putting learners passively listening and processing given information. Additionally, he did not show the critical implementation of LOs in terms of necessary supporting technology, like meta-tagging, intellectual property rights, selection of software tools, etc. Yet, the value of Wiley's work lies in proving that - as the world (obviously) is existing in many shades and aggregation states - there is not just one way of structuring and aggregating digital learning objects.

What increasingly happens is that working and learning run in parallel at work today, which is pointed at in many implications as the main underlying theme of this thesis. For instance, in the office, around 5 pm, an experienced IT consultant prepares a customer meeting for providing the customer an enterprise portal solution for the next day. He only needs to know the newest update information and features of portal technology, adding them to his ten minutes demonstration. And he needs tips from his colleagues where to find more information about this specific customer. In this on-demand situation, the knowledge worker is learning what he needs in his preferred time, sequence, and methodical approach, without going through prepackaged learning objects. As an example, Cisco's RLO model with overview, pre- and post-assessment without any human support, a whole set of product features, and an elaborate summary at the end definitely would not fit the situation. In the real world, a dedicated knowledge gathering scenario like the example above occurs every day at the workplace. Neither Cisco's practice nor Wiley's model will serve this on-demand learning need which requires a collaboration process, dedicated resources, and flexible access concepts to the resources and connection to the right people.

In summary, the missing points of the first generation approach on granularity centre on five misinterpretations or wrong directions in the wider context of learning in a dynamic knowledge world:

1. A single focus on content. The "content-is-primary" thinking has been marked in decline by emergent free accessibility of content on the Internet or Intranet of an organization. Current examples for catching the exceedingly free flow of data, information and knowledge on the web are, as shown above, MERLOT, MIT OpenCourseWare, or Apple Learning Interchange for specific learning resources, Wikipedia as a free encyclopedia, or Google, Yahoo!, Search, or Ask.com as for-free search engines.

2. The attempt to generate one killer application or model to structure a multi-dimensional, multiple standards knowledge world.

3. The narrowness to focus on instructional design for repeated learning or traditional educational models for structuring information and knowledge, which is built for mass education in the industrial era, with only limited recognition of individual learners' needs.

4. The misleading notion to consider reusability as depending on content size being artificially small.

5. The misleading perception to consider reusability as a predictable factor according to the number of anticipated application domains or learning objectives, involved at later stages of creation or reconstruction of content.

If following the above outlined abstract ways of granulating learning resources, the Renaissance master Raphael would have right from the start have to separately create his figures in the Sistine Madonna as well as present them individually for purpose-oriented reuse. For content reconstruction, reducing one piece of knowledge containing rich content and context into a series of smaller ones is even less suitable in a world with high dynamics in the change of information and knowledge – and contexts. Today's software engineers are not learning ALGOL or FORTRAN programming languages anymore, but JAVA or Eclipse. No one knows what comes after three years. Is it worthwhile to reconstruct all JAVA books, videos, demos, etc. into a set of single paragraphs, or minutes of audio material for listening, as long as they are consistent with current learning objectives? Would granulating ALGOL or FORTRAN teaching in an "appropriate" way some decades ago, be of general value for typical/average learners of JAVA or Eclipse today? Who is entitled to decide the underlying learning objectives necessary as a guideline for adjusted granularization? In which way are these guidelines persistent and will make reuse of accordingly established learning objects a reasonable suggestion in three years? How much will this cost? All these are questions left mostly unanswered in the arena of the learning objects approach.

In addition, information technology adds a double-edged sword: It accelerates open accessibility of information and knowledge that is enriched every second. But meanwhile, precisely because of this openness and enrichment, the market value of information and knowledge has been cut short in time. Success for organizations and for the individual depends on the speed of adapting new information and learning new skills. On the one hand it needs defined and well structured processes for rejuvenating old information in the right context of the workplace. This involves the unloading of specific outdated information and replacing it with an actual content instance which is valid for the current necessary competence in handling business processes. On the other hand it needs open and not predefined approaches for learning to enable innovation and competitive creativity.

Nevertheless, some content providers may still realize value in applying a single instructional content sequencing and granularity model, and/or IEEE LOM, and/or SCORM in interoperability efforts. Examples might be content providers producing content for a specific purpose, just in time, for a given context, with minimal redundancy - and reuse not mattering so much. Or, another example, content providers for strictly defined disciplines of classical education on introductory levels, e.g. “Algebra 1.1” or “Biology II b”.

But when it comes to dynamically evolving knowledge at the workplace, granularity does not primarily pertain to content, and reusing means essentially repurposing and perpetually re-referencing in different contexts defined by learners in their organizational environment.

The rest of this chapter will present a contextual model which allows to perpetually (re-) structure, (re-) sequence and (re-) contextualize information and knowledge. This model is based on a multi-dimensional model of multiple domain contexts and can be integrated into the virtual workplace for learning on-demand. Tagging will be referred to in detail as well because it is an essential part of the model.

4.3 Contextual Model for Workplace Learning On-demand (CM-WLOD)

4.3.1 Foundation

For reusing purposes, it has been shown that structuring or restructuring learning resources solely based on content itself has been disappointing. Instead, people should look for more innovative metadata models focusing on: rich context information provisioning via metadata, end-user’s (i.e. not the authors’ of documents) attribution, and on-the-fly manual creation of metadata with tagging mechanisms as “labor of love” (Duval and Hodgins, 2004, section 2, basic message).

Other researchers have also been seeking efficient ways of structuring content based on context information and more. In chapter 3.4.4 of this thesis three individual tactical mechanisms for constructing context have been outlined: Contextual wrapper, adding context links to objects, template design of context information.

Although the importance of context has been stressed by many, currently there exists not a single holistic conceptual approach and data model that can be applied and integrated for virtual workplace learning. Given the principal complexity of the issue and the dynamics of the involved organizational as well as technological environments this is not surprising. So, inheriting existing ideas and following suggestions of rethinking granularity and metadata issues, a *Contextual Model for Workplace Learning on-demand (CM-WLOD)* is developed in the following paragraphs. CM-WLOD is to facilitate workplace learning in an on-demand delivery fashion.

In an attempt to present basic architectural elements of CM-WLOD in an intuitive way, a visual representation used in medical research on *signal transduction* is borrowed. Signal transduction research is focusing on responses of cells to physiological (e.g. stress) and environmental (e.g. toxins) stimuli, external settings and/or contextual factors, which have significant implication on human health and disease (e.g. diabetes, asthma, heart diseases and cancer) (Laboratory of Signal Transduction, U.S. National Institutes of Health, [LST, 2006]). Obviously, the bad air quality and stress factors have negative influence on the development of diseases.

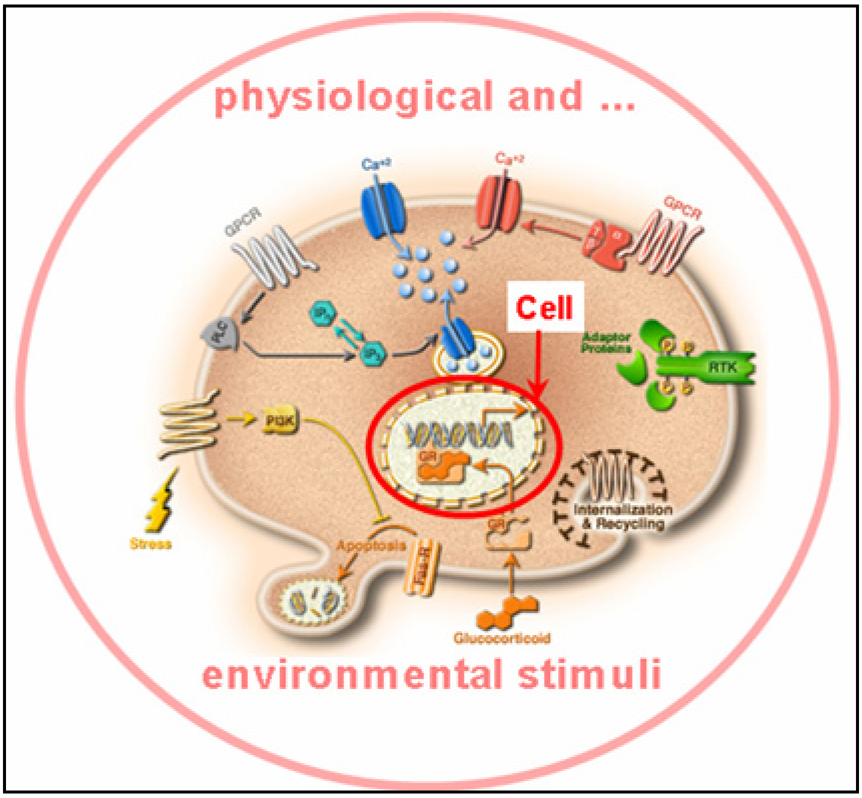

Figure 4-5: Adapted from the cell image of the signal transduction research from LST (U.S. National Institutes of Health, 2006 [34])

Figure 4-5 presents these contextual factors. All the factors shown embody different parameters which are related to the respective external expertise area they are attributed to. To visually make clear that the contextual factors in turn represent distinct external features, different iconized symbols are taken. When it comes to detail each of these iconized symbols might represent a set of parameter values being attributed to the specific contextual factor. The combined set of all these contextual factors defines a contextual profile which is shown in an interaction pattern to the cell in the center of the graph. The contextual parameters are on the boundary of the graph to denote their connection to entities and knowledge domains existing outside. The arrows give a sketchy hint to some of the underlying dynamics of mutually influencing factors.

[34] http://dir.niehs.nih.gov/dirlst/imagemap/cell.jpg

This medical model easily and rather isomorphically relates to the knowledge nugget approach as worked out in this thesis. The common focus between signal transduction research and knowledge nuggets is the usage of a set of contextual factors characterizing a specific context of the content attached to the knowledge nugget. The knowledge nugget is modeled in analogy. It is defined by context information expressed by contextual parameters on the one hand and the content kernel with digital material on the other hand, the latter being the "cell" in medical research. The contextual parameters have to be modeled to characterize a usage purpose of the attached content at the workplace according to a specific application domain. The contextual parameters are not derived "internally" as drawn solely from information about the content. Rather they define a relation between the content and external (to the content) factors derived from actual organizational and business processes of an application domain where the content happens to be embedded during one process state of its life cycle.

The external contextual influences are interacting within the changing process structures of a living organization of which the workplace is a part. But, in this thesis the focus primarily will not be on analysis of the interaction dynamics between single contextual factors and their impact on the content part of the knowledge nugget (as suggested by the arrows in the medical model above). Rather the dynamics of organizational processes as described in appropriate contextual factors will be reflected in different sets of contextual factors which can be assigned one after another to the content part of the knowledge nugget over the life span of the content. This property of assigning multiple contextual parameter sets will be mapped out in detail later. So, a knowledge nugget has always exactly one content part but may have more than one independent set of contextual parameters.

This approach to process dynamics implies that different knowledge nuggets, which being independent from each other have different content parts, might have a similar or even equal set of contextual parameters. So, for an upcoming specific process context in an organization these different content parts can be identified as a suite of content parts supporting exactly the knowledge and learning needs of a specific business situation at the workplace (taking the advice from Duval and Hodgins, as referred to above). This is similar to putting together the chapters of a book. But, here the "book" is created on-demand for one specific purpose. Furthermore, the "book" does not consist of chapters of frozen content but rather of chapters made up by a collection of knowledge nuggets fitting the purpose of a specific learning and knowledge gathering situation in an organization. In the following, CM-WLOD will illustrate some state of the art IT-approaches and tools to efficiently manage this context profiling at the workplace. This way, dynamically and on-demand appropriate content pieces for a given business context are organized using several “push” and/or “pull” mechanisms; more about this later.

To be noticed again, the following explanation of the CM-WLOD approach in this thesis is not a literal translation from medical signal transduction research to the contextual granulation procedure of knowledge nuggets. Rather some parts explaining the most relevant building blocks of evolution processes and related phenomena in the natural sciences are borrowed. This pertains especially to the subsequent visual presentation to be adapted for modeling the data structure between potential learning content (data, information, and knowledge) and the context relation to outer contextual stimuli. Behind this is a model where large amounts of context information are attached to the K-nugget, or cell structure respectively, itself. This is true for cells in living organisms where a cell contains a large amount of information about the whole organism. But it is also analogous to the bottom-up content modeling based on context-enriched K-nuggets in CM-WLOD where out of a K-nugget or a collection of K-nuggets relevant parts of organizational contexts can be (re-) constructed. The data model of the prototypical implementation of CM-WLOD (see chapter 5) is also isomorphic to this cellular and bottom up approach, because in the implementation K-nuggets are mapped onto documents. So each K-nugget document contains context information. Most likely a considerable amount of this context information is similar in different K-nuggets. So, there is a high redundancy of contextual parameters stored over and over again in K-nugget documents. Again this is a basic feature of cellular structures in living organisms and contributes amongst others to providing robustness to the whole system.

Central to this thesis are the contextual elements and process stimuli around information and knowledge. It is not the author’s intention to focus on content generation. In general, in this thesis, content is taken as a given set of assets in any digital format.

Before going further to describe the CD-WLOD architectural and data model in detail, a set of related terms involved in this study will be clarified and defined first in Table 4-1. To be noted, the following interpretations of terms are applied to informal interwoven e-learning and knowledge management processes within organizations for facilitating workplace on-demand learning needs via information technologies. Thus, some of the definitions might also be applicable to similar scenarios, but this is not necessarily so.

Term	Applied Definition
Domain / application domain	A domain or application domain is considered to be a topic, focal point, a practice area, or a specific field of expertise and knowledge in the real world. A domain might be determined by e.g.: individual activities of employees, recurring (business) processes or projects in the organization, learning or training endeavors. A domain might be defined by an individual (employee in a line of business, subject matter expert, trainer, manager, business partner, etc.) or group of users (departments, projects, customer organization, suppliers, etc.). The specific application environment of a K-nugget in the real world is defined as the K-nugget's "application domain" in this thesis.
Content / content material	Given data, information, and knowledge assets being rendered in digital format (i.e. text, graphics, image, video, animation, demo and test cases, etc.).
Contextual factors/ contextual parameters / tag class	Data types and values describing the relation of content to an application domain. Generally, contextual factors can be attributed taxonomies. The assignment of contextual parameters is accomplished via metadata modeling and related tools, based e.g. on tagging, contextual wrapping, adding context links to objects, template design, or individual and specific context objects.
Context information set / context stub	The aggregation and packaging of contextual factors into a specific collection. Within the framework of the CM-WLOD approach tag classes are packaged in parameter containers, denoted as context stubs. A specific context stub is defining one context information set. In addition, specific contextual factors might be closely interwoven with content material, e.g. links or dynamically embedded objects.
K-nugget / knowledge nugget	A digital resource which includes 1) content material and 2) context information sets. In CM-WLOD a K-nugget is modeled as a document. A K-nugget consists of exactly one set of content material contained in a content field, and one or more context information sets contained in respective content stubs associated to the content field. The purpose of a K-nugget is to be used in facilitating workplace information and knowledge acquisition processes on-demand.
Context information	Comprehensive aggregation states or collection forms of contextual factors as modeled in context information sets. In CM-WLOD context information about a K-nugget is revealed to the outside by its associated context information set(s) and/or by automated content analysis (e.g. full text search, semantic analysis). Context information can be rendered in a variety of formats to the user in the workplace environment, using e.g. textual, tabular, list or graphical representations. Basically, the rendering shows the values of context parameters presented in a way appropriate to the purpose of usage of the related K-nuggets in an actual business process situation at the workplace.
Multiple contexts / Multiple context information sets	In CM-WLOD context is modeled in a way that independently more than one context information set can be assigned to one set of content material. This important feature will be referenced to as "multiple contexts". Thus, different context information sets might be indexed as: $context_1$, $context_2$, …, $context_n$ denoting this feature.
Contextual signature / Contextual profile	A Contextual signature is a comprehensive representation of a specific context information set. Contextual signatures are different if they vary in at least one value of a contextual parameter. An arbitrary subset of a K-nugget's actual contextual parameters is called a Contextual profile. These Contextual profiles might be search upon.
Tagging	A mechanism to assign context information by allocating values to contextual parameters, e.g. by assigning keywords, by adding links, or by connecting pre-fabricated templates to the current set of context information. In this thesis, due to the workplace orientation, tagging in most cases exists of adding whole new context stubs to already existing K-nuggets or adding/changing/deleting values of contextual parameters in context information sets during the course of business processes. Tagging can be done by humans or software agents (see also chapter 2.4.2.2.1).

Table 4-1: Definitions of often used terms in the CM-WLOD approach

4.3.2 Composition of a K-Nugget

From a data modeling and implementation point of view, a knowledge nugget as introduced in this research must embody two terrains: 1) content material, and 2) context information.

Context information can be derived from the content material itself, or it is allocated in workplace environments based on external assignments of contextual factors in an organizational process situation. As pointed out the primary focus of this thesis is the latter case which will be dealt with in detail later on. One way to derive context information from content material is to reuse prepackaged metadata which might be included following standards like IEEE LOM or the Dublin Core Metadata Element Set. Context information might also be derived by automatically analyzing and tagging content materials using semantic analysis and artificial intelligence methods. An example of a commercial product for semantic analysis based on artificial intelligence which would be applicable for automatic tagging of K-nuggets in CM-WLOD's prototypical implementation is Cirilab's Knowledge Generation Engine™ (KGE[35]).

For content material the K-nugget must provide a container environment, the content field, allowing embedding all forms of digital assets used in an on-demand learning process at the workplace.

A principal visualization of the knowledge nugget architecture as used in CM-WLOD is outlined in Figure 4-6. In this visual transformation from medical research, all the content material contained in the content field is linked to (nine in the example) contextual parameters, which altogether form one context information set for the K-nugget. Especially, the graph visually emphasizes the concept of allowing different and independent contextual parameters with their own taxonomy to be part of a context parameter set. This is illustrated in the graph by using a variety of pictograms derived from medical research.

The content field is designed to serve as container for a collection of digital assets of any given digital format of data, information and knowledge used at the workplace. The term "knowledge" is used here following the conceptual notion of knowledge management pointing out the transition between tacit and explicit knowledge in organizations from Nonaka and Takeuchi (1995, pp. 57-59). In this thesis, the CM-WLOD approach is centered on the codification of tacit knowledge to explicit knowledge by a process of contextualization and

[35] More information about the Cirilab "Generation Engine™" at http://www.cirilab.com

internalization via interactions among knowledge workers enabled by a set of tools. This will be shown in the next chapter.

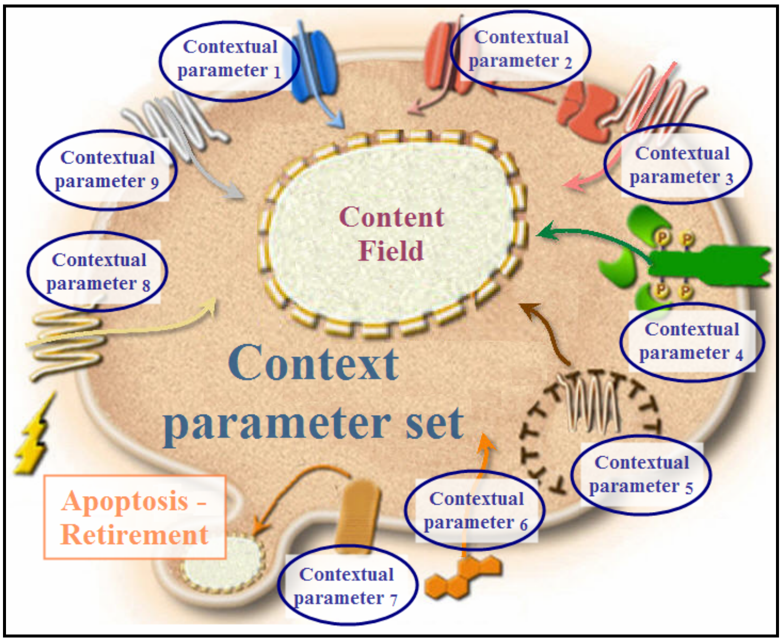

Figure 4-6: K-nugget - visualization of contextual model (adapted from medical research, LST, 2006)

Modelling process dynamics within the context parameter set is a challenging area for in-depth research of context information, applied taxonomies, or interrelations of contextual parameters. As mentioned earlier this will not be a central point of this thesis. But, to understand some of the underlying principles the example of medical research is utilized again. The concept of "retirement" of a knowledge nugget will be picked out as a case. At the lower left-hand corner of Figure 4-6, borrowing findings from the evolution process of cells in response to outside contextual stimuli, there is a stage of "Apoptosis" (= cell death), a programmed natural evolution cycle of cells related to a normal and necessary biological process. For example, in a human embryo's growth the separation of fingers is due to deliberate cell death. All processes related to the different contextual parameters have to be balanced, so does the Apoptosis. Too much cell death is not good, too little will cause diseases (e.g. cancer tumors).

When in analogy treating information and knowledge as dynamic, living entities, the life cycle of a knowledge nugget certainly resembles a withdrawing process as in the cell cycle. Moreover, the contextual parameter pertaining to model the life-cycle will be related in many ways to other contextual parameters ascribed to the knowledge nugget.

The retirement of a knowledge nugget might be a response to, possibly, business strategy changes in a company, simple out-dating of content material (new product versions), or changes in the corporate market of the information systems (like the example of ALGOL and

FORTRAN material mentioned above), etc. These influences can be explicitly reflected in the knowledge nugget by deliberately assigning an appropriate "retirement" value to a respective contextual parameter. Thus, by looking at the knowledge nugget there might be a tag "expired on 04-Apr-2007" which directly without further context information indicates that the content is outdated after this date. But, in the workplace environment the retirement phenomenon might also be reflected implicitly, which is more related to what this thesis is about.

When there is a digitized book about the ALGOL programming language embedded as PDF-object in the content field of a knowledge nugget, this knowledge nugget most likely will be in the retirement stage for workplace usage on-demand, given the current state of information technology. This retirement of the knowledge nugget is caused by the advancement of technology which might indirectly be reflected by lack of up-to-date context information suited for bringing the object into current awareness. So, using "pull"-mechanisms like e.g. full text search will not bring up the knowledge nugget because no one is looking for "ALGOL". "Push" mechanisms on the other hand, like e.g. used by a project leader posting important background information about a software development project in the project's "Background Material Folder", will not likely lead to including an ALGOL related knowledge nugget as up-to-date material. So "retirement" is not a special state of a knowledge nugget itself in the CM-WLOD approach, but might be denoted explicitly by one of the contextual parameters or implicitly by the lack of external contextual stimuli defined by current application domains to pull the knowledge nugget out of a dormant or retirement stage.

4.3.2.1 A Narrow Interpretation of Context: Single Context Information Set

The term "context" seems intuitively to be understood as describing the environment of an object in a specific setting. But it is difficult to define. In this research for the purpose of modeling processes of information and knowledge within an organization, the author explores two types of context interpretation. The first is a narrow one derived from content or in many cases related to the first apparent usage of a knowledge nugget in a specific application domain. The second is a broader understanding of context associated to later reusing, repurposing, and referencing events of a knowledge nugget.

A suitable approach to articulate the usage of context at this point appears to be to take a real world example. In the following, meaning and mechanics of a single set of contextual parameters are explained. As exemplary content material a demonstration of a piece of current technology is taken, a video clip showing various aspects of IBM's "Websphere Portal" system (= IBM Corp.'s approach to corporate Web technology). The video clip was prepared by a team of IBM experts. Its digitized assets had been embedded in the content field of a knowledge nugget. Context information was derived from the viewpoint of context available at this first usage of the K-nugget in its life-cycle. This context information includes as contextual parameter_1 "Conference", as contextual parameter_2 "Software Architecture", etc. The knowledge nugget had been stored in a knowledge management system accordingly, including content material "IBM Websphere Portal Demo" as video clip (plus describing textual material) in the content field and a (first) context information set. The descriptors for the respective contextual parameters of this context information set speak for themselves: The video was produced as a "Portal Demo" for a "Conference" for the purpose of "Marketing" for "Customer Service". It was shown on "20.01.2007", presented by "Jane Smith" as "Portal" application for a "System Integration" solution.

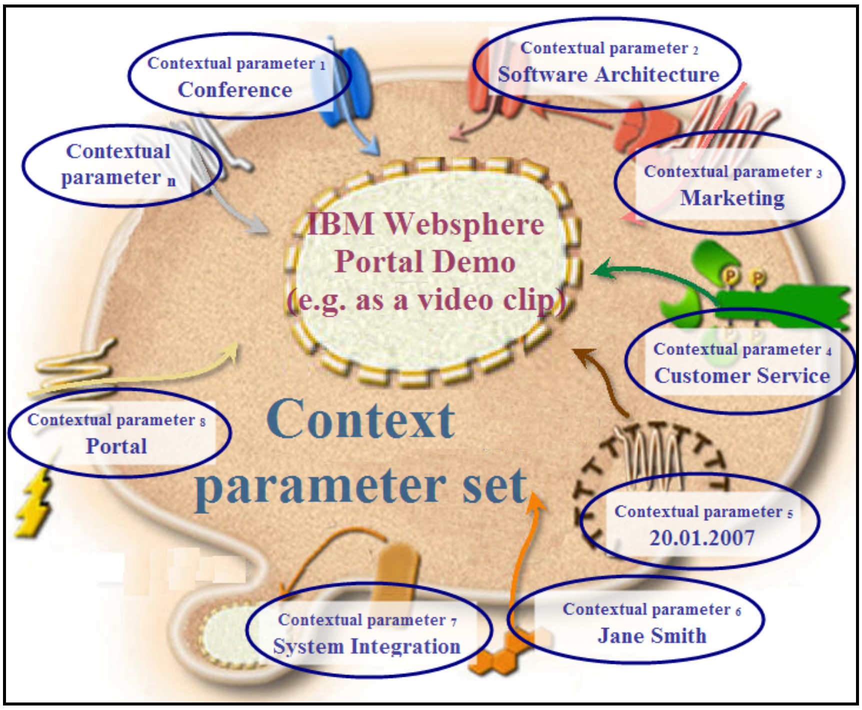

Figure 4-7: Example for narrow interpretation of context: single context information set

Figure 4-7 shows, as an example, the simplest case that all contextual parameters take exactly one value. In general this will not be the case. Thus, the contextual parameter_6 , apparently denoting the presenter, alternatively might take as value the list "Jane Smith" and "Howard Miller", if in addition to Jane Smith also Howard Miller would be presenter on 20.01.2007. Similarly, contextual parameter_9 might take as value the list "Portal", "Portlet" and "Page". To summarize: A context information set consists of a specific collection of contextual parameters where each parameter can take as many values as necessary (or reasonable) to describe the content material with respect to the application domain.

The presentation of the Websphere Portal Demo by Jane Smith on 20.01.2007 turned out to be a great success and especially conveyed the excellent underlying concept of software design. So, the people involved decided to include it as another sample in the "best practice" pool of training material. In addition the material was suggested to be used for subsequent sales, marketing and conference events. Thus, a sequence of reusages and repurposing of the knowledge nugget was about to be started in various organizational processes, such as sales events, marketing events, other conferences, or workshops. For these subsequent activities more context information has to be added. The question is: What is the best approach?

4.3.2.2 A Broader Interpretation of Context: Multiple Context Information Sets

The context information set of Figure 4-7 makes up only one incident referring to one specific application domain where the "Websphere Portal Demo" has been used. When aiming at modeling reusability in more application domains one way could be to add more values to existing contextual parameters and/or include, if necessary, more contextual parameters with their respective value(s) into the existing context information set. But, this would turn out misleading context information. Here an example: Betty Cole is about to use the "Websphere Portal Demo" at an upcoming sales event in March. If she would be included in the contextual parameter denoting the presenter (in addition to Jane Smith and Howard Miller) this contextual parameter would have three values. But then, wrongly, she would be related to the date "20.01.2007" of the first event "Conference" as well. Thus, to model multiple usages of shared content material, independent contextual parameter sets are necessary which respectively possess their own individual contextual signature relating to a specific purpose of usage.

This approach will be called "multiple context information sets" for knowledge nuggets. With this approach a more general model allowing broader and extended usages of content material in workplace learning on-demand environments is introduced.

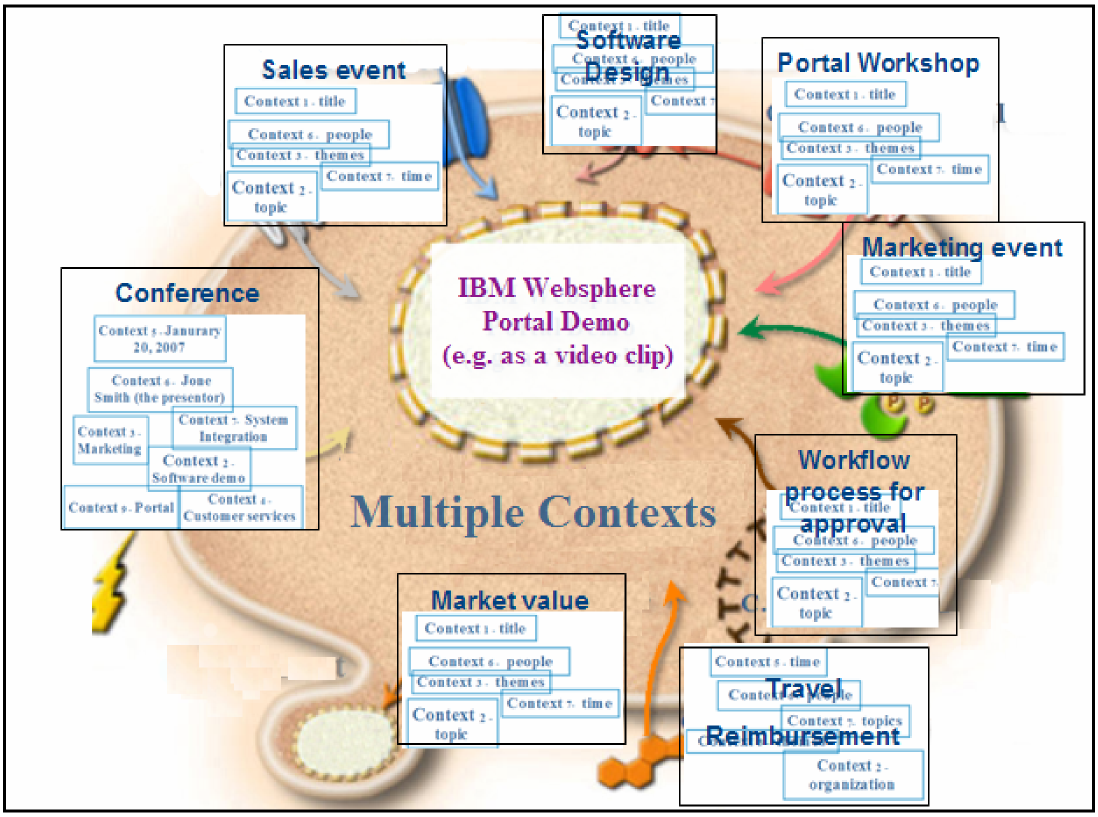

Figure 4-8: Example for broader interpretation of context: multiple context information sets

Figure 4-8 gives an example for multiple context information sets. Exactly eight context information sets are assigned to the “IBM Websphere Portal Demo” video clip. One of these context information sets including all its contextual parameters is the one assigned by first usage, as exemplified above (“Conference”, Figure 4-7). Context information sets “Conference”, “Sales event”, “Portal Workshop” and “Marketing event” relate the video clip to separate events; they all include their respective contextual parameters with a distinct contextual signature. “Software Design” and “Market value” define the use for training and learning purposes. “Workflow process for approval” currently links the knowledge nugget to an approval process; when this approval process is terminated this context information set will be purged (or archived, if it seems appropriate). Similarly, the knowledge nugget is temporarily linked to a “Travel Reimbursement” context in the organization.

The next section will articulate more in detail the basic model of context information sets and the mechanism for assigning them to content as used in the CM-WLOD approach and leading to a prototypical implementation.

4.3.2.3 Structuring Context Information Sets

Structuring context information sets has to be understood as being equivalent to content metadata modeling, here for the specific usage in the CM-WLOD approach. IEEE LOM or the Dublin Core Metadata Element Set are examples of context information sets that are generated from the original application domain of the content. In CM-WLOD a more general metadata model is used. The reasons for this are manifold. A first main reason is that multiple context information sets will be considered; this is not the case e.g. for LOM and the Dublin Core Metadata Element Set. A second important reason is that CM-WLOD is focused on organizational learning usage on-demand at the workplace and repurposing around organizational processes. Hence, specific metadata entities are included which are not - or not to this extent, or not in this specific structure - part of approaches for modeling learning content metadata. A third reason is that CM-WLOD will be demonstrated to be fully functional based on prototyping in a layered approach which will be further explained in chapter 5. Thereby, important services will be provided by the K-pool system layer on top of which CM-WLOD is directly positioned (Table 5-1). So, many of the existing functions are to be tapped embracing K-pool's general data model. Some functions and parameter presentations are added due to this research, some parameter settings are due to pragmatic refinement and experiences of knowledge management endeavors based on the use of K-pool's content repository over the years.

It has to be kept in mind though, that the further outlined CM-WLOD metadata approach is not intended for the purpose of establishing another candidate for competing in the arena of "the best" metadata model. On the one hand it is not difficult to convert CM-WLOD metadata to other metadata models; e.g. during the course of this research an IEEE LOM interface had been easily constructed (see chapter 6.3). On the other hand ample experience of designing workplace software components in industry suggests that interoperability with respect to data mapping is not any more the challenging issue it used to be. So, the stance here is that the parameters and attributes of the CM-WLOD metadata model can be easily translated into other metadata models.

Against this background one context information set for a K-nugget in CM-WLOD comprises the following contextual parameters:

1. Themes
2. Title, and short description
3. Keywords, being organized in separate and independent sets of keyword-classes
4. Categories
5. Access control parameters

6. Workflow parameters
7. Miscellaneous other parameters

(1) “Themes” are represented by short character strings. These strings characterize the K-nugget for the application domain, with respect to the purpose of the actual context information set and the content material. Themes can be categorized to present a collection of K-nuggets belonging to the same theme. Multi-dimensional categorization is possible. Accordingly, a context information set can have more than one value for the “Themes” parameter. In general, an organization will define guidelines for the appropriate usage of the “Themes” parameter according to the conventions used in the organization to categorize organizational entities. Allowed values for “Themes” might be based on organizational data dictionaries.

Examples:

- Marketing\EMEA (theme for collecting marketing material for the “Europe-Middle East-Africa” region) [36]
- Software Design\Best practices (theme for collecting “best practice” material for software)
- Software Design\New Guidelines (theme for collecting new guidelines for software development to be learned)
- ProjectsAsia\China\Current Policies (theme for collecting current policies for projects in China)
- Smith Jane\Conference presentations

  Websphere\Portal

  (themes for collecting Jane Smith’s conference presentations <u>and</u> Websphere Portal material. Here, an example for multi-dimensional categorization is given; the context information set has value assignments to both themes simultaneously)
- Sales\Global Business\Country Information (theme for collecting information material about customer countries)
- H&R\Learning Material\Languages (theme for collecting language learning material)
- Projects\New Services\Competitive Analysis (theme within the organizational project folder, sub-project “New Services”, to create and study material for competitive analysis)

(2) A “title” is a compact line of text describing the actual context information set and the content material in a summarized fashion. A title is to be understood to be analogous to the “subject”-field in an e-mail message or calendar entry, or to headlines and chapter titles in a book. The related “short description” parameter allows adding a short summary, like an abstract for a paper.

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[36] “\” (= backslash) denotes sub-categorization in the sequel of this thesis. Here, it is used for denoting “Sub-Themes”. The same notation holds for other contextual parameters as well. “\” can be used subsequently as many times as necessary for defining sub-sub-… etc. categories. Thus, category trees of arbitrary depth are allowed.

Examples:

- Title:
  Websphere Portlet Factory: Advancing Beyond Builders (Rego & Wilmeth, 2007)
- Short description:
  Websphere Portlet Factory can help you build enterprise-quality portlets right out of the box. But make no mistake, it doesn't stop there; you can reach much farther than this. By understanding the many extension points that Websphere Portlet Factory provides, you can accommodate custom design patterns, take complete control of your user interface, pre-describe all of your data, farm out application tasks to custom and pre-existing code, and of course expose it all to be configurable as necessary. Developers rejoice! Automation with flexibility is available now.

(3) “Keywords” in CM-WLOD are being organized in a multiple keyword model which comprises separate and independent sets of “keyword-classes” to provide very flexible and rich means of attributing details and structure to context information sets. This is opposed to the use of keywords in many cases where there is just a flat unstructured way to assign keywords. E.g., keyword tagging in research papers follows this type of approach of a flat keyword list. On millions of occasions the current use of (keyword) tagging in typical Web 2.0 applications, with social tagging instruments around folksonomies, follows flat keyword assignment as the de-facto standard. “Tag clouds” add some structure on keyword assignment by counting the numbers of occurrences of the referenced keyword values and by relatively visually enhancing and highlighting higher number occurrences (see Figure 2-16). But, in this thesis a much more structured approach to keyword tagging is taken, which - similar to the concept of “multiple context information sets” - allows for a classifying structure of multiple independent keyword tag assignments.

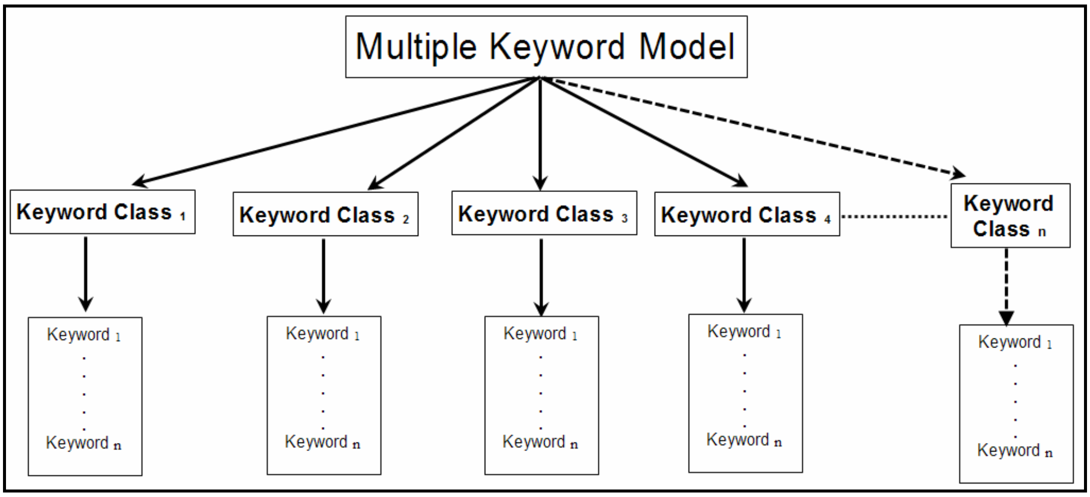

Figure 4-9: Multiple keyword model with keyword-classes

As outlined in Figure 4-9 the multiple keyword model takes a two-step approach to assign keywords to K-nuggets. The first step consists of defining keyword-classes as containers for collections of keywords. Each keyword-class reflects basic structural necessities or preferences of the application domain and is determined by conditions from the real world. Very simple examples are keyword-classes like “PEOPLE”, “ORGANIZATIONS”, “PLACES” or “TIME”. They respectively constitute containers for keywords like

- “Jane Smith” - “Howard Miller” (PEOPLE),
- “IBM” - “University of Paderborn” - “Department for Business and Human Resource Education” (ORGANIZATIONS),
- “Berlin” – “Boston” – “China” (PLACES) or “Good Friday” – “2007” – “Bank Holiday” (TIME).

From the viewpoint of the CM-WLOD model there is no restriction on the number of keyword-classes. The number of keyword-classes and keywords are left open for the system implementer to decide whether it should be based on organizational policy, specific industry practice, based on standards as offered in glossaries and dictionaries dedicated to specific application domains, or left to the users’ deliberate choice.

The use of keywords being organized in keyword-classes together with “access control parameters” (see below) as another contextual factor offers very subtle structuring means for workplace learning on-demand. In the CM-WLOD implementation it is possible to define keyword-classes either as mandatory and prescribed by the organization or as being freely introduced by users or groups of users. The latter mentioned self-determination of keyword-classes can be controlled by access control parameters which allow to assign the right of creating a keyword-class to individuals, organizational units (division, departments, subsidiaries, etc.), workgroups (project groups, peer groups of learners, special interest groups, task forces, etc.) or roles (trainer, content manager, content provider, content editor, project coordinator, etc.). A similar approach for differentiation is given for keywords. They can be decreed as a closed list, they can be decreed as a closed list with an option for adding new keywords or they can be completely open. As above, access control parameters grant the rights as to who can do what. So, some individuals (or: organizational units, workgroups, roles) can be assigned the right to create new keywords or to tag a K-nugget with keywords, while others are not allowed to do so and thus can only read and make use of existing keywords assigned to a K-nugget.

(4) The purpose of "categories" is primarily to provide a generic mechanism for personal tagging of employees/learners or individual tagging of workgroups.

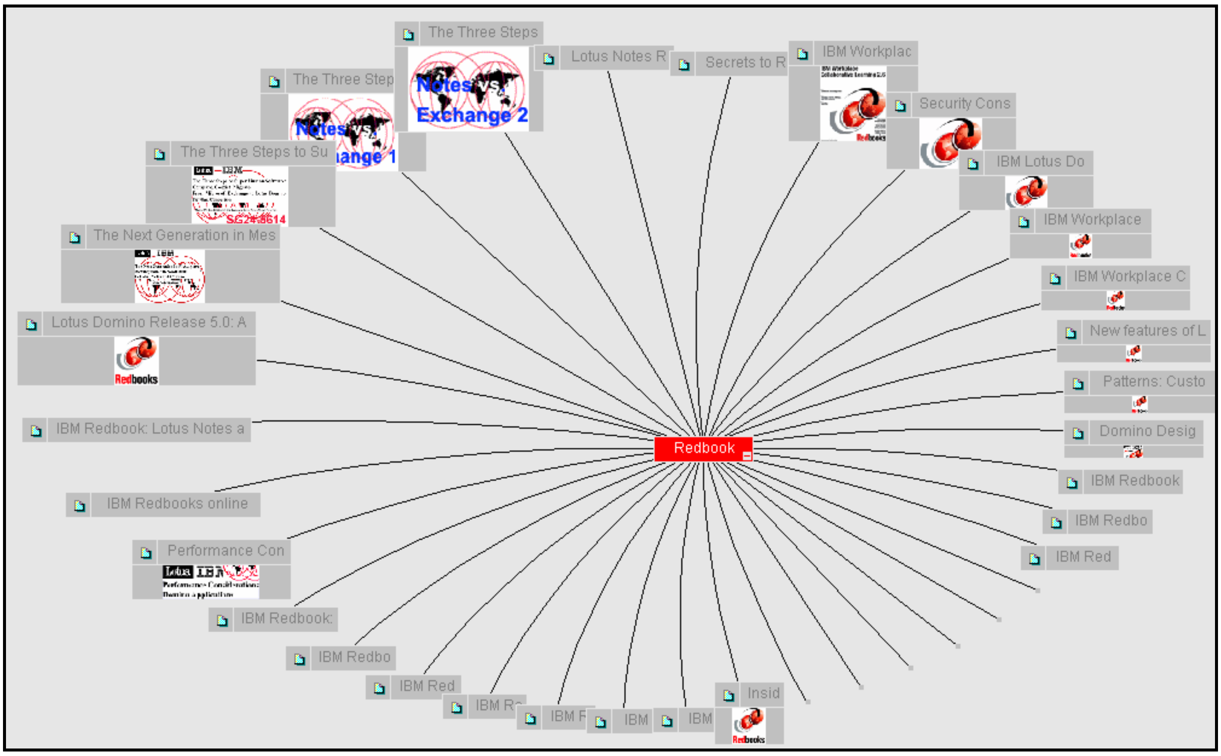

Figure 4-10: Hyperbolic Tree example of a K-nugget collection using the "Categories" contextual parameter "IBM\Redbook" (CM-WLOD K-pool prototype)

This tagging can be used e.g. for creating personal or team folders, or for various graphical representations and context analysis purposes of specific collections of K-nuggets. As opposed to the stricter consensus necessary for allocating "Themes" contextual parameters, the usage of "Categories" in an organization needs guidelines only in so far as to avoid overlap and confusion. But in principle it is intended that the choice of parameter values for "Categories" needs no coordination between individuals or teams.

Examples:

- IBM\Redbook (category for rendering the collection of available IBM Redbooks in the graphical representation of a hyperbolic tree, see example Figure 4-10)
- Smith Jane\lessons learnt\2006 (category for summarizing Jane Smith's learning materials having been studies in 2006)
- Smith Jane\lessons open (category for summarizing Jane Smith's learning materials intended by her for being studied)
- EMEA team\cross cultural issues (the EMEA-team [Europe – Middle East – Africa] consented to collect miscellaneous material pertaining to cultural issues under this category)

(5) "Access control parameters" define access rights for reading and/or writing of K-nuggets. Multiple context information sets of a K-nugget can have their respective independent sets of access control parameters. This allows for very flexible modeling of the many possibilities of reuse practices in an organization via content access control. So, some context information sets of a K-nugget might not be visible to individuals or groups because these individuals or groups are not granted reader rights to these context information sets. Another practice might be that the H&R-department wants to have specific content material being studied as a prerequisite for a training course for an identified target group (this might be, e.g., part of the material being collected as K-nuggets under the above mentioned "EMEA team\cross cultural issues" category). This preparation task can be executed by assigning workflow information to context information sets and this way "pushing" the content precisely to the targeted user group. To be able to initiate this workflow H&R needs write access to context information sets. The appropriate assignment of access control (and workflow) parameters registers this forced reading of the K-nugget's content material - including, most likely, some obligatory responses being asked for - only at people's workplaces of the identified target group. To make the mechanism clear: The involved and intermediately workflow-embedded K-nuggets which belong to the "EMEA team\cross cultural issues" category might still be visible to other individuals or teams, this by triggering some other context information set which is (currently) not involved in a workflow.

(6) "Workflow parameters" provide the means of putting content in process contexts of an organization. If they are allocated, the K-nugget will be embedded in organizational workflows. In most cases this will be an intermediate state, from the start of a workflow, over several "hops" defined by process tasks where the content plays a role to perform the tasks in an appropriate way, up to the end of the workflow. This way, content can be delivered to workplaces in a structured and planned manner. In learning processes this could be mandatory material to be studied for a specific learning or training task. Workflow parameters can be

designed to allow for many shades of "learning" endeavors based on a K-nugget at a workplace. This might range from simple "acknowledgement" mechanisms, implying that a person has become aware of the K-nugget, up to successfully working through complex instructional sequences before the workflow task on the K-nugget can be finished. Usually the workflow parameters include gestures where the user at the workplace indicates that she has finished her work on the K-nugget. E.g. the gesture clicking a button "chapter completed" changes the current state of the contextual workflow parameter set in such a way that the involved K-nugget is released from the "to-do"-list at the workplace – and possibly routed to another workplace.

(7) "Miscellaneous other parameters" comprise an open list of contextual factors which might be necessary to model specific individual preferences or needs of knowledge management in an organization. Examples for often used "Miscellaneous other parameters" are type information about the digital asset(s) in a K-nugget (digital image, video type, document format, etc.), versioning, parameters for re-referencing (URL, permanent URL, unique key, etc.), date/time information associated with the K-nugget (date created, list of dates of changes), authoring information (name of creator, name list of editors), and others. Some of these parameters may be assigned deliberately by users; some may be maintained automatically by the underlying system platform. For the purpose of this thesis it is not necessary to do an in depth analysis on these "miscellaneous other" contextual parameters because they are not in the foreground of the research leading to the CM-WLOD approach.

In the rest of this chapter it is shown how these different contextual parameters work together in attributing distinct contextual signatures for a K-nugget. Figure 4-11 repeats the rather illustrative outline of a K-nugget structure as drafted in Figure 4-7 in a more formal way, according to the above definition of seven contextual parameters. A given value set of contextual parameters defines a precise contextual profile of a K-nugget, which makes it possible to practically search K-nuggets with similar contextual signatures (see chapter 6.1, example and suggestion of contextual parameter #8).

To generalize, the basic structure of context as defined for a K-nugget for workplace learning on-demand can be seen as an extension of basic approaches for metadata modeling as used e.g. in IEEE LOM or the Dublin Core Metadata Element Set. The K-nugget modeling in the CM-WLOD approach is to be positioned as an application of ontology theory analogous to Smolnik's Topic Map design (2005, p. 80). Accordingly it maps information and knowledge, context information and structural relationships of an application domain in the real world to the digital world.

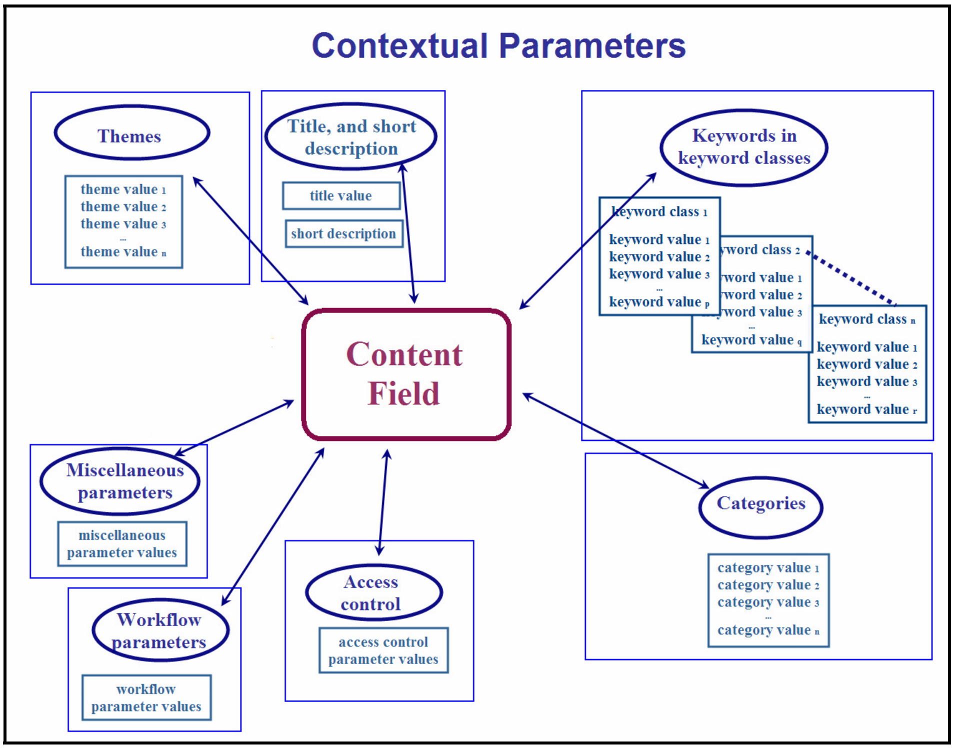

Figure 4-11: Data model for contextual parameters for a K-nugget in CM-WLOD

CM-WLOD compliments the traditional, linear and flat taxonomy approach used for “learning objects” of defining knowledge based primarily (or alone) on content. Thus, in other words, the CM-WLOD approach includes an ontology - in the IT sense of use -, which is based on a flexible data model comprising concepts and an open space for their possible relationships for learning on demand at the workplace. It is used to reason about the objects within that application domain. The traditional flat approach tends to restrict the revelation of information and knowledge within the complexity of a living organization or the formal infrastructure of an information system. Especially, the concept of two-stage keyword modeling based on keyword-classes in CM-WLOD offers much flexibility and many (re-) structuring opportunities for customization and adaptions to the versatility of the real world. As certain keyword values and keyword-classes are sharable or exist as common elements among different contextual signatures, CM-WLOD enables multi-dimensional and crisscross structuring of data and information that is contained in the content field; this will be further explained in chapter 5.

An example, which extends the focus of Figure 4-11 to the CM-WLOD multiple context information set model, is illustrated in Figure 4-12. The example shows four specific contextual parameter sets, linking the content of the K-nugget (as stored in “Content Field”) to contexts “China Project”, “Workshop”, “Conference Presentation” and “Workflow” in different application domains. These four contexts are defined by four distinct contextual signatures which are made up by a respective collection of contextual parameter values.

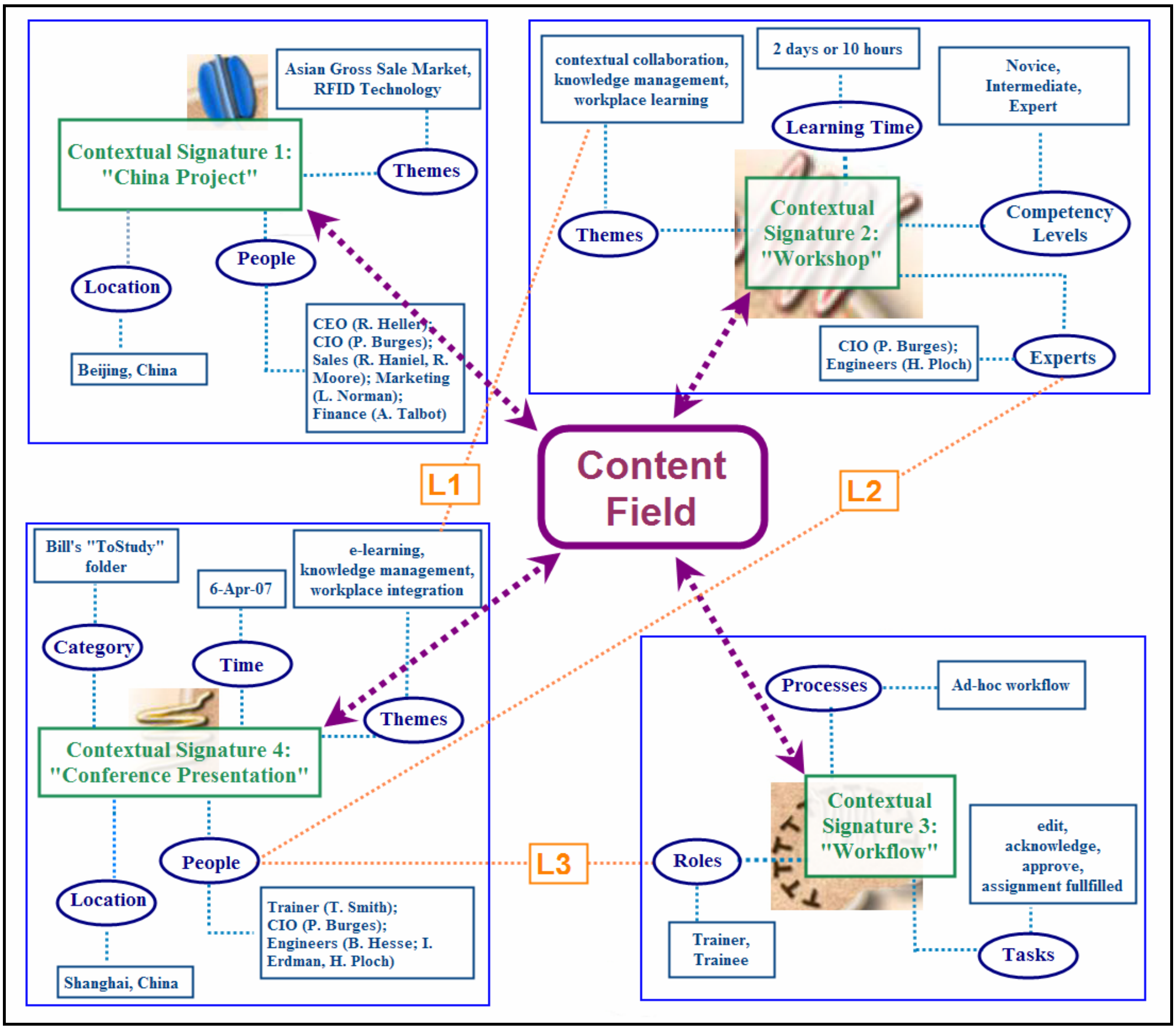

Figure 4-12: Example of multiple context information sets with their respective contextual signatures

Different contextual signatures may share the same values of some of their contextual parameters (see the dotted connection lines L1 through L3 in Figure 4-12), like “knowledge management” being a “Theme” in “Workshop” and “Conference Presentation” (line L1). Or, a member of the “People” keyword-class in “China Project” explicitly shows up in the “People” keyword-class of “Conference Presentation” as well as in the “Expert” keyword-class of “Workshop” and is implicitly referenced by a “Role” contextual parameter of the “Workflow” contextual parameter set - all referring to the same content but out of different contexts in different application domains. Anything existing in the content field will be multiply linked to different contextual signatures, and when applicable, interlinked via shared contextual keyword parameters in respective classes.

As depicted in Figure 4-12, the contextual signature of “Conference Presentation” consists of a context information set including keyword-classes, namely, according to the figure, “Time”, “Location” and “People”. These keyword-classes in turn include parameter values to describe this specific conference. Another remark about the example: “Bill” has become aware of the K-nugget by stumbling into it at the “Conference Presentation” on “6-Apr-07” and found the content of the K-nugget relevant for his work to further study it in more detail. So he tagged it “Bill’s ToStudy folder” using the “Categories” contextual parameter. Provided he is using one of the “pull” mechanisms at his workplace which automatically select all instances of content tagged with “Bill’s ToStudy folder” (what he does of course) the K-nugget will show up in the “ToStudy” portlet of his workplace triggered by the “Contextual Signature 4: Conference Presentation” of the K-nugget. How this workplace interface might look like is mapped out prototypically in chapter 5. The “ToStudy” tag is an example for what is called a “loosely-coupled” relation in this thesis: Bill thinks the content is important for him and he decides to put it in his personal “ToStudy” list; when and whether he really does work on the material is left to him. The concepts behind this will be outlined in the next chapter.

Contextual parameters in this example have been investigated from the viewpoint of the single K-nugget. But, they pertain to the whole organization and are an integral part of the organization’s data model. So, they are not only related to learning and knowledge management issues but also to general business processes. This is what has been mentioned above that the cellular structure of a K-nugget contains context information about the whole system. So, e.g. starting from the keyword-class model many structured search and classifying approaches can be taken to organize K-nuggets. In the application domain of workflow, job task sequences, line of business processes, and employee’s roles (e.g. department head, sales manager, front desk receptionist, etc.) contextual parameters reflect process instances in an organization. Again, starting from the contextual parameters associated to workflow processes K-nuggets can be managed according to their process status in an organization. Examples are: “show the percentage of background material for the Asia-market project which had been worked through by people involved in this project”, “indicate the departments where the new policy documents have not been acknowledged yet”, “identify the list of people who have acknowledged working through the EMEA environmental hazard study 2005”, “does anybody have ever acknowledged having read the new research results on mobile phone handset usage?”, etc. How all this works together from a practical point of view in the whole organization is mapped out in chapter 5.

4.3.2.4 Strongly-Connected and Loosely-Coupled Relations

Learning scenarios which center on learning processes being delivered in classroom settings have implications. One of these implications is that the teacher or the institution offering the class impose the curriculum material being used for all learners in the class. As a result the learning cohort of a class is obliged to synchronously work through the same content in class. The liberty to choose complementary material to one's own choice, speed and schedule is granted for learning outside of the class by the learner's deliberate selection of material related to project tasks, field work, report assignments, or free studies. How can this approach, i.e. the use of mandatory content in an organized form on the one hand, and complementary content in an emancipated way on the other hand, be modeled in workplace learning on-demand scenarios?

In a workplace learning environment the hosting organization, i.e. a business or public organization, is certain to want to have control over specific content and related material it expects their employees to know precisely about or to be familiar with. This content is related to knowledge for competently pursuing regular business processes or specific project assignments demanding respective skill profiles. In a classroom setting this content normally would be part of a dedicated training seminar and delivered as associated seminar material (in more or less impressive folder handouts). On the other hand an organization normally will not only tolerate but support means of fostering the goal of a "knowledgeable organization" induced by employees who are educated on a broad level and continue in their pursuit of steadily gathering additional knowledge. Part of the sources for this individual pursuit of learning will be available or made available at workplaces inside the organization. For a classroom setting, this type of material would be considered as either recommended background information, or would be discovered as likely useful and relevant material by the individual class members. It would be gathered and worked upon not within the classroom setting but outside.

Breaking this down to the CM-WLOD approach means that at the workplace there must be an infrastructure for both: On the one hand content delivery for prescribed material following organizational rules and compliance, and on the other hand for emancipated material collection according to individual preferences. The first implies rendering a stream of K-nuggets at the workplace according to prescribed organizational processes which are mandatory to be worked upon. The second implies a more nonrestrictive option for individually collecting K-nuggets which have the property of background or complementary material - but, they still impose a high degree of structuring options and necessitate embedding in organizational processes as opposed to, say, completely random browsing of web content.

If this might sound all too constructed or theoretical, have a look at the typical physical workplace setting of the office in the pre-computer time. In principal, you would a) expect the desktop filled with material in the center organized in folders indicating their importance or relation to the owner's job responsibilities, b) you would have additional material related to the office inhabitant's job located at the edges of the desk, another table in the office or shelves (maybe not so perfectly organized in general), and c) you would find places where the daily newspapers, journals, flyers, or whatever papers are more or less randomly scattered around. CM-WLOD deals with a) and b), focusing on content and material which is related to learning and knowledge management, and which is considered being presented at the workplace together with line of business tasks in an integrated way. To distinguish between the cases a) and b), in this research the notion of "strongly-connected" [a)] and "loosely-coupled" [b)] is used. Type c) is left out to individual styles of handling e-information, which are not part of an organization's responsibility and not part of this thesis.

Strongly-connected or loosely-coupled relations of K-nuggets to workplaces are modeled via appropriate value settings for contextual parameters. These settings in turn are used within the underlying IS-infrastructure of the organization to provide functions for overall management of K-nuggets. Simultaneously, handling of the contextual parameters is assisted by a rich tool environment to deal with these K-nuggets at the workplace. Obviously, these contextual parameters and related functions must enable the organization to "push" K-nuggets with mandatory content down to the targeted workplaces. On the other hand, the tools must enable users at the workplace to "pull" up K-nuggets they deliberately choose as complementary material for their individual knowledge gathering endeavors. The "push" principles are relating to the organizational "demand" side of workplace learning on-demand, the "pull" principles to the employee's "demand" side.

The concept of strongly-connected and loosely coupled has to be understood with respect to the application domain. Specifically, a domain can be related to organizational entities such as the whole organization, a sub-structure of an organization (e.g. divisions, departments, workgroups), or individual users (e.g. trainer, manager, line of business experts, project leaders, etc.). As more as larger aggregates of the organization are involved in defining an application domain, as more widely used the understanding of a domain will be among individuals in the organization. As more as application domains are defined by individuals themselves, as more they relate to their personal tasks and activities in the organization; then, most likely, they will not be shared with many others. Practically speaking, an application domain might be a general topic, area of responsibility of a department, specific line of business task, project, field of expertise, merger endeavor, financial planning, marketing and sales project, strategic educational focus of the organization, dedicated training area, etc. and thus relate to a specific expertise and knowledge area. Coming back to the case scenario in the previous chapter, examples of application domains can be the "China Project", "Workshop" at the University Paderborn, "Conference Presentation", "Workflow" in a training project, etc.

Learning in on-demand mode requires a versatile approach of assigning anything contained in the content field to a specific application domain. Versatility is required because this application domain might not be previously defined, or prepared for, or stable in a repetitive pattern, or agreed upon among a larger group of individuals in the organization. In order to accommodate both stable and dynamic domain incidences matching the ever changing patterns of business processes in the application environment, the domain-to-K-nugget(s) relations presented in this thesis are modeled according to the following guidelines which are called "strongly-connected" or "loosely-coupled" respectively:

1. A strongly-connected relation between domain and K-nugget: When a larger body in an organization explicitly or implicitly agreed to the definition of particular application domains, a hard-defined domain name will be implanted as descriptor in the contextual signature. This domain name might stem e.g. from a data-dictionary in the organization, from rules of corporate compliance, from principles how to code project names, from abbreviations which the training department uses for their announcements, etc. The respective domain name (i.e. a character string) will be among the values of contextual parameters. In CM-WLOD the contextual parameters "Themes", "Categories", a keyword-class "Project-IDs", or the contextual parameters for "Workflow" are considered to be appropriate value containers for modeling a strongly-connected relation. This modeling on the K-nugget side has its counterpart on the design side of the workplace infrastructure: fixed mechanisms which are guarded by organization wide rules must guarantee that K-nuggets which are tagged as strongly-connected to a specific application domain are guaranteed to be "pulled" or "pushed" into knowledge worker's workplaces related to the specific application domain.

2. A loosely-coupled relation between domain and K-nugget: The application domain is connected to the workplace in an ad-hoc fashion, rather than pre-defined or predictable. The domain naming might be created by the individual or by choosing an existing domain name in the organization. The domain tagging is deliberately at the user's choice thus associating it to his workplace, while it is not assigned by the forcing mechanism of a strongly-connected relation. In CM-WLOD, especially the contextual parameters "Categories" and "Keywords" organized in keyword-classes are considered to be appropriate value containers for modeling a loosely-coupled relation. This modeling on the K-nugget side has its counterpart on the design side of the workplace infrastructure: flexible mechanisms which can be controlled by the employee at the workplace allow rendering and organizing K-nuggets which are tagged as loosely-coupled to the workplace. Here, in the CM-WLOD approach this binding of loosely-coupled K-nuggets to a user's workplace nevertheless follows corporate rules and provisions at least to some degree. It is not just left to the (very) individual and not replicable style in which users tend to organize their personal to-do-list or individual bookmarks. Rather, the CM-WLOD workplace provides a well defined and integrated environment for knowledge management and learning including both an area providing mechanisms for strongly-connected relations and a complementary area for managing content due to the user's free choice.

This approach, loosely-coupled and strongly-connected content, to maintain links between application domains and K-nuggets will be explained more and demonstrated how it is implemented in a knowledge management system in chapter 5.2 & chapter 5.3. Here, the approach shall be exemplified on the basis of the CM-WLOD data model as mapped out in Figure 4-12 and illustrated Figure 4-13.

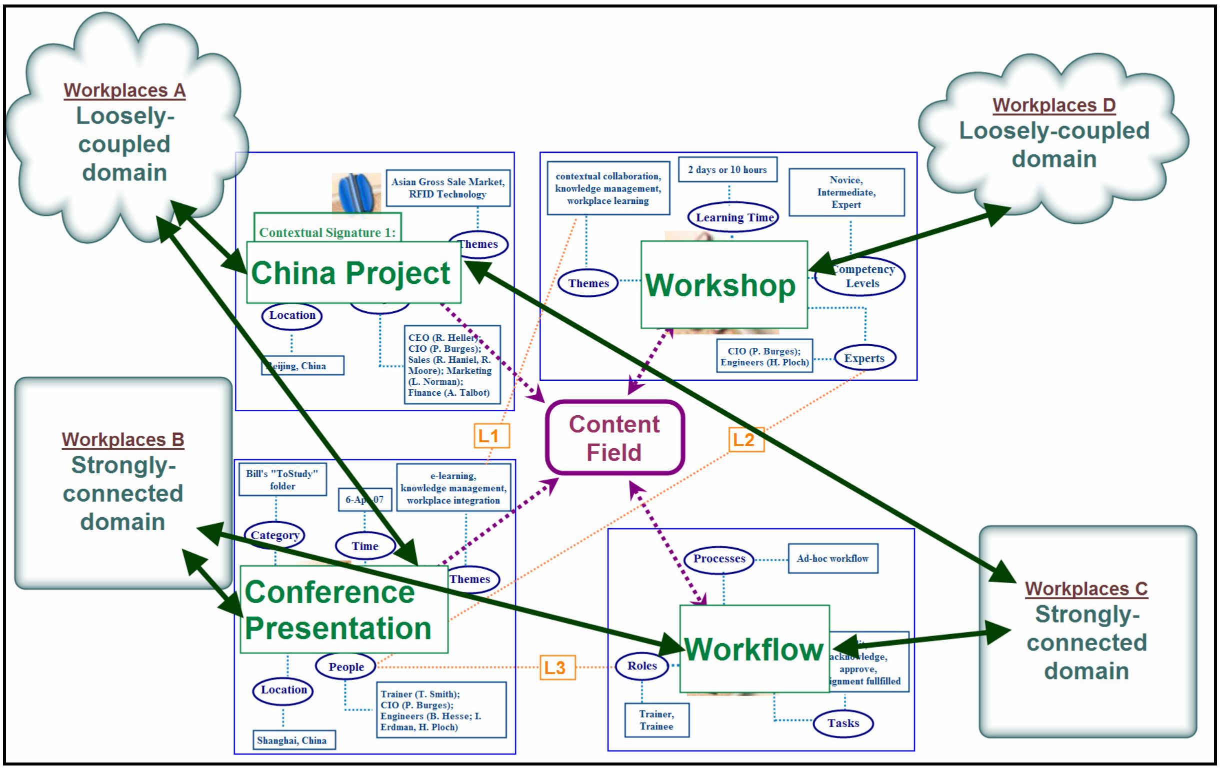

Figure 4-13: Relation between application domain and contextual signature

In Figure 4-13 the four application domains of Figure 4-12 are repeated. In addition, it is assumed that the four workplace groups "Workplace A" through "Workplace D" consume the underlying K-nugget. The domain "Conference Presentation" is loosely-coupled to "Workplaces A". It has been shown as an example in the previous chapter that employee "Bill" deliberately has chosen to connect the conference material to his workplace by assigning the value "Bill's ToStudy folder" to the "Categories" contextual parameter. Bill's workplace belongs to the group "Workplaces A". So at all workplaces of this group (this might be just one, namely his own workplace) the K-nugget shows up in a user-interface area representing loosely-coupled material. "Workplaces C" are strongly-connected to the domains "China Project" and "Workflow". The forced connection of "Workflow" to the workplaces might be enacted by the organization's workflow system, the forced connection "China Project" by the project folders on "Workplaces C", reflecting that all people working at these workplaces are involved in the "China Project". It has to be noted that the underlying mechanism is exemplified here using just one K-nugget and thus one piece of content. This is done to not overload the example. As the contextual signatures are formally independent from the "Content Field", for this purpose of exemplifying strongly-connected vs. loosely-coupled it does not matter whether more than one K-nugget is involved.

In an attempt to positioning "traditional" e-learning systems against the CM-WLOD approach of loosely-coupled and strongly-connected content, CM-WLOD would play the role of the content management system in e-learning with respect to the strongly-connected content part. Regularly, the management of loosely-coupled content is not part of e-learning systems. Whereas traditional e-learning systems represent dedicated and standalone system concepts, CM-WLOD defines an integrated part of a regular workplace infrastructure in an organization. From a system standpoint, CM-WLOD can be easily embedded in the ECM-infrastructure (Enterprise Content Management) of an organization. This holds with respect to the content repository, as well as system integration with standard business components and content delivery to workplaces.

4.4 Reflecting on Tags and Tagging as Essential Building Blocks of CM-WLOD

4.4.1 Issue of Number of Contextual Parameters in CM-WLOD

When it comes to application at the real workplace, a concept must survive on the solid ground of practical implications. This thesis focuses on the issue of workplace learning on-demand. As outlined above a central concept to be used is taking a set of contextual parameters to define the relation between an application domain of knowledge and K-nuggets being tagged for this domain. This mechanism must be sustainable in a clerical work environment at the workplace.

In the setting of mundane everyday routines at the workplace, a knowledge worker must blend his/her learning endeavor with daily job tasks effectively as well as efficiently. When content overload and handling all too many business tasks is already an issue (this will be the normal case everywhere), there is a need to find the optimal amount of metadata describing context information in order to identify the right piece(s) of knowledge in the right setting for repurposing or referencing (see chapter 3.4). In addition, the way metadata are modeled should not suggest an all too large perceptional distance to the daily work done at the workplace. However, how to find the optimal point? Or, how many contextual metadata is just enough for being effective and efficient?

In trying to find support for an answer to this question, a renowned research outcome from George A. Miller (professor of psychology from Princeton University) will be taken as a reference. Miller's 1956 article named *The Magical Number Seven, Plus or Minus Two: Some Limits on Our Capacity for Processing Information* is attributed as having a great impact on the design of information presentation. Some people apparently took the 7±2 rule literarily. This lead to hilarious examples of interface designers (physical or digital) strictly demanding only 7 items on a billboard or no more than 7 items on a slide or list. Miller's response to this simplified interpretation of his findings is “7 was a limit for the discrimination of unidimensional stimuli (pitches, loudness, brightness, etc.) and also a limit for immediate recall, neither of which has anything to do with a person's capacity to comprehend printed text” (as cited in Sharman, 2003, section: The Myth of Seven, para. 2). Tufte (professor emeritus at Yale University) hits a more profound point of Miller’s research in which Miller “suggests strategies, such as placing information within a context, that extend the reach of memory beyond tiny clumps of data” (Tufte, 2003, section; The magical number seven, plus or minus two: Not relevant for design, para. 1).

To apply Miller’s suggestion in defining context information surrounding knowledge in workplace learning on-demand, a five to nine count (“7±2”) for contextual parameters, which allow an unlimited number of values respectively, seems to be a reasonable suggestion. People may counter this specification, and have as many tag classes as one may wish; this is possible because there is no limit in the contextual referencing model CM-WLOD itself. Yet, at today’s workplaces where efficiency and speed play a decisive role, it makes sense to have in mind Miller’s 7±2 idea with respect to tag class count. This seems to be a reasonable number of contextual parameters a knowledge worker can juggle in a short time span.

The next section will deal with the range and characteristics of tag classes specifically.

4.4.2 Other Workplace Learning On-demand Approaches

The CM-WLOD approach is intended to seamlessly blend learning into the usual business activities performed at the workplace. Thus, learning is considered as part of knowledge management endeavors in a business, the content side is modeled to be integrated in the enterprise content management environment (ECM), the metadata model outlined above for a K-nugget is designed to coexist with typical organizational data models and business objects in an integrated fashion.

In balancing a general approach there is always a compromise. So, systems specifically dedicated for “e-learning” might have more focused and restricted mechanisms to support just learning activities as compared to CM-WLOD. Two aspects shall be taken as examples to indicate that from the conceptual side there are, nevertheless, no restrictions to adapt CM-WLOD for supporting management and delivery of learning content due to whatever the specifications of an e-learning scenario might be. The first aspect is handling of time, the second is hinting at characteristics of dedicated learning-only data models.

In chapter 2.4.3, Bersin & Associates (2005) have identified two specific contextual tag classes that influence the aggregation of content of learning on-demand in a workplace setting. Namely, *time to solution* and *performance problem* are the two dimensions that an organization may use to categorize their digital content serving on-demand learning needs. However, as shown in the previous section on the conceptual level of contextualizing knowledge, there are more than these two or three dimensions in defining contextual classes. Researchers (chapter 2.4.1 & chapter 2.4.3) advocate workplace learning should be relevant to job tasks, a collaborative interaction among peers, a self-controlled process, and last, but not the least, just-in-time. It is apparent that *time* is positioned as a critical contextual factor. In Bersin & Associate's understanding, time means time to solution, but to others, time can be average learning time or learner's availability (e.g. how much time he/she can spare to learn at work among other tasks) as illustrated in Figure 4-14.

In CM-WLOD the contextual parameter "time" can be dealt with in much more manifold ways. This might be by explicit assignment of date/time parameters or implicitly and automatically, e.g. by the underlying middleware-platform, by an ECM-system, or by workflow engines. Accordingly, the content management system underlying the CM-WLOD prototype is always automatically provisioning a K-nugget with a date/time stamp "created" and a list of "modified" date/time tags, including the corresponding authors who created or modified the K-nugget. Assignment and management of start dates, due dates or hand over dates (including the supporting alarm or sequencing mechanisms) is the dedicated arena where workflow systems are made for and can be modeled in a variety of ways within the "Workflow parameter" class of CM-WLOD. Periods and durations can be constructed by assigning a specific keyword-class, like the example in Figure 4-12 illustrates for the contextual parameter "Learning Time" in tag class "Workshop".

The second constructional aspect pertains to mirroring the general data model of the CM-WLOD approach to dedicated e-learning systems. Figure 4-14 gives an example (Tribe & Roche, 2006) and will be used to hint at basic differences.

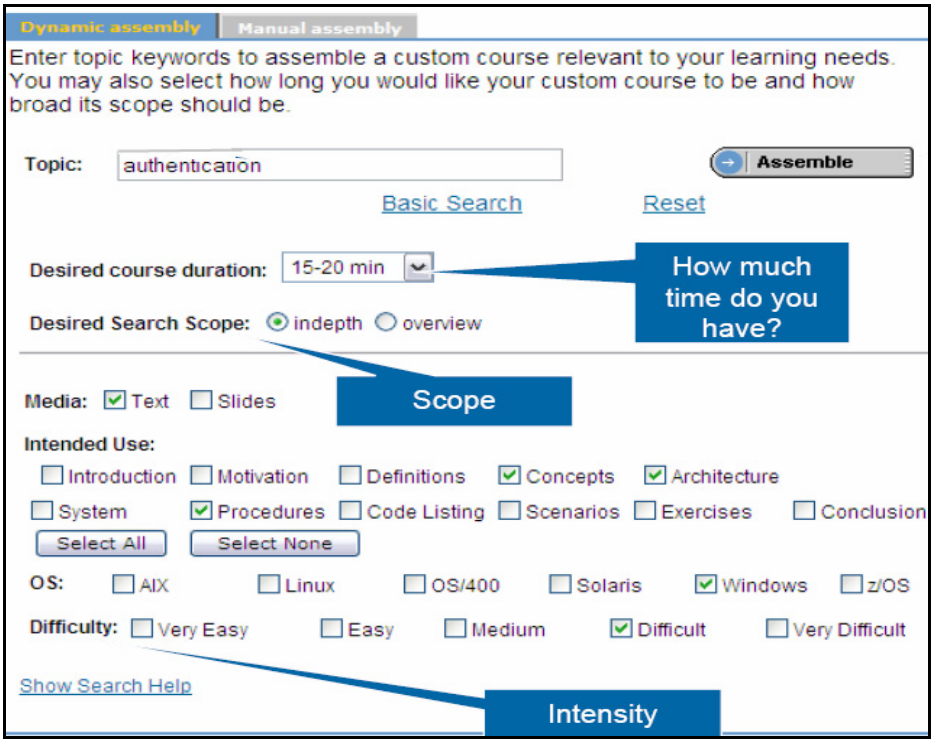

Figure 4-14: Example of contextual keywords used in assembling learning courses from IBM Lotus' perspective

In this specific design of assembling learning content, there are 7 keyword/tag classes that learners can choose for dynamically assembling content for learning: Topic, Desired course duration, Desired Search Scope, Media (rendering type), Intended Use, OS (operating system), and Difficulty. This user interface shows how IBM learning technology developers view as well as tag digital information and knowledge with content-centric metadata (e.g. media, OS) and learning centered keywords (e.g. desired course duration, desired search scope, difficulty) determined by the individual user, and not the context the content is used for or embedded in at the workplace in organizational processes.

There is no one holy method of defining context and explicit contextual tag classes. But when it comes to constructive implementation of knowledge nuggets for CM-WLOD, it is important to define a parameter environment for arbitrary taxonomies with multidimensional contextualization. As outlined in many places in this thesis, state-of-the-art research and technology applications recommend a seamless integration of learning into workplace contexts - activities and processes via collaborative efforts among people for on-demand learning needs. Specific examples from Bersin & Associates on contextually structuring on-demand learning content and the application example from IBM Dynamic Learning each show only part of the picture. Synthesizing them together with specific aspects of people-centered collaboration at work, including learning phases, and blending them into coherent workplace processes was the underlying reasoning behind the suggestion for contextual parameter classes made in chapter 4.3.2.3. Furthermore, the concepts of strongly-connected vs. loosely-coupled relations between application domain and content allow to prioritize the learning side of an employee's activities at the workplace (i.e. by provisioning of strongly-connected content, including the related functionalities how to deal with the content) or to loosen the learning impact (i.e. by loosely-coupling, leaving open what the user/employee can decide as to how to deal with the content).

4.4.3 Tagging Continuum

When applying all the above concepts in an information system, specifically to a knowledge management system, the contextual data model is revealed by assigning metadata to information and knowledge – simply, by the tagging mechanism. From the technical implementation perspective, metadata tagging is the first and foremost important step on modular design of content, not only for describing related content, but also to prepare it for easy reusing, repurposing, and re-referencing in future occurrences.

Figure 4-15 exemplifies how metadata tagging used to be done in the "good old days" using colored cards for what is called in this thesis a "metadata stub". Starting in 1998, the author was a team member in GLOHBE (Global Partnership for Hospitality Education), an international distance learning project aiming at professional education in the hospitality business (Holland, 1999, p. 94-98; Holland, Clements & Buergermeister, 2000). Project leader for GLOHBE was the University of Wisconsin Stout (USA), and the author was an assistant in Prof. Joseph W. Holland's group at Stout. In the start phase of the project the involved international partners from USA, United Kingdom and Germany had to perform the task to structure and classify content for creating a common contextual basis for their intertwined curricula. In those days, this type of task was most efficiently achieved in a same time/same place arrangement of a (physical) workshop like the pictures denote. The (colored) cards refer to the content pieces being taught in the curriculum. These content pieces were one-dimensionally clustered in theme classes, e.g. "Knowledge of Hospitality Industry", "H&T Operations", "Financial Management and Analysis", etc. The colors were used to easily identify the theme classes, in the case of the referred GLOHBE project four colors. The author's role was to protocol the agreements reached in the group about positioning corresponding themes together, about the sequencing in the course of the delivery process, about priorities being set for the involved partners in their respective country, etc. – in other words she wrote down the tags for each card/theme. The common curriculum developed in the GLOHBE project framework was finally delivered over the Internet using the Lotus Notes based "Learning Space" e-learning system in a decentralized fashion by each of GLOHBE's partners.

Figure 4-15: Tagging in GLOHBE project (Minneapolis workshop, October 3, 1998)

It is this type of setting that has dominated the first approaches for international metadata standards in e-learning. From the IEEE LOM standards over SCORM specifications and a current development focus of IMS, the synchronization of metadata tags or how to describe content has received precedence. However, the standardization effort has not proven success and has not yielded wide acceptance because it is costly to follow, driven by content, and/or lack of multi-cultural perspectives as discussed in chapter 3.5.2 and 3.5.3.

As said, the current trend is going towards open content with open access, particularly, led by international distinguished nonprofit academic institutions such as MIT Open Course Ware, Open Learning Initiative, Carnegie Mellon University, Harvard University Library Open Collections Program, etc. The for-profit organizations or non academic institutions have also contributed to open content access, e.g. the Apple Learning Interchange, or the complete open source environment of Linux software[37] which is also embraced by information technology leaders like IBM and others. The message is that having in hand training/learning materials, digital or not, is only one part of the process of learning and gaining knowledge. Complementary importance lies in context – what, when, where, and how to use them.

[37] Linux website: http://www.linux.com/

This makes tagging concepts an all important issue. Context attribution for open content environments by metadata tags is acted out not only by experts, but also more and more by non-expert “normal” users and consumers in their pursuit of gathering information and becoming knowledgeable in their areas of interest. The advances in information and communication technologies are pushing the world from a current stage of decentralized, open and low cost passive access to information, to another interactive era. This era consists of interactively sharing with others the experiences with information being accessed and knowledge being gained in a collaborative fashion – thus building personal networks with participating peers. This is best illustrated by the emergence of folksonomies. Chapter 2.4.2.2.1 has denoted that the decentralization of categorizing and classifying information and knowledge by common end-users eclipses traditional tagging mechanisms by a restricted number of experts following pre-described taxonomies of their respective field of expertise.

The common thinking of technology-aided learning processes often relates to machine generated automation, from automatic generation of metadata over approaches of packaged learning content to systems enacting learning processes. Such an interpretation of e-learning technology, specifically during the first generation of learning object development, has invoked a stream of skeptical and critical voices on wasting millions of dollars on machine communication, instead of focusing on people and the individual learner (chapter 3.1.2). The taxonomy approach with its basic properties of controlled vocabularies and structures for contextual metadata tagging is a ground for synchronization and standardization. However, if this is the final stage to be achieved, it blocks the dynamics of information sharing and knowledge collaboration driven by the end-users, i.e. the knowledge workers who apply information which is continuously updated in the real-world in an ever changing flow of contexts. The goal to support and capture multiple contextual sets of content, each relating to their respective application domain, is to capture reusable variations, to share them, and rejuvenate them by collaborative activities in a workplace environment. This approach is key to organizational competitiveness and agility today – and is serving as a design focus in the CM-WLOD prototype for intra-organizational application.

On the other hand, in the setting of workplace learning enabled by an enterprise knowledge management system, a completely free or democratic approach to contextualize content most likely will lead to chaos and is inefficient if not impossible to manage. Therefore, this research work advocates a versatile metadata tagging concept for workplace learning on-demand which balances the extreme approaches between fixed machine tagging mechanisms based on prescribed taxonomies and the folksonomy approach imposing more or less no structural conformation.

In Table 4-2, the author of this thesis has mapped out a continuum of tagging methods which apply to organizational usage of content contextualization. The underlying organizational governance approach is identified by different "Tagging Models" describing a continuum from open to restricted, as denoted in the columns of the table. Each model is characterized by a set of elements as indicated in the rows of the table. Namely:

- "Tag Domain" means a specific vocabulary set used in a specific application environment, for example some industry specific terminologies (e.g. workflow, knowledge management, and folksonomy are terms in the IT industry).
- "Tag Classes" are used to categorize tags; they relate to what is defined as "keyword-classes" above.
- "Tag Values" are words, phrases, numbers; in general they are alphanumeric strings as written descriptors.
- "Relations Among Tags" is pretty much self-explanatory as any type of relationship between tags, which is often researched in detail and defined in ontology specifications.
- These elements reflect different types of "End-User Activities" when assigning metadata tags to content, with respect to how much they are able to define, freely, or partially, or nothing.
- The "Public Visibility" of tags changes on a scale from invisible to visible following an increasing degree of controlled organizational governance.

The "Tag Structure" is spanning a continuum from a folksonomy type of governance to application environments based on a strict organizational ontology. The "Data Structure" of the tagging mechanisms is accordingly shifting from flat to hierarchically interwoven. Last, but not least, the activity status of "Knowledge Contextualization" is going from an improvising state, when more freedom is given to the knowledge worker, to a fixed one without interaction for knowledge workers, i.e. workers who cannot personalize tags but have to follow the prescribed contextual structures.

Organizational Governance	Bottom-up ⟵⟶ Controlled						
Tagging Model	Individual Tagging	Open Tagging	Semi-structured Model A	Semi-structured Model B	Semi-structured Model …	Restricted Tagging	Not allowed
Tag Domain	Open	Open	Given	Given	Open	Given	Given
Tag Classes	Open	Open	Given	Open	Open	Given	Given
Tag Values	Open	Open	Open	Open	Given	Given	Given
Relations Among Tags	Not defined	Not defined	Loosely-defined	Loosely-defined	Loosely-defined	Pre-defined	Pre-defined
End-user Activities	Self-defined	Self-defined	Select and Contribute	Select and Contribute	Select and Contribute	Point – and - Shoot	Nothing
Public Visibility	Invisible	Visible	Partially Visible	Partially Visible	Partially Visible	Visible	Visible
Tag Structure	Folksonomy ⟵⟶ Ontology						
Data Structure	Flat ⟵⟶ Hierarchical						
Knowledge Contextualization	Improvising ⟵⟶ Fixed						

Table 4-2: "Tagging continuum" model

Some of the implied details shall be explained, starting from the left hand side. A complete free and open individual tagging mechanism is represented by folksonomies (e.g. Flickr.com) in which "normal" end-users with or without expertise can tag content according to their own preferences. From left to right more pre-defined elements that end-users have to adjust and adhere to are introduced. Eventually, at the far right-hand side, the other extreme of a tagging approach is exemplified by an ontology type of completely pre-defined and controlled tagging. Here the vocabularies of tag domains, categories of tag classes, tag values, and relations are given by the organization and regularly pre-defined by a group of experts, and rendered e.g. in corporate dictionaries and data models. So the normal employee, the knowledge worker, cannot add or contribute anything at all regarding contextual tags.

The grey-shaded columns of tagging mechanisms in the center of Table 4-2 denote a variety of semi-structured tagging approaches in an organization which are neither completely free-spirited nor top-down prestructured. Included in this range are two examples ("Model A" and "Model B") denoting what is open for end-users to decide, and/or how to categorize, and/or what vocabulary has to be used for metadata tags. In this thesis, the prototypical implementation of CM-WLOD utilizes this middle ground of tagging models. So a certain degree of guidance and organizational governance is provided while simultaneously offering the freedom and encouraging bottom-up personalization of information and knowledge - which is essential in facilitating on-demand workplace learning needs. Hence, a semi-structured tagging model is able to capture the multiple application domains of content associated to a multitude of knowledge workers at their respective workplaces, while maintaining a basic structure of information and knowledge in a commonly agreed upon organizational setting.

As an example Figure 4-16 denotes a snapshot of this semi-structured tagging mechanism as applied in CM-WLOD. The illustrated chapter-styled and outlined view is typical for content materials for traditional thinking of learning/training, as denoted at many places above. The K-nuggets - "Workflow Process", Assessment_PM", etc. - are represented in the rows of the view. Here, in the CM-WLOD approach, this view represents only one out of many sequencing variations and collections of knowledge nuggets which make sense. In this example, the collection and sequencing is defined for people involved in the "2007/04/Shanghai" project. Because this collection is drawn in a well organized way suggesting a complete work list, the associated K-nuggets most likely will belong to "strongly-connected" content of the project team. Other collection and sequencing patterns will be addressed in later chapters.

Figure 4-16: Applications of semi-structured tagging

As learning on-demand is highly contextual, the contexts not being predictable attributes, the tagging approach in a knowledge management system must allow and encourage sharing individual experiences of content. This is necessary in order to reveal as many shades of context as appropriate - for peers and colleagues on an individual basis, for organizational units on a process basis - to retrieve K-nuggets depending on their respective contextual signatures related to specific application domains. In the course of business processes where content in K-nuggets is reused, the tagging approach must provide mechanisms to repurpose or re-reference K-nuggets in related contextual settings by defining new contextual signatures without losing the systematic side of management of organizational knowledge. The above outlined semi-structured tagging approach has a combined power to facilitate these needs. It adds more dimensions for individual perspectives and interpretations of content as compared to formalized computer automated tagging which follows pre-defined elements.

4.5 Summary

Chapter 4 has shown that appropriate granularity, the core challenge of reusing data, information, and knowledge for learning and knowledge gathering, is difficult to standardize. This, because the role of context in which the content is reused, repurposed, or re-referenced during its life-cycle is too versatile to be predicted and thus pre-constructed.

Secondly, while decentralized sharing and collaboration is becoming the center of gravity at work and in learning, the emerging mass phenomenon of bottom-up approaches in tagging content and thus recognizing the power of contextualization empowers the individual knowledge worker at their individual workplaces.

The underlining strategy of this study is to provide and prototype concepts which decentralize the process of contextualizing content. This is done for increased visibility and shared accessibility of contexts, in order to support a variety of references for future reuses of content embedded in K-nuggets among knowledge workers in an organizational on-demand learning setting. To achieve this strategy, both, the contextual model for mapping information and context onto knowledge nuggets for workplace learning on-demand, and the semi-structured tagging model are defined and clarified as essential building blocks for the prototypical implementation in chapter 5. CM-WLOD's contextual model for a K-nugget is built upon seven contextual factors. These factors provide on the one hand the flexibility necessary for fine-tuning the description of context information for as many application domains as demanded at the workplace of an organization. On the other hand they allow relating the learning parts of employees' tasks seamlessly to their daily work experience.

5 Implementation of CM-WLOD

> ***"What is new is that young people today, and most people in future, will be happy to decide for themselves what is credible or worthwhile and what is not. They will have plenty of help. Sometimes they will rely on human editors of their choosing; at other times they will rely on collective intelligence in the form of new filtering and collaboration technologies that are now being developed."***
>
> *(The Economist, April 22, 2006, p. 5)*

5.1 Introduction

5.1.1 Contextual Tools in the Physical World and the Virtual World

In a classical physical office environment, important parts of informal learning activities are to read and simultaneously contextualize paper-based materials via a set of tools. For example, 3M's Post-it is for bookmarking, paper folders for categorizing, clips for binding, highlighters for emphasizing, index cards for referencing, and pens for annotations like scribbling comments, etc.

Figure 5-1: Office workplace of a knowledge worker (author's photo)

Figure 5-1 shows an example of an employee's office workplace with desk and shelves. On the desktop, there are different piles of folders with papers and books which are bookmarked, annotated, and categorized. On the shelves there are books, folders, boxes with index cards, more piles of material, etc. The workplace radiates a non separable collection of materials being used for mundane office processes as well as knowledge gathering and “learning” endeavors, the same setting being the foundation of the e-workplace approach in this thesis as well. Although the illustrated arrangements in the physical office make sense to the office owner for a while, in the long term it is often a burden to dig through papers for needed information and knowledge when the piles grow bigger and messier (like the example suggests). From an organizational knowledge management perspective, the comments, the scribbles, and the bookmarks, the index cards, etc. belong to one person and only person forever. Instead of sharing important contextual information in a team, they are locked by papers and folders in one specific physical office environment. In addition, from the technical point of view, when treating the paper-based folder as a container of context information, one copy of paper-based material can only be categorized once. In other words, there is a one-to-one relation between the context container (e.g. the folder), and the content material (the papers) in the physical world. This brings up another burden in knowledge management in an organization. When the content material is updated or edited, paper copies have to be re-made and to be refiled into respective folders (so long as someone remembers and is able to find them). Furthermore, the context folders in a physical office are regularly filed in one dimension, e.g. the alphabetical order of names of departments, or classification of projects, or customers, etc. A multi-dimensional or crisscross linking of contextual factors for paper-based material demands tremendous resources and is prone to errors.

Use of computers at the workplace is common practice right now. But to do without paper in the office is not, especially for knowledge workers (Figure 5-1 happens to show a professor’s office). The physical arrangement of paper-based information in particular helps to establish context information, implicitly or explicitly (see also chapter 4.3.2.4). By using computers spatial arrangement in two dimensions is principally available, though on a rather small real estate delimited by the computer screen. But easy and intuitive three dimensions ional arrangements are not employed yet for actual office system metaphors at the corporate virtual workplace - they are standards in computer games though. Together with the experience that people are not automatically disposed to long-term anticipation and practice in storing and sharing context information for team usage (e.g. categorizations, comments, links, process information about handling specific content material), to handle context information turns out to be not that easy. Some reckon that sharing and collaboration is a challenge anyway, due to human-selfishness or a management style based on short-term quota (Senge, 2006, p. xii). On the practical side, the author of this thesis adds that the lack of contextual sharing is also due to the deficit in efficient tools and know-how in facilitating contextual collaboration at a knowledge-intensive virtual workplace. In a way, these shortcomings are understandable. Sharing content material in the physical office setting of the past was bound to acting out logistics, for materials or people. That sharing of information in the e-office can be enacted by just clicking appropriate options on the computer screen is not part of common sense so far or passed on as commonplace experience.

However, can the disadvantages of contextualizing content material in the physical world be avoided in the virtual environment? And, can the challenges to practically enacting contextualization at today's virtual workplaces be overcome? The answer is "yes" and will be presented in many facets via a prototypical implementation of the CM-WLOD approach in the rest of this main chapter.

5.1.2 Choosing a State-of-the-Art System Layer for CM-WLOD Prototyping

The technology convergence of workplace learning and knowledge management (KM) corresponds to the trend of learning at the workplace as introduced at the beginning of this thesis (chapter 1.1). In addition, chapter 2.4.2.1 shows that a knowledge management platform is a medium which enriches as well as enhances knowledge sharing and collaboration while integrating learning within workplace contexts and processes. The technology has to facilitate on-demand learning needs and processes which are not following a predictable schedule, like e.g. a classroom timetable. Via a KM platform encompassing knowledge, people/experts, their communication and collaboration, it is possible to support the 24/7 needs for knowledge acquisition and maintenance in a global connected workplace environment.

Moreover, chapter 4 of this thesis denotes that as naturally as cells must live in a body of a human-being, digital K-nuggets can only be vigorous enablers of learning when they reside in an information system (IS) integrated with employees' e-workplaces and business processes. Therefore, the author of this thesis builds upon a state of the art layered system approach to implement CM-WLOD, precisely taking into account these versatile demands on IS-design.

The overall layered architecture for prototyping CM-WLOD is indicated in Table 5-1. The author uses K-pool as a reference layer to design the specifics of CM-WLOD as a workplace system for knowledge management and contextual learning. Firstly, this design work encompasses the lay out of a model for WLOD which on one hand has a sound theoretical foundation and on the other hand fits - for its constructional parts - the architecture, data model, functionalities, user-interfaces, etc. defined by layers 1 through 3. This task has been accomplished in the previous chapters. Secondly, the constructional parts have to be carried out. This encompasses prototypical development of a usable CM-WLOD system, validation for typical WLOD scenarios and reflections about usability. In detail, issues like the ones outlined in Table 5-1 (see layer 4) have to be constructively tackled. This task is about to be accomplished in the subsequent chapters.

Layer	Layer Services	Applied System
4	**Workplace application layer for KM & contextual learning** Use of layer 3: customize, set general contextual parameter contexts, define organizational infrastructure (elements, processes), create CM-WLOD specific templates, create profiles & dashboard views/portlets, provide infrastructure for embedded objects, etc.	**CM-WLOD system**
3	Enterprise content and knowledge management layer	K-pool system
2	Collaboration services layer	IBM Lotus Notes system
1	Corporate workplace services layer	Operating system (MS Windows, Linux, Apple Macintosh)

Table 5-1: System layers of CM-WLOD

As Table 5-1 indicates, CM-WLOD is well suited for cross-platform usage. Practically speaking, the employees' workplaces can embrace technologies as different as MS Windows (currently, industry standard worldwide), Macintosh (widely preferred by creative and individualistic people and teams) or Linux (currently on the rise); the Lotus Notes layer 2 provides the integration services. Furthermore, advancement on the K-pool content management layer 3 will be directly usable to improve CM-WLOD, be it in enriched functionalities, advancements in performance, or new backend services. Because CM-WLOD is closely interwoven with K-pool, the services provided by this layer will be frequently referenced in the following sections.

Core parts of this CM-WLOD system design comprise K-pool, as the content and knowledge management component, and IBM's Lotus Notes as middleware platform for enterprise and organizational usages at the workplace. With some 60,000 corporate customers (Rhodin, 2007) and some 125 million users around the globe (Raven, 2006), IBM Lotus Notes/Domino is the world leading workplace collaboration technology for enterprises, in both for-profit and non-profit organizations. The author sees the advantages of implementing CM-WLOD on this layer stack three-fold: (1) The application can be practically used and thus the derived results allow validation of many theoretical and conceptual aspects of CM-WLOD based on state-of-the-art technology. (2) By taking an IBM Lotus Notes based KM platform, CM-WLOD is ensured as an integrated part of a worldwide used technology defining e-workplace infrastructure on an international organizational scale. (3) The know-how gained in this application, technically and practically, can be extended and leveraged to many other Lotus Notes applications in the corporate world and millions of Lotus Notes users. For simplicity, IBM's Lotus Notes/Domino system will subsequently be referred to as "Notes" in most cases.

The reasons for not prototyping CM-WLOD based on the patchwork of abundant innovative approaches surfacing under the "Web 2.0" umbrella (see chapter 2.4.2.2) are manifold. The Web 2.0 environment is characterized by user masses interacting on the open Internet choosing applications on an individual and free preference basis not guided by conventions issued by an organizational body. So, compliance issues are not in the foreground. Most of Web 2.0 application systems are innovative and support content oriented communication, in principal characterizing them as prospective candidates for the constructional purposes of this thesis. But, the systems create more or less application islands in a stovepipe manner (see chapter 2.1.4) so far. They don't integrate, and they are not made for integration. Security is another issue. Approaching the era of a knowledge based society in many countries, information and knowledge are key competitive factors. Consequently, knowledge management in an organization has to be implemented in a controlled and highly secured intranet environment which contradicts the open and "for everybody" focus of Web 2.0 applications. Another point is that with regard to leadership issues, or management and practical organizational questions, current businesses or public organizations are simply not ready to cope with the open flow of content and communications being core characteristics of Internet and Web 2.0. The big question is whether this type of openness can or should be accommodated for internal organizational structures anyway. Taking together all these aspects – e.g. compliance, governance and leadership issues, system integration and compatibility, security, support of a reliable IT-vendor infrastructure – the very goals and target environment of CM-WLOD currently cannot be convincingly pursued and practically demonstrated on the basis of an IT-infrastructure not existing in the corporate world. And this is the case for almost all Web 2.0 labeled applications, including the completely open questions whether, how, and when these applications or their matured offspring will penetrate the corporate world. So, the author has decided to prototype CM-WLOD on top of a technology platform accepted and proven in the corporate world.

As outlined in Figure 5-2 the overall technical architecture of the K-pool system consists of the “K-pool”-database for content material and contextual information as the central repository. This repository is supported by a set of databases for defining organizational structures and processes, general settings, glossary and taxonomy information. These supporting databases store organizational structures (e.g. employees’ data, departments, workgroups, roles, access control information), routine work processes (i.e. workflows), general settings (e.g. forms, keyword-classes, accessibility levels to keywords, re-usable components) as well as organization-specific terms and taxonomy information. As for the originators of these databases: The “Knowledge Pool” repository in the center has been developed at GCC and includes software components from PAVONE AG. The “Process Database” and “Organization Database” are industry strength systems, and are standard products from PAVONE. The “Glossary Database” and “Taxonomy Database” are research prototypes developed at GCC. Typical for the underlying Lotus Notes platform is that in addition to the user data all these databases completely contain all software components and design information about the application, pertaining to user interfaces, software object libraries, user agents, user profile enabled customization features, etc.

Moreover, in the upper part of Figure 5-2, some core graphical engines of the K-pool system are denoted. From left to right: Organization and process modelers provide interactive graphical design of the organizational structure and repetitive workflow processes. Examples for workflow processes are: daily credit approval in a bank, forced push of mandatory report material for projects, or managing the stream of training material for a learning cohort over a given period. The latter two of these examples thus allow accomplishing the “strongly-connected” K-nugget mechanism as denoted in chapter 4.3.2.4. Organizational and process data as well as the necessary business logic for enactment at the workplaces on a daily basis are drawn from the organizational and process databases. Further, as shown at the top of Figure 5-2, K-pool also includes an „Ad-hoc workflow“ engine in facilitating temporary or on-demand workflows. The „Ad-hoc workflow“ mechanism is suited for modeling and enacting context specific working environments which exist only for a limited period of time, with a particular business agenda and a temporary group of team members. Examples for using „Ad-hoc workflow“ are spontaneous setups of interest groups in attempts to swiftly research and resolve open issues for business plans, special customer requests, project management, change management, production issues, market evaluation, etc. These are all settings in which the processes and people involved are context specific. As opposed to standard workflows, „Ad-hoc workflows“ most likely provide functionalities to manage "loosely-coupled" content at the workplace (see chapter 4.3.2.4). Last but not least, K-pool has tools to visualize content collections due to user selected contextual signatures, e.g. via tools like Hyperbolic Trees (Figure 4-10), or Topic Maps (Smolnik, 2005).

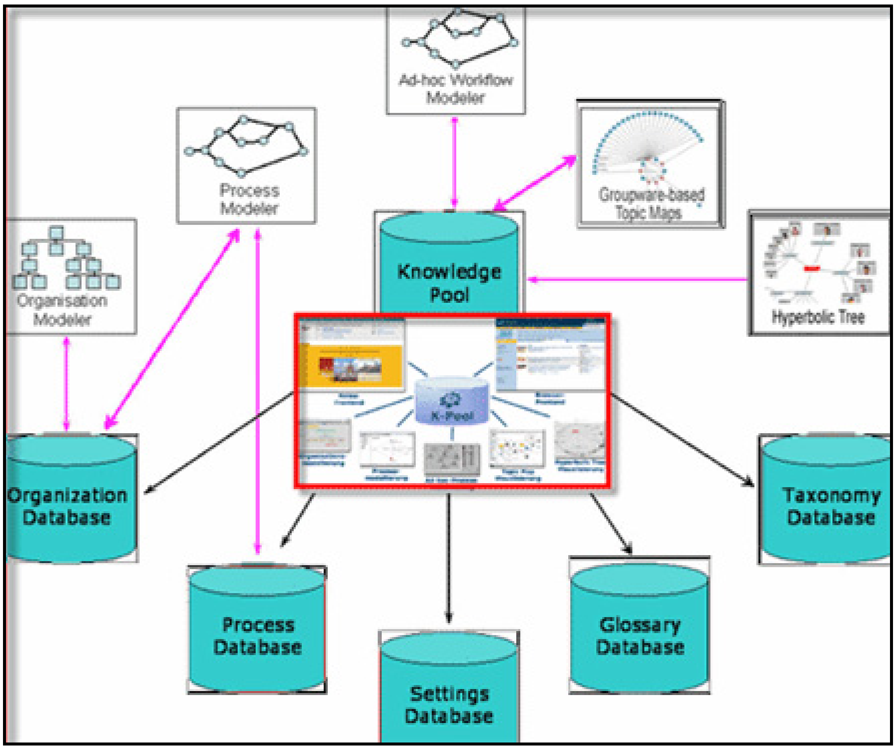

Figure 5-2: GCC K-pool system (GCC, 2006)

This thesis is not intended to delineate technical aspects of the K-pool platform. In so far, all databases and functionalities briefly mentioned above are backbones of the conceptual approach in prototyping CM-WLOD layered on top of K-Pool. Their respective services will be shown in the further derivations of CM-WLOD's core functionalities. The collaborative development of K-pool has been under way at GCC for over ten years by a team of PhD candidates (to mention some of the main contributors: Huang, 2004; Huth, 2004; Ott, 1999; Riempp, 1998; Smolnik, 2005; Zhang, 2001), by students seeking their master degrees, and professional software engineers from industry partners (especially: PAVONE AG). The members of the GCC team, including the author of this thesis, have contributed to K-pool's conceptual framework, architecture, application development, user interfaces, functionalities and more from different research perspectives. K-pool is integrated in various shades at employees' e-workplaces in the Groupware Competency Center (GCC) and the Faculty of Business Administration and Economics at the University of Paderborn. GCC's partners in Germany and abroad currently are using K-pool in nonprofit research and university environments, as well as in research & development in industry.

In this study, the CM-WLOD key focus is to use K-pool's services assembled and adapted for knowledge gathering and contextualization from a learning perspective, driven on-demand by the individual employee in his/her collaborative team structure at organizational workplace settings.

According to the architecture outlined in Table 5-1 K-pool, a K-nugget is modeled as a "document" following the semi-structured data model of a Lotus Notes based application. "Semi-structured" means, that parts of a document have to follow rigid formatting requirements, other parts don't. It is exactly this structure which has been introduced for modeling K-nuggets in chapter 4.3.2 as well. Thus, the context stub containing metadata defining contextual parameters is precisely pre-formatted, according to CM-WLOD's approach as defined in chapter 4.3.2.3. The content part on the other hand serves as a container for content material which can be deliberately formatted according to the needs and preferences of content creators, content contributors, or content editors. So, a "good" K-nugget consists of a context stub containing a reasonable set of contextual parameters (remember Miller's 7±2 rule and Tufte's comments, chapter 4.4.1), well structured by formal format enforcement of the CM-WLOD system. A second element is a content part containing the content material, well structured by the content creators using a format fitting the respective needs of the material, e.g. underlying application domain, knowledge area, or processes involved in working through the material (an example: Figure 5-3).

There are two possible approaches to work with a K-nugget: in an intranet environment via the rich-text editor being a central part of the Notes client, or, in extranet or Internet environment via web-browser which is supported by the HTML task of the Lotus Domino backend server. It is recommended that for easy working, secured infrastructures, good desktop integration or higher quality demands on content structure and layout K-nuggets be worked upon in the Notes client environment. Meanwhile, a web-browser is suitable as an environment e.g. for spontaneous access to K-nuggets, attachment contributions not demanding subtle rich-text editing, adjustment of contextual parameters or open communication activities. Other important issues in choosing the right workplace approach for working with K-nuggets is that the Notes client does not depend on network connectivity, so much of the "learning" and contextualizing work in CM-WLOD can be done in offline mode. Furthermore, the Notes client generally delivers more easy to use and versatile tools and functionalities in contextualizing K-nuggets than the web-browser front-end in the K-pool platform.

The rest of this main chapter will be divided into two constructive parts in presenting contextualizing and working with K-nuggets in practice: Firstly, the technical implementation of the CM-WLOD approach on the K-pool platform will be derived. Secondly, from an individual employee's point of view, the practical use of CM-WLOD will be demonstrated for building a just-in-time learning and knowledge creation environment embedded in a nonprofit workplace context.

5.2 Technical Implementation of CM-WLOD

5.2.1 Application Scenario and Overview

As opposed to the abstract conceptual introduction and definition of CM-WLOD'S elements and building blocks in chapter 4.3 the following chapters will be presented on a show-case basis, following a real-life project scenario where the author has applied CM-WLOD's core concepts. This way it seems, that the rather abstract and possibly vague notion of "context", being used everywhere throughout this thesis, can be better filled with practical meaning and convey more substance for concrete reflections and associations for the reader.

The referred project is a knowledge transfer endeavor. It involves – as shortly mentioned in the introduction, chapter 1.1 - preparing, organizing and carrying out a one week workshop at the "Chinese German Graduate College" at Tongji University in Shanghai. CDHK (German: Chinesisch-Deutsches Hochschulkolleg) has been initiated and co-founded by the German Academic Exchange Service (DAAD). The "METRO Group Innovation Center" at CDHK is one of GCC's international partners. The workshop topic is "Information Management", with focus on workplace and knowledge management systems. The author has been part of the team, her roles during the several project phases comprising manager and coordinator functions as well as being part of the project staff on an operational level. The workshop is carried out once a year. So the project constitutes one instance of a repeating event.

Figure 5-3 shows the "CDHK workshop logbook 2007" document, structured as a K-nugget, denoting the event at the METRO Group Innovation Center of CDHK, Shanghai, China from March 20 – 24, 2006. Figure 5-3 presents the overall structure of a K-nugget which is rendered within three inter-connected spaces from 1 to 3.

From the bottom up, area 1 denotes the content part of the K-nugget which can be generally used for one content piece or a set of content materials in any digital format as outlined above. Here, a set of content materials is included. The content part is a Notes rich-text field which in this example contains – formally speaking - text, tabular structures, images, graphics, and embedded objects interwoven with links. Speaking from the application domain side, this CDHK K-nugget is realized as a structured logbook in a tabular format which contains a set of content materials allowing a top-down access to the workshop for all participants. Parts of the content are links to other knowledge nuggets containing further related workshop materials, e.g. media K-nuggets of the workshop with photo collections and videos. The overall tabular structure of the workshop logbook is organized by dates, as shown by the row of “tabs” with date entries on top in area 1. The Notes rich-text field provides many functions for structuring content in “real” e-document fashion, e.g. recursive use of tables or sections which can be opened or closed at the user’s choice. Here, this is applied for a table-in-table format for each date-tab to render the workshop topics of the day in an hourly sequence. Another option of “real” e-documents is the use of embedded objects, like here an “embedded view”, a contextualization mechanism which will be explained in detail later in chapter 5.3.5. The embedded view here “pulls in” a list of accordingly tagged documents related to extended materials for this workshop (see the expanded view from the “Resources”-tab). The term “real” e-document in this paragraph is about to denote that this K-nugget by use of essential and powerful “e“-functions in presenting its content cannot be rendered on paper media, i.e. simply speaking, printing of the content part of this type of K-nugget is not possible in a reasonable style.

Area 1 of Figure 5-3 offers a rich presentation of content materials, not based on a linear, page-by-page display of data. Rather the content materials are crisscross linked and woven into a comprehensive set of data suiting the very needs of a workshop logbook in the CDHK application domain. The structure is apparent and speaks for itself, offering intuitive and convenient access for later information and knowledge discovery by other employees at GCC’s workplaces who have not participated in the 2006 workshop event at CDHK.

Figure 5-3: A contextualized K-nugget rendered as Lotus Notes document

The context information relating to the application domain is defined in the context-stub of the K-nugget. This is represented in area 2, denoting the actual set of contextual parameters referring to the CDHK workshop of 2006. According to CM-WLOD's definition, the context stub comprises seven contextual factors (chapter 4.3.2.3), namely, "Themes", "Title, and short description", "Keywords" in keyword-classes, "Categories", "Access control parameters", "Workflow parameters", and "Miscellaneous other parameters". In Figure 5-3, the values of some contextual parameters are visible, and some are not. Examples are:

- Themes, contains a list of three values: "CDHK - Chinese German Graduate School", "CDHK – Chinesisch Deutsches Hochschulkolleg", "GCC Teaching …"

- Title and short description: “Workshop Agenda: Workplace & KM …" and “This workshop emphasizes on e-workplace and knowledge management systems …”);
- Keywords in keyword-classes: Visible are the keyword-classes LABEL, ORGAN., PEOPLE, PLACES, TIME and WLM. These in turn contain the values, e.g. “K-pool”, “Laptop”, … in keyword-class “LABEL”; “CDHK Raum 2004”, “China”, “Shanghai” in keyword-class “Places”; etc.
- Miscellaneous other parameters: e.g. the thumbnail image, URL from document ID and permanent URL, area for “Comments”.

In addition to area 2, area 3 provides a tooling environment to contextually customize and structure K-nuggets. E.g. via “Meta Structures” a tool will be accessed where end-users may dynamically tag K-nuggets based on a taxonomy (simply: category list) for their individual and personal categorization. For example, besides being organizational information of GCC, the “CDHK workshop logbook 2007” nugget can also be individually categorized under “*Pei Wang-Nastansky\Important”* in which Pei has collected a set of K-nuggets which are important in her personal context. By the very definition of the “Categories” contextual parameter in CM-WLOD this personal tagging habit does not interfere with the personal tagging of others.

Figure 5-3 demonstrates the basic manifest how the CM-WLOD approach is mapped on the K-nugget format via the K-pool platform. Next will be a deep-dive on how to contextualize K-nuggets based on the seven contextual parameters outlined in chapter 4.3.2.3. But before articulating the prototypical implementation, the triple roles of employees in the process of knowledge contextualization at the workplace must be emphasized one more time. In the workplace learning on-demand environment, without formal instruction and instructors, the employee is in the roles of the worker, the learner, the knowledge creator, and even the teacher all at the same time. This has been made profoundly clear in previous chapters of this thesis. Therefore, in the remaining part of this chapter, there won’t be a line to distinguish a learner from an employee from a knowledge creator or a teacher - here, they all fall in the same category of CM-WLOD “users”.

5.2.2 Themes

In chapter 4.3.2.3, “Themes” is specified as a flexible contextual parameter of K-nuggets, classifying content material by use of a compact text descriptor which easily relates K-nuggets to the application domain(s) in the common understanding of the users. In the individual organization or among a community of common interest, the use of “Themes” is at its best for describing the application domain and synchronizing taxonomies based on consensus of profession terms, corporate data models, phrases, jargons, acronyms, or idioms. “Themes” is an obligatory contextual parameter.

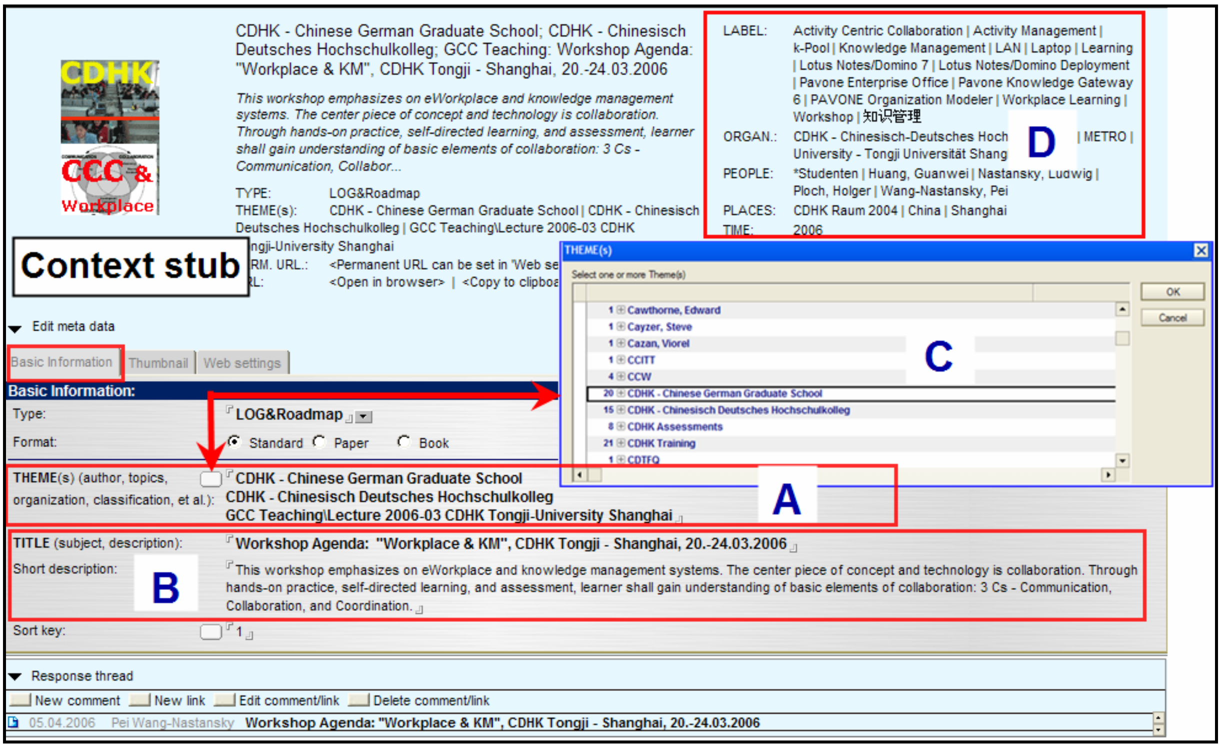

Figure 5-4: Mapping “Themes”, “Title”, “Short description” and “Keywords” on a K-nugget

In Figure 5-4 the K-nugget is captured in editing mode. Under the first tab of the “Edit meta data” section the “THEME(s)” value entries are shown. According to the three listed values multi-dimensional categorization (4.3.2.3 (1)) is given in this example. So, the “CDHK workshop logbook 2007” nugget is simultaneously assigned to three parallel “Themes”-categories:

1. “CDHK - Chinese German Graduate School”
2. “CDHK - Chinesisch Deutsches Hochschulkolleg”
3. “GCC Teaching\Lecture 2006-03 CDHK Tongji-University Shanghai”.

These “Themes” can be manually typed in by the user, in case the context of the content material or the application domain is new. However, in order to keep the context information consistent in a systematic organizational approach, the assignment of “Themes” values can also be done by “point-and-shoot” mechanisms. This is accomplished by selecting an entry value against an existing list of “Themes” (shown in area C of Figure 5-44) and reuse this entry value in the new K-nugget. Where the user types in a new entry, the new entry is added to the existing list and thus becomes part of the organizational memory with respect to the

"Themes" contextual parameter. This basic concept is used throughout for other contextual parameter lists as well, when suitable.

Figure 5-5 shows in more detail that according to the three values assigned to "Themes", the (same) CDHK workshop logbook nugget is simultaneously represented in three different contexts: (1) For an English speaking community under "CDHK - Chinese German Graduate School"; (2) Analogously for Germans "CDHK - Chinesisch Deutsches Hochschulkolleg"; (3) For the GCC team the workshop is just another teaching endeavor and thus catalogued under "GCC Teaching", specifically sub-theme "Lecture 2006-03 CDHK Tongji-University Shanghai". As a reminder: "\" backslash can be used subsequently as many times as necessary to denote sub-sub- … etc. categorization, thus defining category trees (see footnote 36).

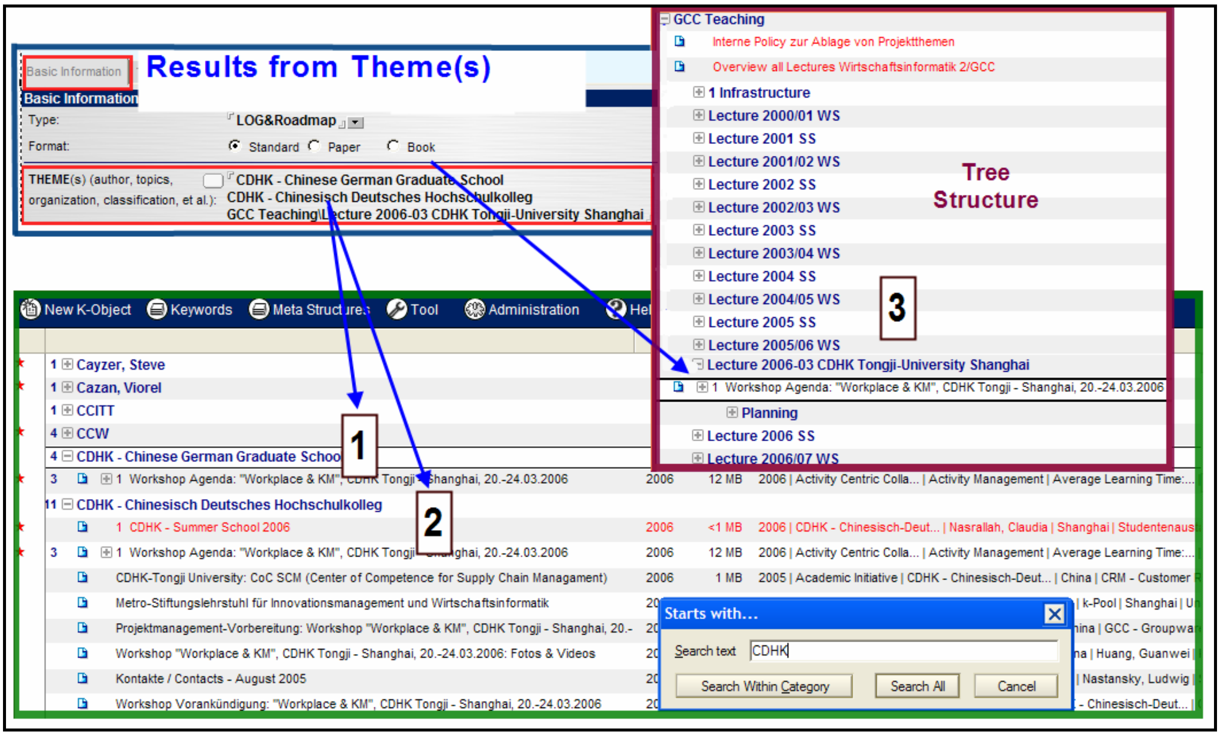

Figure 5-5: Revelation of the "Themes" parameter

The outcome of implementing the "Themes" contextual parameter as an open "Themes"-space in K-pool is that without physical duplication of the K-nugget, the same piece of CDHK workshop logbook nugget emerges multiple times under different application domain descriptors at work. In other words, the "Themes" space may accommodate as many contextual parameter values as demanded, e.g. from working to learning application domains. This offers convenience in information and knowledge discovery by different employees from different working/learning backgrounds and domains.

5.2.3 Title and Short Description

The “Title” and “Short description” parameter is presented in area B of Figure 5-4. An entry for “Title” is obligatory, whereas “short description” is allowed to be omitted. Altogether, the minimum requirement for assigning values to contextual parameters in CM-WLOD is for two entries, one must be at least in “Themes” and one in “Title”.

5.2.4 Keywords, being Organized in Separate and Independent Sets of Keyword-Classes

In addition to the “Themes” and “Title and short description” parameters, area D of context stub in Figure 5-4 shows “Keywords” parameter values. Visible are the keyword-classes LABEL, ORGAN., PEOPLE, PLACES, and TIME.

These keyword-classes are to be considered as an intuitive classification of an otherwise flat keyword tagging mechanism. Currently the basic keyword-classes: LABEL, LANGU (language), ORGAN. (organizations), PEOPLE, PLACES, TIME, and THINGS are in use. Most of the descriptors speak for themselves. The THINGS keyword-class embodies common/spoken language in daily life, not jargons or terms of a particular profession or industry. The keyword-class LABEL denotes context descriptors drawn from a vocabulary related to specific application domains or knowledge areas (“LAN”, “Laptop”, “Lotus Notes/Domino 7” are examples). However, the K-pool infrastructure is flexible for different organizations in defining “keyword-classes” freely based on their specific industry, application domain or expertise area. This can be carried out via the multilingual “setting database” (depicted in Figure 5-2), which is responsible for managing and maintenance of keyword-classes. As illustrated in Figure 5-6, each keyword-class serves as container for a list of keywords that are used to contextualize K-nuggets.

All keywords, when rendered in a K-nugget or in other K-pool interfaces, form “clickable” hyperlinks in both the Lotus Notes Client and Web-browser environments. This implies that when the learner/employee is in an information gathering and knowledge exploring mode, the contextual parameters “Keywords” (or “Themes” alike) serve as connectors to collections of other K-nuggets related to the respective keyword.

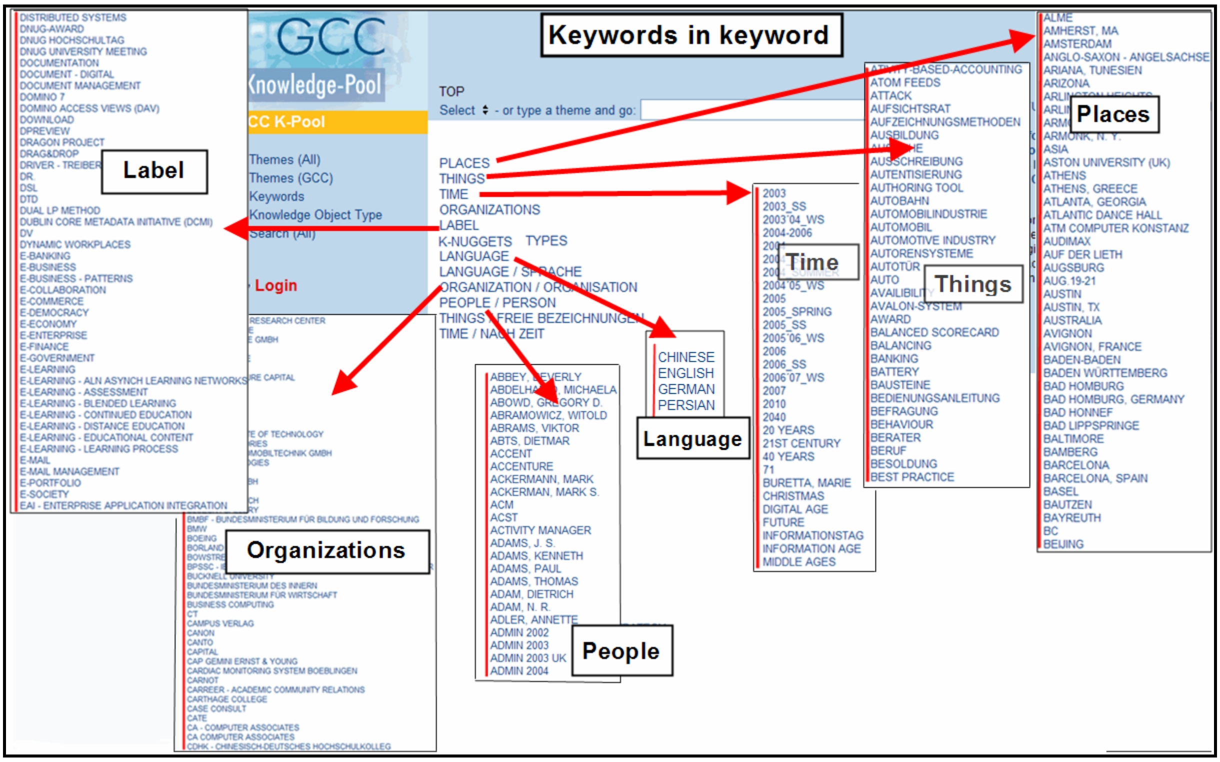

Figure 5-6: Keywords, being organized in separate and independent sets of keyword-classes

For instance, Figure 5-7 displays a K-nugget list pulled by (clicking [0 Start]) the keyword "University of Paderborn" in the ORGANIZATION keyword-class. In the resulting K-nugget list (area 1) parts of the context information sets of the displayed K-nuggets are exhibited. For easy identification of a K-nugget a thumbnail pictogram is painted in the first column. The context information shown is organized according to contextual parameters, amongst others "Themes" and "Title" (middle column), and "Keywords" (right column). Keywords are organized according to the keyword-class they belong to. Unlike an unstructured "tag cloud" (chapter 2.4.2.2.1) of context information, the implementation here puts structured context information before content so that employees may take advantage in systematically digging/selecting/choosing information and knowledge pieces relevant to their application domains at an organized workplace environment.

Moreover, when browsing on the web via Internet search engines (e.g. Google.com, Yahoo, Microsoft MSN search, etc.), content is often presented with little, unstructured or no dynamic (and clickable, i.e. easily reachable) context information. Based on the CM-WLOD approach, K-nuggets are accompanied consistently and persistently by context information sets. This information might be used for knowledge discovery. Starting with the selection displayed in area 1 (relating to the "University of Paderborn" context) two search paths shall be exemplarily followed. When following up on the keyword "Communication" under keyword-class "LABEL", the list of K-nuggets and context information sets in area 2 is displayed. When choosing "University - Tsinghua University Beijing" under keyword-class ORGANIZATION, the user accordingly will be presented the further set of knowledge nuggets related to this specific application domain (area 3).

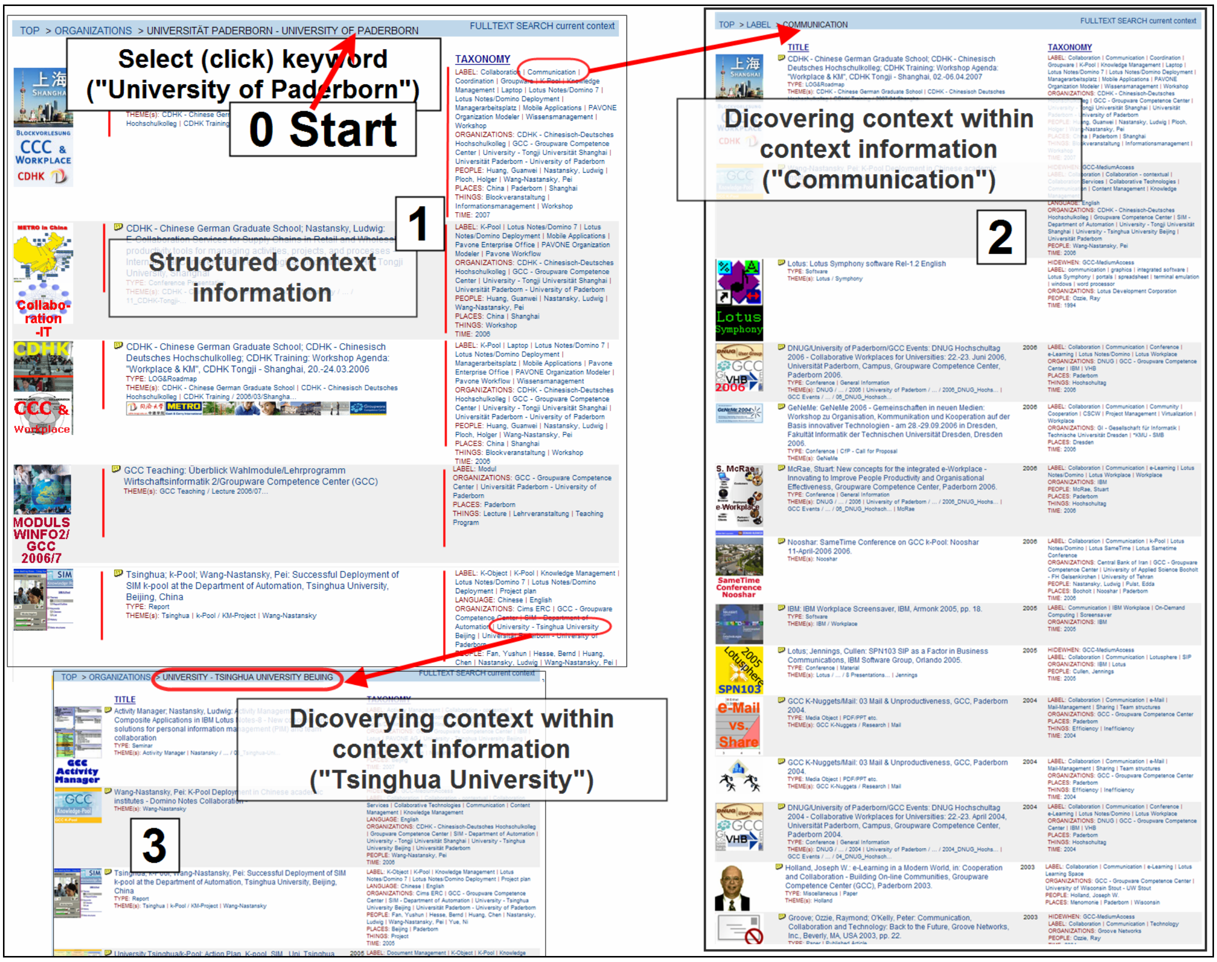

Figure 5-7: K-nuggets accompanied by consistent and persistent contextual information sets

In one word, the structured and dynamic context information implementation of the "Keywords" parameter serves the knowledge acquisition/creation process at the organizational workplace.

With reference to the tagging continuum model (see chapter 4.4.3) the following basic authorization schemes in tagging for keywords and keyword-classes are available for CM-WLOD. These schemes are based on levels of granted access control rights which have to be set up in the core K-pool repository and in K-pool's "Settings" database as one of the five major databases supporting the K-pool system (Figure 5-2). An underlying concept is to distinguish between keyword-classes with a restricted and predefined list of keyword values or an open list of keyword values. These characteristics are defined in the "Settings Database". Depending on the combinations of access rights - reader, author or editor - on either of the two databases (see chapter 5.2.6) a wide range of authorization in assigning tags is possible. Table 5-2 enumerates the possible combinations.

Tagging Continuum In CM-WLOD	KR: Reader in K-pool	KA: Author in K-pool	KE: Editor in K-pool
SR: Reader in Settings DB	• K-nuggets: No tagging possible • Keyword-classes: Cannot edit • Keywords: Cannot edit	• K-nuggets: Can edit tags in own created K-nuggets • Keyword-classes: Cannot edit • Keywords: Cannot edit	• K-nuggets: Can edit tags in all K-nuggets • Keyword-classes: Cannot edit • Keywords: Cannot edit
SA: Author in Settings DB	• K-nuggets: No tagging possible • Keyword-classes: Can edit own and create new ones • Keywords: Can edit predefined keyword set for own classes and create new ones	• K-nuggets: Can edit tags in own created K-nuggets • Keyword-classes: Can edit own and create new ones • Keywords: Can edit predefined keyword set for own classes and create new ones	• K-nuggets: Can edit tags in all K-nuggets • Keyword-classes: Can edit own and create new ones • Keywords: Can edit predefined keyword set for own classes and create new ones
SE: Editor in Settings DB	• K-nuggets: No tagging possible • Keyword-classes: Can edit all and create new ones • Keywords: Can edit predefined keyword set for all classes and create new ones	• K-nuggets: Can edit tags in own created K-nuggets • Keyword-classes: Can edit all and create new ones • Keywords: Can edit predefined keyword set for all classes and create new ones	• K-nuggets: Can edit tags in all K-nuggets • Keyword-classes: Can edit all and create new ones • Keywords: Can edit predefined keyword set for all classes and create new ones

"Edit" denotes: add, change or delete

Table 5-2: Tag Continuum for "Keywords" in CM-WLOD

Some of the possible options according to Table 5-2 shall be outlined (denoted as row/column combinations):

1. SR/KR: The user can do "nothing" in contextualizing K-nuggets via the "Keywords" parameter. This is most likely for an employee only "consuming" K-nugget content in a passive way.

2. SR/KA, only restricted and predefined keyword lists are available: This authorization scheme is necessary when the organization must keep a predefined integrity of context information and classifications. Hence, only the experts are allowed to name/define specific context information related to keywords. As shown in Figure 5-8, the keyword list in keyword-class LABEL is fixed by the organization. The end-user can only select keywords from this given list to tag content. The employee can neither edit the existing keywords, nor add new ones, nor delete anything from the list because all editing functions are disabled (see deactivated grayed/dimmed button options).

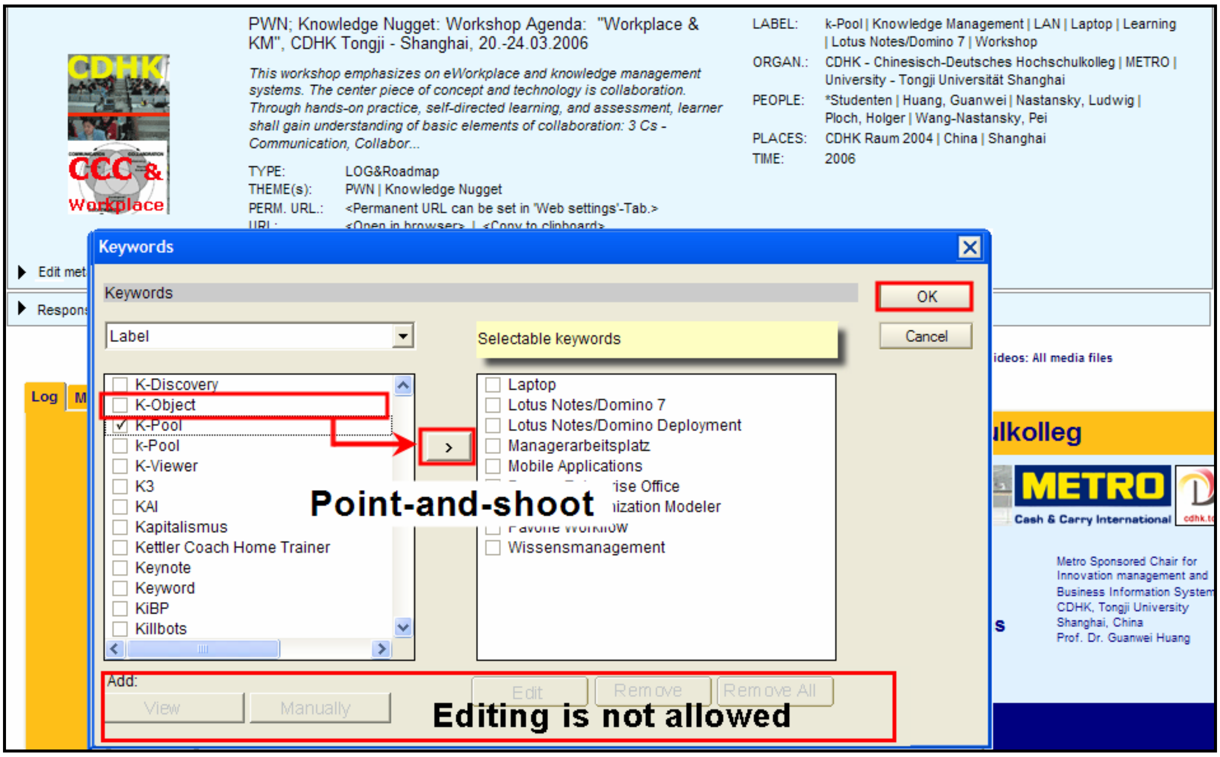

Figure 5-8: Restricted "Point-and-shoot"-only tagging of "Keywords" contextual parameter

3. SR/KA, open keyword lists are available: The user can freely tag all K-nugget content, whether it is their own contribution or that from others. For content they have not contributed they have to use the mechanism of "multiple context information sets" (chapter 4.3.2.2) by adding their own context stub to an existing K-nugget. This type of tagging authorization will be the standard for employees with full control over adding and editing their own contextual information and (re-) using contextual information from other team members. Figure 5-9: shows this case for the tagging dialogue. All editing functions are active. Adding own keywords is not disabled as in the previous case, Figure 5-8. Although a set of keywords has already been put in, the user may change them in a just-in-time manner and on-demand as needed. For example, to edit the context information of the CDHK workshop logbook nugget, the user is capable of: (1) browsing existing K-nuggets which bear the same keywords, i.e. "Learning\lifelong"; (2) adding new keyword(s), like "Learning\on-demand"; (3) when not satisfied with the keyword description "Learning\lifelong", they can immediately change it to "Learning\lifelong and distance", for example; (4) certainly, users may remove a single keyword or remove a set of existing keywords.

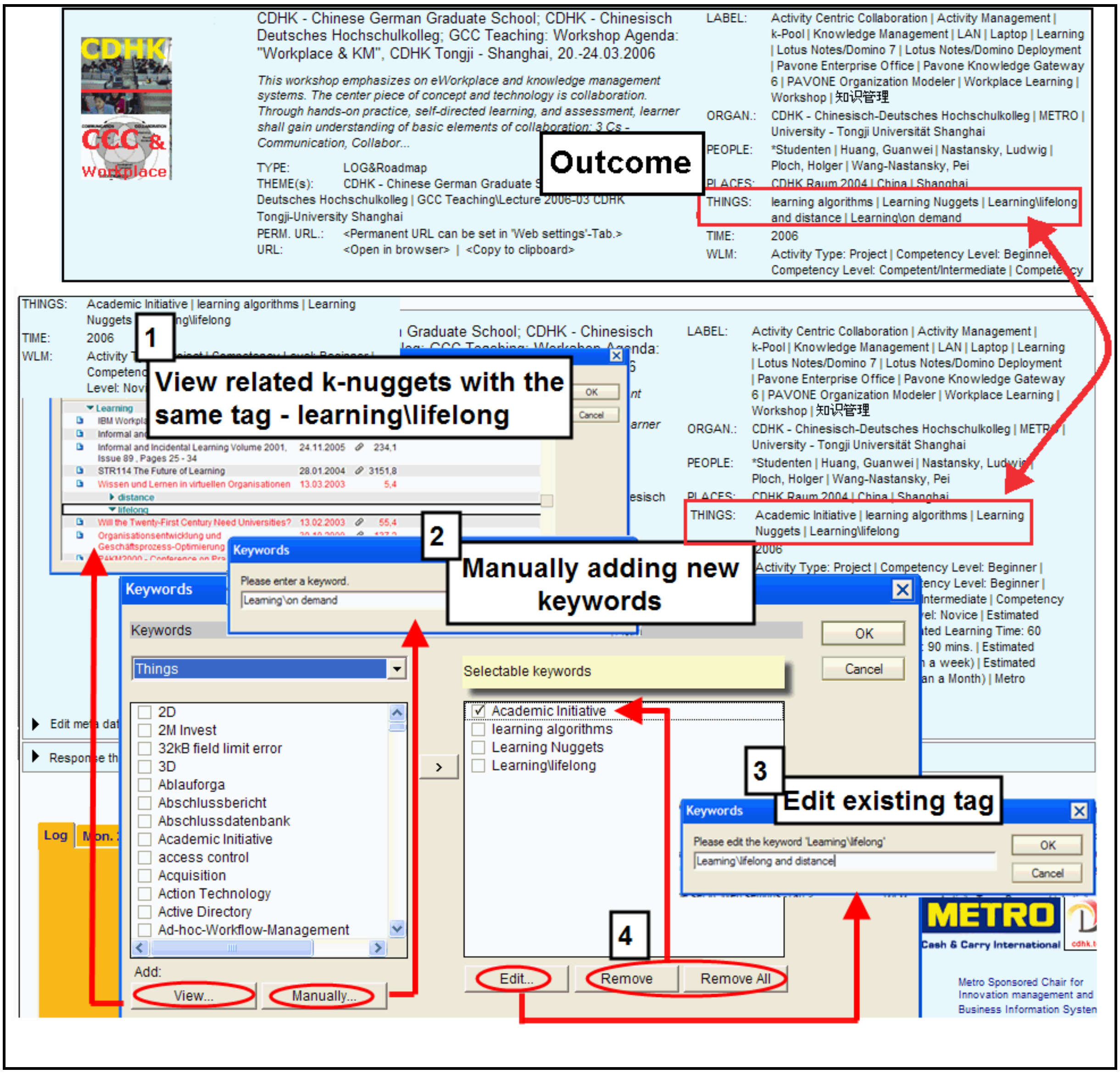

Figure 5-9: Open and flexible tagging of "Keywords" contextual parameter

4. SA/KA: In addition to cases SR/KA the user can influence the taxonomy used for K-nuggets by adding and editing keyword-classes and their respective properties. For instance, they can change a keyword-class maintained by them from restricted and predefined to an open list of keyword values, or, they change elements in a restricted and predefined keyword list. In addition to SR/KA the employee has control over the taxonomy of keywords used for K-nugget contextualization.

5. Row SE: The user has full control over the keyword taxonomy. They can change existing keyword-classes and create new ones, can change keywords from restricted and predefined to an open list of keyword values, can delete tags to inhibit further use.

6. SE/KE: The user can add, edit, and remove both keyword-classes and keywords, as well as K-nuggets in K-pool. This is the highest authorization level being granted. This is most likely an authorization given to content managers in an organization.
7. "Manager" access control rights, to K-pool and/or "Settings Database": As a basic Notes mechanism employees with "manager" access control rights have the authorization to set the access rights of the user groups mentioned, i.e. reader, author and editor rights. This is intended as an administrative role.

As discussed above (chapter 4.4.1), the number of keyword-classes and assigned values for the "Keywords" parameter is a practical issue in implementing the "Keyword, being organized in keyword-classes" contextual parameter in a real-world workplace environment. This is because too many are going to overwhelm people, and too few will bring no value in articulating clearly the specifics of an application domain in a shared and collaborative workplace. Facing this issue, Miller's "*7±2* rule" of information presentation gives hints for a practical implementation of context mechanisms with respect to the number of keyword-classes. In a practical organizational workplace setting, it makes sense to have a limited number of keyword-classes and the rule of thumb is 5 to 9 keyword-classes.

To sum up, different authorization classes and combinations for assigning "Keywords" and/or keyword-classes have been discussed above, and each has practical implications in the daily practice at the workplace. Certainly, the organization or a working group/project team may decide to give everyone the same capability in tagging, out of any of the above outlined options, but regularly this will be a mixed structure. For the CDHK workshop logbook nugget, for example, the CDHK/GCC project manager is in the role of being granted full access to K-nugget (re-) contextualization and the ability to assign keyword-classes, keywords, add and/or edit them at any time and as often as he/she wishes – denoted as option SE/KE above. At the same time, the project team members are only able to assign keywords without modifying any keyword-classes so that they can personalize K-nuggets to certain degrees without disrupting the basic structure of the taxonomy – denoted in option SR/KA, open keyword lists available. External project partners of GCC and CDHK are only authorized to point-and-shoot keywords from the given lists of keywords and keyword-classes - the tagging option as shown in the SR/KA case, with availability of only restricted and predefined keyword lists. The SR/KR authorization role may be assigned to outsiders or anyone who is allowed to view the information, but not permitted to do any type of modification.

This shown cascade model of a granular authorization continuum for tagging in applying the “Keywords” contextual parameter is a versatile and systematic approach for contextualization usages in an organizational workplace and for WLOD. On the one hand, it serves hierarchical needs for an organization’s workplace infrastructure in order to preserve contextual integrity and consistency. On the other hand, it can be utilized in an open and bottom-up democratic process in knowledge creation in which every member of the organization/team is encouraged to contribute context information in the form of keywords and keyword-classes.

5.2.5 Categories

When regarding the “Themes”, “Title, and short description”, and “Keywords” contextual parameters as more or less official context tagging dimensions or spaces in an organization, the “Categories” parameter in CM-WLOD opts for personalized contextual spaces for an individual employee/learner or group usage. The “Categories” parameter is related to a variety of functionalities summarized as exploiting “Meta Structures” in the underlying K-pool system. Here, in CM-WLOD, the options offered thereby are reserved as a generic space for any perceptual representations, mental models, or hierarchical/sequencing structures defined by teams or individuals for their individual use. The “Meta Structure” functions presents individuals and workgroups the maximum flexibility to assign and re-assign private contextual parameters to K-nuggets, as many times and in as many varieties as they need without disturbing existing organizational structures of contextual information.

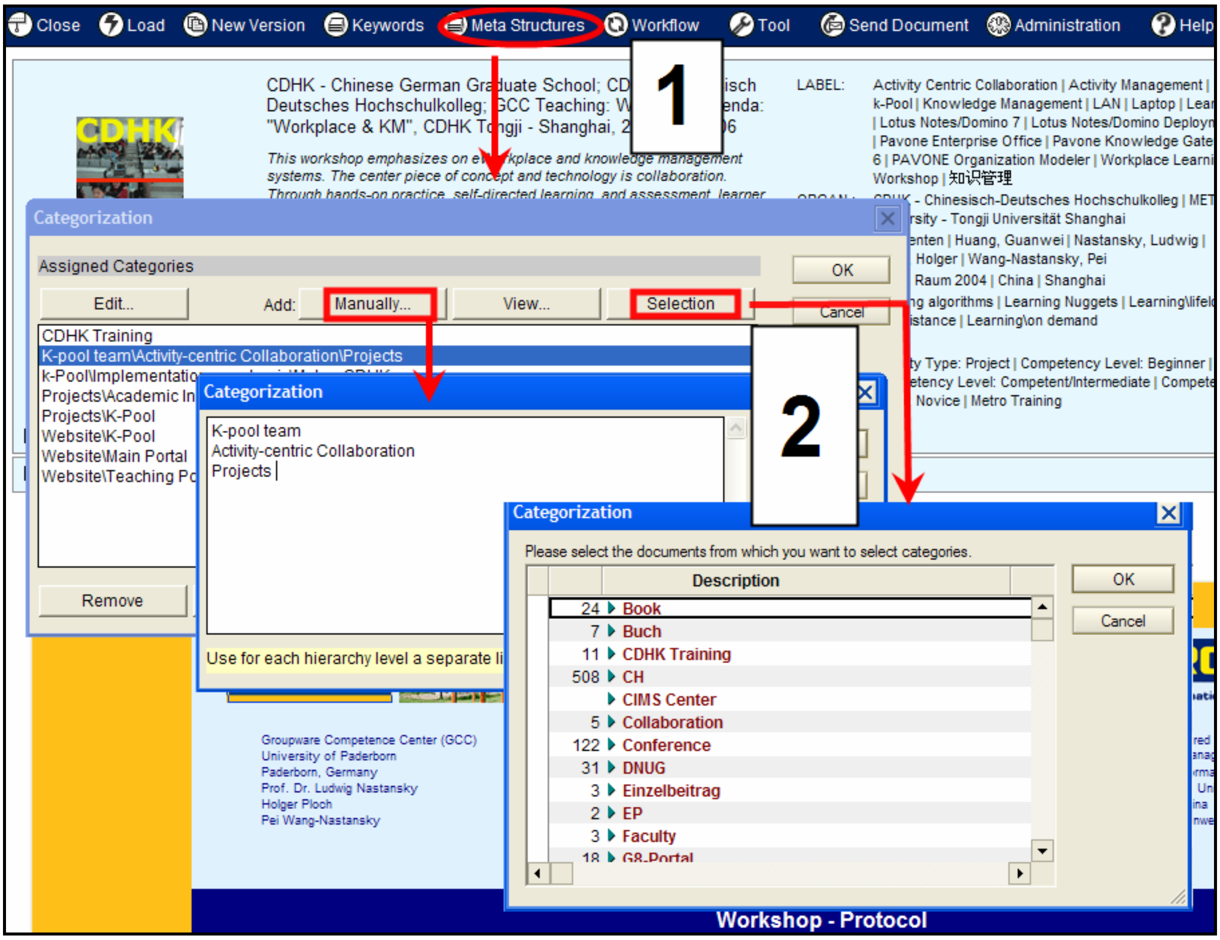

Figure 5-10: "Categories" contextual parameter for personalization of contexts

Figure 5-10 displays procedures of embedding personal contextual structures on the exemplary CDHK workshop logbook nugget. Via the dialogue box in area 2, the employee/learner may edit assigned categories or manually add new personal categories. Here, a new category – "K-pool team\Activity-centric Collaboration\Project" - is manually keyed in to the CDHK workshop logbook nugget. The back-slash "\" is putting a hierarchical structure into the categorization (the same as in defining the structure of "Themes"). In addition, the "Selection" function of Meta Structures enables the user to pick a value from the existing list of already used "Category" entries as shown in space 2 of Figure 5-10.

Consequently, the "Categories" contextual parameter offers an option to dynamically tag knowledge and information on-the-go in a structured fashion. Best usage of this dynamically binding of K-nuggets in an on-demand fashion for just-in-time working/learning needs at the workplace will be the focus of chapter 5.3.

The "Categories" tags can be contextually rendered based on several view options, complementary to similar mechanism available for the "Themes" and "Keyword" contextual parameters. Figure 5-11 shows view examples for the CDHK workshop logbook nugget after being tagged into the private application domain “K-pool team” (which in turn defines a whole category tree by “\” sub-categorizations).

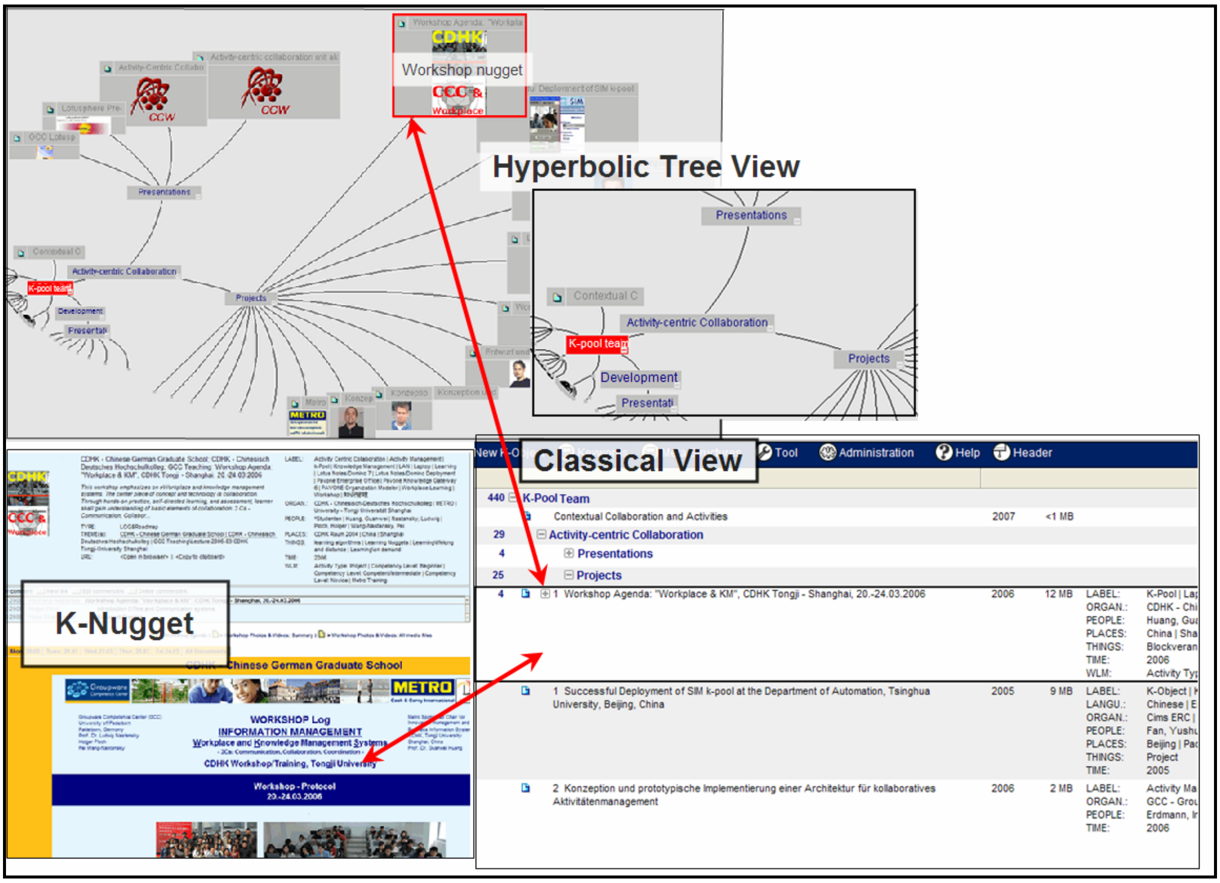

Figure 5-11: Different views of K-nuggets according to “Categories” contextualization

On the bottom left of Figure 5-11 the original K-nugget of the CDHK workshop logbook from March 2006 in Shanghai is shown. After adding it to the project team’s category “K-pool team\Activity-centric Collaboration\Project”, it shows up in the “Classical View” of the Notes outline-structure. It appears as one of the K-nuggets tagged with the “Categories” parameter, denoted at the bottom-right hand corner. In the top part of Figure 5-11, the CDHK nugget appears again at the upper-left as a snippet in a “Hyperbolic Tree View”. A hyperbolic tree is a 2½ dimensional sphere-structured view perspectivally spreading trees in two dimensions on a half-sphere, and interactively allowing the user to drag arbitrary parts of the tree zoomed into the “foreground”, i.e. center of the host window on the screen.

The CDHK workshop logbook with all related nuggets which are assigned to the same direct parent category “Projects” (in the center) are spread out to the right. Some K-nuggets tagged as members of the “K-pool team” category are contextualized as “Projects” (e.g. the CDHK workshop logbook), some as “Presentations”, and some as “Development” works as seen in the magnified view of the Hyperbolic Tree View in Figure 5-11. “Projects” and

"Presentations" in turn belong to the same direct parent category "Activity Centric Collaboration".

Based on personalized categorizations, the hyperbolic tree view exhibits a richer and more intuitive visual interface of the tagging structure of K-nuggets as compared to the classical outline view. The end-user/the learner can easily have a bird's-eye view of all knowledge nuggets related to a specific personal application domain. The hyperbolic tree view offers not only just another user interface for tagged K-nuggets but embeds several interactive functionalities. So, the K-nuggets can be directly accessed via the hyperbolic tree pane (normal "click" gesture on the K-nugget thumbnail pictogram), and, more importantly, they can be restructured and re-purposed. Via graphical gestures (i.e. drag and drop) add, delete and move functions are available to re-assign tags of a K-nugget in the "Category" contextual parameter space.

From the sheer functionality point of view "Themes", "Keywords" and "Categories" are all contextual parameters which principally provide the same set of mechanisms for (re-) classifying, (re-) structuring, and (re-) categorizing knowledge nuggets in the K-pool system. But, following the CM-WLOD semantics they are applied to fit different dedicated uses. "Themes" are used for consensus or officially defined classifications which are widely accepted across the organization. The "Categories" parameter is at its best for individual learning/working context that is ad-hoc and spontaneous, relating loosely-coupled content materials to the workplace. The "Keywords" parameters are in-between the strongly-connected and loosely-coupled contextualization. This is because "Keywords" provide a flexible tagging continuum based on versatile authorization mechanisms, from forced use of predefined tags to completely open tagging spaces (see Table 5-2).

5.2.6 Access Control Parameters

Implemented on the Lotus Notes and K-pool middleware layers as a general horizontal functionality, the "Access control parameters" serve a wide variety of functions to be used in contextualization of content materials in the CM-WLOD approach. Especially they serve embedding contexts related to people, as individuals, but also in the collaborative organizational infrastructures of workgroups and departments, or in specific roles in the organization. In principal, via "Access control parameters" control of access to content materials on one hand, and contextualization of content on the other hand is managed. As mentioned already above, these parameters play an important role in workflow management (see chapter 4.3.2.3 (5)) and in keyword management (chapter 5.2.4, Table 5-2).

Following the versatile as well as strict Lotus Notes security model, a hierarchy of access rights is given. In this thesis the access rights of “editors”, “authors”, and “readers” are most relevant. Due to the hierarchical structure “editor” rights include “author” and “reader” rights, in turn “the “author” right includes the “reader” right. As mentioned already above, “managers” are on the top of the hierarchy and have control over assignment of access rights of all levels to all users. Thus they have an administrative role not interfering with access levels determining the daily tasks of CM-WLOD operations. The access authorizations necessary for running CM-WLOD operations are those of “editors”, “authors”, and “readers” respectively. These terms speak for themselves and have been discussed for the case of keyword assignment.

Important is the scope of these access rights. They are designed for a collaborative workplace environment. So, access rights can be granted to the following entities: individual users, workgroups, departments and roles. “Roles” denote specific tasks which can be assigned to an employee, e.g. “Supervision for all new K-nuggets”, or, “Layout refinement for content part of K-Nuggets”. The other entities speak for themselves. So, the scope of access rights is relative to individual users, workgroups, departments or roles respectively. This type of structural information about an organization relating to access control is defined in the K-pool “Organization Database” (see Figure 5-2) and can be intuitively modeled via the associated “Organization Modeler” (see the example Figure 5-14 for modeling workgroups).

In CM-WLOD access to content materials is controlled by these access rights. The understanding is straightforward: If a K-nugget is tagged with one or more of these organizational entities (user, workgroup, department, role) including the respective access level, all individual users explicitly being tagged in the K-nugget, or belonging to a workgroup or department tagged in the K-nugget, or owning a tagged role, inherit the respective access level to the K-nugget. For access control via roles this implies, for instance, that the role “Supervision for all new K-nuggets” has to be granted “editor” access rights. The task of the role’s current owner(s) is to check all new content to see whether it follows the compliance demands of the organization, and if not, to do the necessary changes or deactivate/delete the K-nugget. At least one employee will be assigned this role. This role’s access rights, tagged into K-nuggets, will not show an employee’s personal name. Rather it will be formally explicated by a tag stating:

< Role “supervision for all new K-nuggets” has “editor” access rights >.

At another place, in the “Organization Database”, the current owner(s) of this role is/are specified. The “Organization Database” correspondingly holds employees’ assignments to departments and workgroups. So, without any changes of tag structure and tag values in the CM-WLOD content repository, a subtle access control strategy can be realized by attaching/detaching people to departments, workgroups and/or roles respectively. The CM-WLOD model is intended as a bottom-up, loosely-coupled approach in empowering every individual employee/learner with the ability to disseminate information and collaboratively create knowledge among teams or workgroups. Given the flexibilities of the access control mechanisms in K-Pool and Notes this can be achieved by granting appropriate access control rights in the “Organization Database”. There, the relation between individual users and abstract schemes describing the organizational embedment of their workplaces is established precisely. The right to do this is normally dedicated to system administrators or managers. This indirect scheme for managing access control rights in enterprise content management or e-collaboration systems is typical for industry strength applications in the corporate world.

This architecture has been embedded in CM-WLOD. The specific value for learning and knowledge creation is in an organizational context that thereby the organization is supported in maintaining an abstract model of their organizational knowledge and its memory, not solely based on the snapshot of individuals running current operations. For instance, the tagging “Trainee program Asia-Pacific” for a workgroup gives access to the related K-nuggets for all individuals being part of the group. If another trainee, “Pei”, joins the group she has immediately access to all the materials by just one entry adding her to the group in the organizational database. Furthermore, the infrastructure of “Trainee program Asia-Pacific” from a material collection point of view is maintained even if all the current members are not assigned anymore.

In the case of the CDHK workshop scenario, most of the K-nuggets related to the training event can be read by employees of GCC. But, certain K-nuggets shall not be edited (i.e. changeable) by everybody because their context and content is defined by the project leader, and incremental updates will be carefully coordinated within the project team. Sensibility and security is another issue for some K-nuggets, related to the specific nature of the project. Hence “assessment” nuggets, containing individual assessment information and evaluations of workshop participants should only be readable by the team responsible for the content and assessment part of the workshop. For a just-in-need purpose, the project leader may change the “Access control parameters” of the context stub. So, during daily operations the right to edit sensible K-nuggets can be easily granted to other members of the project team, temporarily if suitable for the situation. In Figure 5-12 it is shown that (only) "Holger", "Pei" and "Heiko" in the CDHK project team, as part of the larger complete GCC team environment, can contribute/change context information or content to the respective K-nuggets.

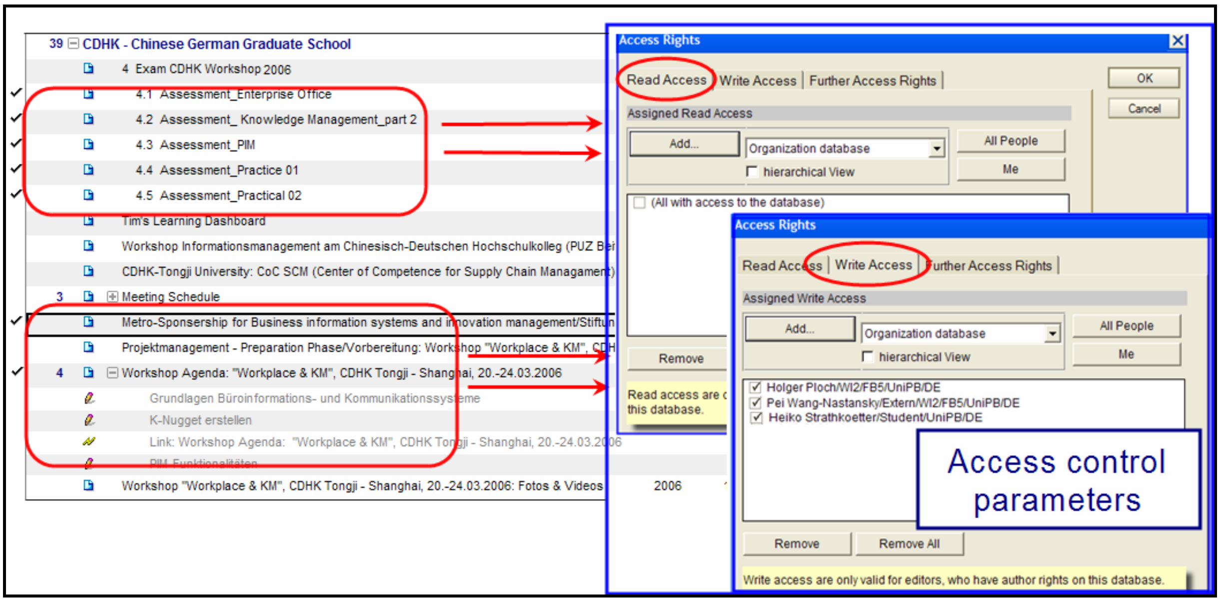

Figure 5-12: "Access control parameters" are assigned to the context information set

The contextual factors "Access control parameters", together with the subsequently delineated "Workflow parameters", provide a very versatile tool environment in seamlessly embedding learning with workplace processes. This versatility is necessary to map, or better re-model, the subtleties of access control management from the paper-world to the e-world. There seems nothing needing more attention than taking into account the "optimal" architecture and operational handling of access rights and related privacy issues in collaboration and learning. This is especially true for a democratic bottom-up approach which is intended to vibrantly be driven by learners/employees like CM-WLOD is aiming at. The subtleties of the manifold layers of group interactions and related dynamics cannot be solely handled by the coarseness harsh access control rights can radiate for some people, being excluded from access to interesting content materials.

Therefore, one additional remark to this issue: In the collaborative world of Lotus Notes based handling of shared document pools for more than 15 years now, the notion "security by obscurity", adapted from the world of system administrators, circumscribes an important "soft" approach to access control issues in the organizational world. Here is one example. Have a look at the knowledge worker's/learner's (alias, professor's) desktop shown in Figure 5-1. There, hidden under piles of other documents and folders, documents with a certain degree of sensibility will be found for sure, say, student grading, or, a draft of an innovative idea not being ready for publication yet. The desktop context secures them from direct accessibility for a passer-by in the office, rather than a red-stamp “classified”, or a locked folder. The “gesture” to secure information of this type, of just a certain sensitivity level, at the paper desktop is simple: just put the document out of sight, locate it under a pile of other documents. This way it is definitely not excluded, that some more curious people having access to the office, will become aware of the content not dedicated for him/her. And also, the owner of the document was not forced to explicitly express to others that they do not have access to the information. This type of abundant “soft” security and privacy approaches in the paper-world reality has to be kept in mind in appropriately modeling an e-workplace environment taking security and privacy issues seriously within the complex network of team interactions. In CM-WLOD this means, for instance, to take into account tagging K-nuggets with contextual parameters which by their individuality (or scarceness) most likely will result in documents being hidden “under the pile” of thousands of other documents, i.e. won’t be pulled by contextually driven investigations like the ones demonstrated in Figure 5-7. But, it is not excluded that the content will be visible for someone stumbling into it. So, being asked by someone why he was not informed about the findings in this document the (anticipated) apologetic answer might be: “But I posted it in our document pool, didn’t I?”

5.2.7 Workflow Parameters

In CM-WLOD three specific functions for workflow management are available and mapped to corresponding contextual “Workflow parameters” respectively: (1) an “acknowledgement” mechanism, (2) an industry strength workflow engine for predefined workflows (from PAVONE AG), and (3) an „Ad-hoc workflow“ engine developed as an academic prototype at GCC.

The “acknowledgement” mechanism provides a soft process management function for sharing content material. The employees tagged in a K-nugget for acknowledgement get this K-nugget automatically delivered to their workplace. The only interaction demanded is to tag a notification into the K-nugget that they have opened the K-nugget at their workplace and accepted it, i.e. “acknowledge”. One application to use this mechanism is to push loosely-coupled content material to workplaces of peers for the purpose of sharing the content (see example Figure 5-13). When using the “acknowledgement” mechanism, the end-effect with respect to monitoring attempts at successful knowledge acquisition is that the K-nugget accumulates a list/log of “acknowledged” tags, denoting people who have taken a look (or a click) at the assigned K-nuggets. There is no other means to recognize whether the K-nugget is truly processed or worked through by the people on the list.

It has to be taken into account that the “acknowledgement” mechanism can be used independently and in parallel to workflow assignments. And, it allows addressing a group of people in one process step, where it is at the user’s choice when to perform this step, without interfering with others. So, the “acknowledgement” mechanism will not block any working/learning process. On the other hand, the workflow parameters of both workflow engines are suited to support what has been outlined above as a “strongly-connected” relation to content (4.3.2.4), forcing down working/learning processes on designated people’s workplaces. If there is sequencing involved (like: “Please add your suggestions before you hand it over to the next”), both in a routine workflow and an ad-hoc one, a person can block the whole job progress by not diligently working on the assigned task.

The PAVONE workflow engine can be used to schedule repetitive and routine daily business processes in an organization or enterprise setting. Examples are: bank credit approval process, assessment/testing process in a repeating training event, predefined routine flow of material from research & development, creation and approval process for complex content materials.

The GCC „Ad-hoc workflow“ engine is suitable for project management or coordination of collaboration in workgroups. Both application areas share that they have been set up for specific tasks in a particular time frame in which the work processes are unique to the specific project or dedicated task structure. Regularly, documents, i.e. content material, have to be routed over a small number of workplaces, i.e. people “hops”, in an ad-hoc fashion.

At a knowledge-intensive workplace as in GCC, the CDHK project coordinator may assign an „Ad-hoc workflow“ as a process of information and knowledge contribution to three people in the team for sequential work. This is presented in Figure 5-13. The “Ad-hoc workflow” engine automatically and transparently for the three users handles the correct contextual parameter settings. This includes, in addition to routing to the workplace, automatically granting “editor” access for the next person who has to work upon the K-nugget - and taking away this access right level if he/she has accomplished the task. In the example, after the 1st ad-hoc process of updating the CDHK workshop logbook by the three involved people, all members of GCC will be “pushed” to the “2nd Acknowledge” process for renewing their awareness/knowledge about the CDHK workshop logbook.

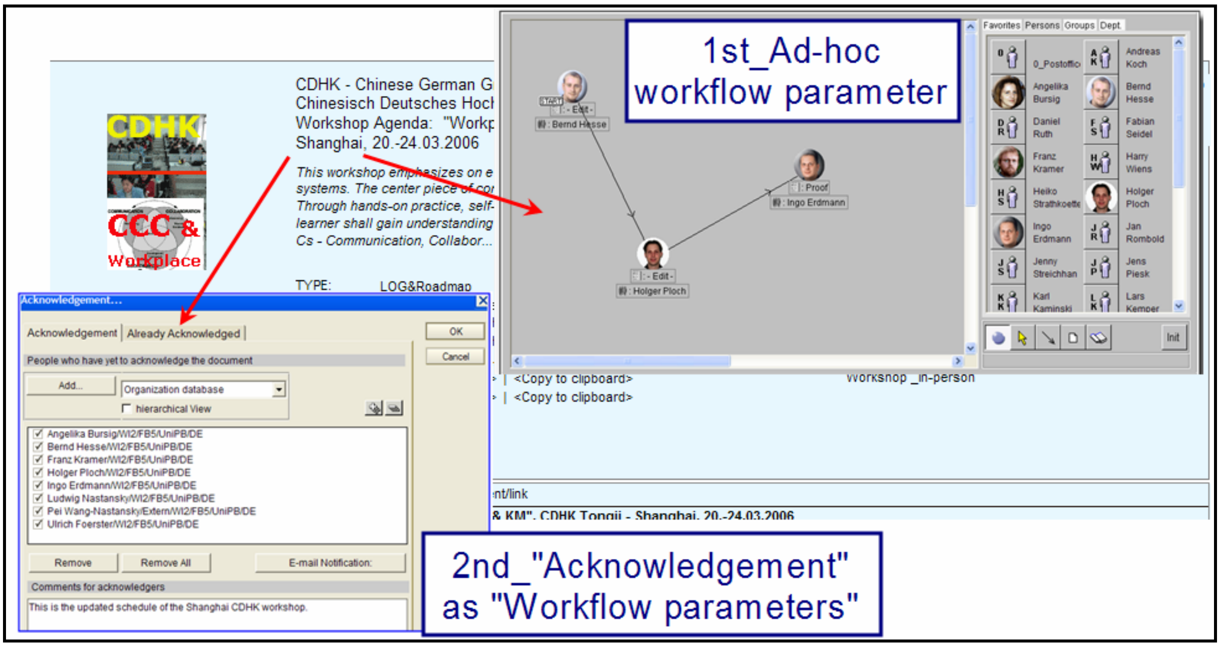

Figure 5-13: Assigning different "Workflow parameters" to the context information set.

In chapter 4.3.2.4 and at the beginning of chapter 5, the author has hinted at the personal desk spaces in a classical physical office environment where information and knowledge are classified and contextualized by the nature of projects and points of interests. This is a norm at modern workplaces where the employee often works simultaneously in different roles (some may call it multi-tasking). This has to be mapped into the world of virtual workplaces, to simultaneously and independently handle, in an organized way, different processes which correspond to the different job roles of different tasks.

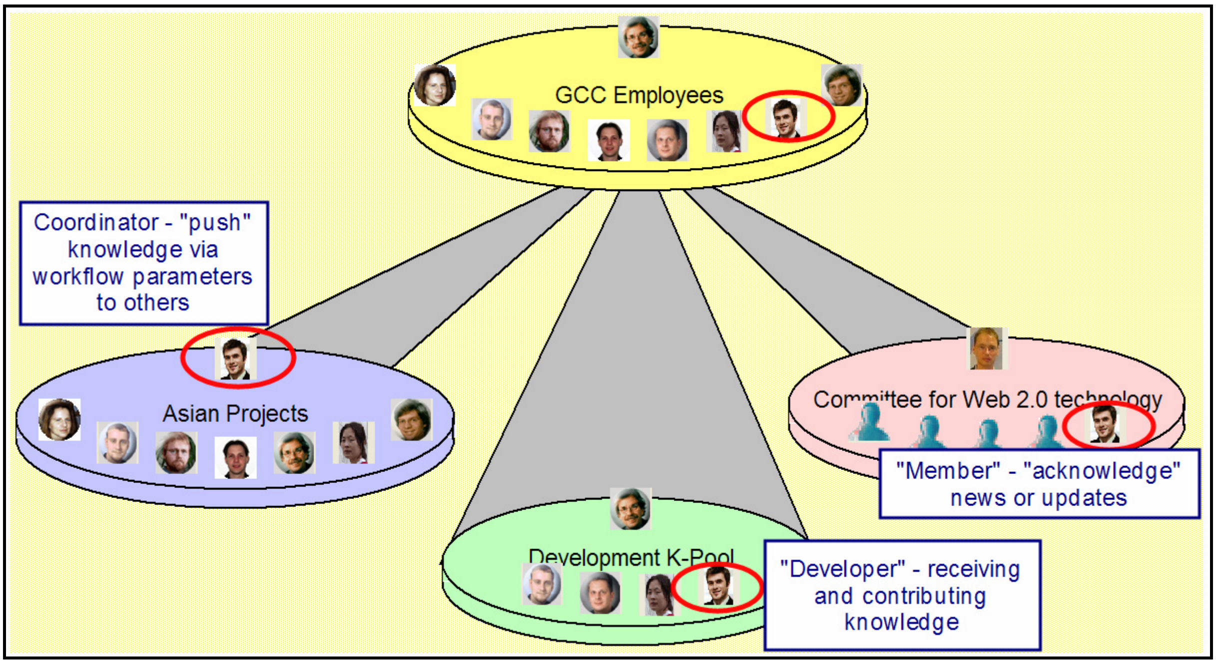

Figure 5-14: Different workflow parameter usages from individual employee/learner perspective.

For instance, in the GCC case scenario, "Tim" is a project coordinator for the CDHK project in China, and a software developer for the K-pool platform, and a committee member for Web 2.0 technology (here, with "Tim", the persona approach as indicated in chapter 1.3 is introduced). Presented in Figure 5-14, via the "Organization Modeler" as one of building blocks to support the workflow parameters denoted in Figure 5-2, "Tim's" formal relations to the two projects/tasks and his interest group are outlined. Although, in each role learning is a requirement for Tim, the workflow processes for him are quite different in the three groups. As a coordinator of the "Asian Projects", he utilizes the „Ad-hoc workflow" parameters to "push" knowledge to his team colleagues. For the on-going "Development K-pool", routine workflows (e.g. coding process, quality assurance process, deployment process) will be scheduled and "pushed" to Tim. At the same time, as a committee member, Tim only needs to "acknowledge" the K-nuggets (e.g. updates, news, policies) of the "Committee for Web 2.0 technology", "pushed" to him by the committee coordinator/secretary. Tim's precise various workgroup relations, as modeled in Figure 5-14 and embedded accordingly as data in the "Organization Database", are automatically reflected in the process operations due to the different workflow designs.

To summarize: "Workflow parameters" in the K-nugget, loosely-coupled or strongly-connected to the context information sets, enable the project coordinator/group leader/trainer to disseminate and create information and knowledge embedded in working processes.

5.2.8 Miscellaneous Other Parameters

There is a variety of "Miscellaneous other parameters" for K-nuggets contributing to different aspects of denoting context information in the application domain. The following will specify three of them which are embedded in the context stub of the K-nugget implementation: "Thumbnail", "Web settings" and "Comment" parameters.

Firstly, the "Thumbnail" contextual parameter is used to represent the K-nugget with an iconographic snapshot, a graphic stamp for easy retrieval and visual recognition by human-beings, and rendered by a variety of fitting user interfaces at employees' computer workplaces. Figure 5-15 illustrates how a thumbnail image can be easily attached to a K-nugget by the individual employee/learner (simply "four clicks", not prone to interrupt work routine): A) select thumbnail dialogue, B&C) capture thumbnail image from your hard disk, and D) view and cross-check successful completion. Here, the successful completion is shown at the web front of the CDHK workshop logbook nugget, contextualized together with other K-nuggets's thumbnails belonging to GCC's "Shanghai" activities. When exploring/discovering information and knowledge via web-browser, the thumbnail provides a richer portrayal of the information and content material of the represented K-nugget, in addition to the other context information in text format.

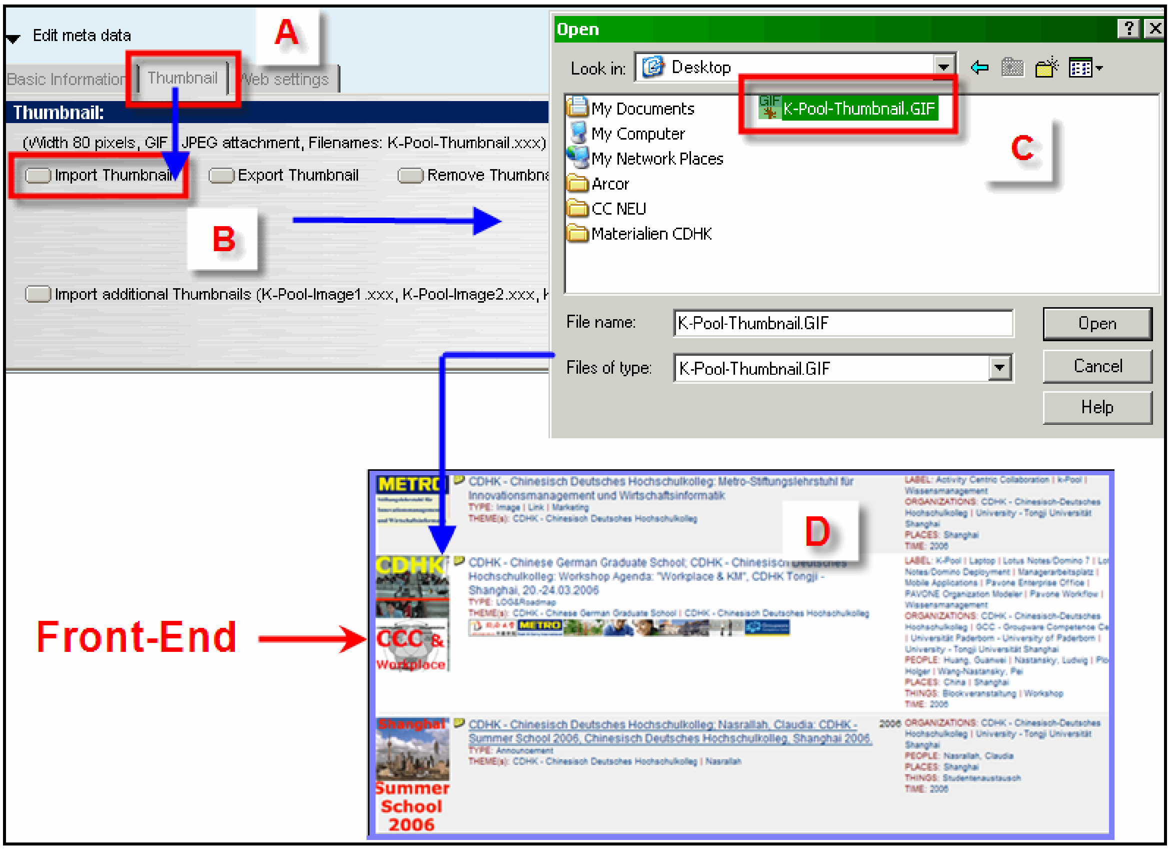

Figure 5-15: Miscellaneous other parameters – "Thumbnail" parameter

Secondly, the "Web settings" contextual parameters allow flexible control of publishing and URL-referencing of the K-nugget. Figure 5-16 displays the options as listed in the context stub, for the K-nugget itself (area 1), for attached "Comments" (area 2). It has to be noted that control over web-availability is strictly an issue of "hard" security, controlled by the "Access control" parameters: If a K-nugget ought not to show up for free access on the Internet it has to be explicitly denied "reader" access right for the "anonymous" user, a commonly used approach to block non-registered users. So, the sole purpose of the web publishing control mechanism is to make the K-nugget automatically show up in the abundant variety of K-pool views offering content contextualizations to an open web-audience, or not. The thinking behind this is related to the softer and more subtle sides of access control issues as being hinted at under the label "security by obscurity" above (chapter 5.2.6). So, a K-nugget tagged "Direct/View Web Access = No" can be only retrieved by somebody who knows the exact URL/Id, but won't be listed in contextualized views. This exact URL for access can be transmitted via an individual mail to a person interested in the K-nugget, usually following a respective direct communication between a member inside the organization, who knows about the K-nugget, and the person outside.

Part of the "Web Settings" is assignment of permanent links. As discussed in chapter 2.4.2.2.3, the concept of a "permanent URL" contextual parameter derives from the notion of "PermLink" (= permanent URL link) in the blogging arena, for unambiguously URL-stamping and archiving information objects for prospective later retrieval. In the CM-WLOD approach the default access mechanism for content retrieval is using information from a K-nugget's contextual signature to contextually place it at the workplace. Against this background, a permanent URL offers a complementary scheme which allows unique identification for accessing a K-nugget, without any context information. PermLinks in CM-WLOD should be individually named by users for easy memorization (and not obscured by unreadable automatically machine generated character sequences). So, in the case of the CDHK scenario, the workshop logbook has been christened with a "CDHK-GCC-06-Workshop" PermLink tag, the k-Pool system automatically providing the necessary preceding WebSite-URL.

Thirdly, "Comment" options are available. There are two types of comment. One is including content/information in the comment object itself. The other one is to include a link reference to another information object, be it another K-nugget or a reference to an external content material set. The commenting feature follows the metaphor of typical discussion threads, as used e.g. in forum software or e-mail systems. So comments-to-comments are provided. The "Comment" feature is very valuable for enabling and enacting interaction and collaboration, e.g. by collecting suggestions, by documenting feedback from people who access the K-nuggets, for provisioning additional complementary material, for opening a discussion thread in a dedicated learning setting. As opposed to discussion and interaction in typical forum environments, here, the discussion is strictly bound to knowledge gathering or clarification with respect to the K-nugget context, comprised by its content part and context information. Comments are related to and owned by a context stub of a K-nugget. So, the commenting and interaction on specific content material is highly structured, and can be contextualized by attaching it to the appropriate context stub of a K-nugget. All comments/responses attached to a K-nugget are listed in the respective context stub to which they apply. Figure 5-16 shows how the CDHK workshop logbook nugget is enriched by comments, including link-comments.

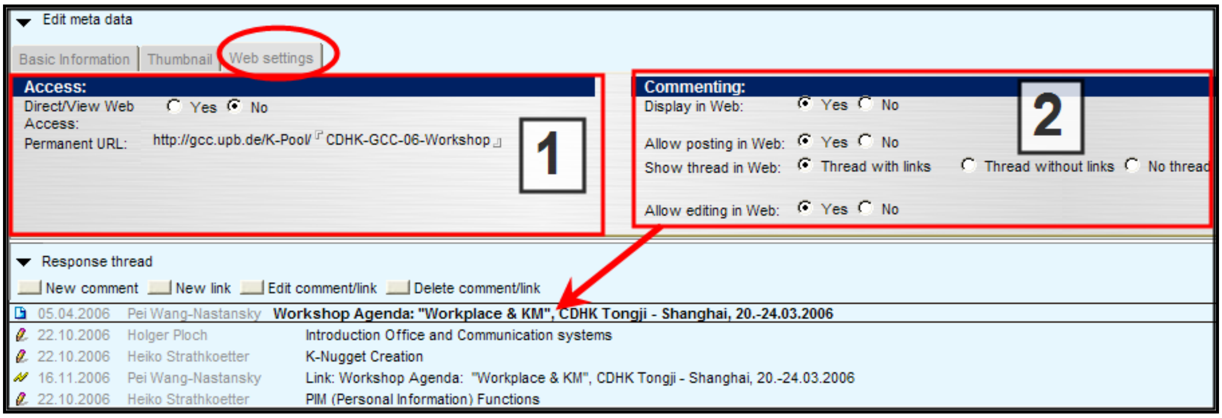

Figure 5-16: Miscellaneous other parameters – "Web settings" and "Comment" contextual parameter

As indicated in area 2 of Figure 5-16, the employee may decide whether or not to offer the commenting options for an open user community on the web: In the case of the particular knowledge nugget of the CDHK workshop logbook, it is allowed for web users to post comments. The implementation of the "Comment" parameter rendered via web-browser is especially powerful in sharing information and communicating in a content-centric orientation with people who have no or limited access to the internal CM-WLOD platform. At workplace learning on-demand, this applies to employees on the road who have limited connectivity to the office network, or seeking short and immediate content-centric feedbacks from team members who have not installed the Notes client at their workplace.

For organizational security issues, another layer of security parameters can also be added to ensure that only desired employees/learners may have the rights to submit comments on the web. This is exemplarily shown in Figure 5-17 where the user Pei has to identify herself by Login in order to post a message on the web related to the CDHK logbook K-nugget.

In workplace learning, on-demand learners/employees may take advantage of this light-weight web-browser-based commenting feature to interact with knowledge experts when access for the Notes client interface to CM-WLOD is limited. For instance, workshop attendees of METRO Group, China, can post their feedback in China regarding knowledge nuggets that are stored in a METRO CM-WLOD repository in Germany. Another option for usage is for customers to give feedbacks on specific services or products.

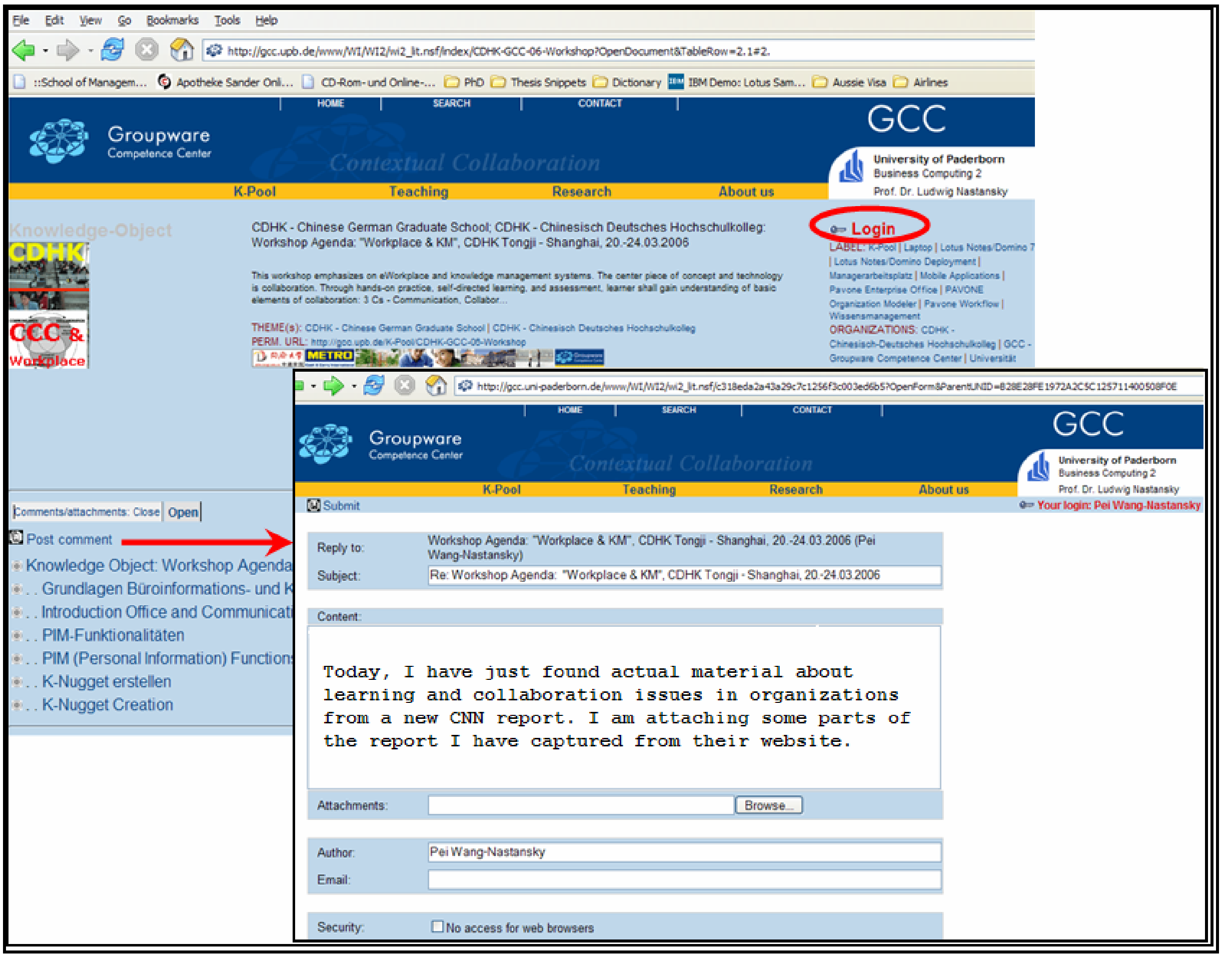

Figure 5-17: Commenting on the web, here: Login required

5.2.9 Contextual Signature – Contexts as Nuggets/Objects

As outlined in a summary of terms above (chapter 4.3.1) a contextual signature is understood to be a comprehensive representation of a specific context information set. Contextual signatures are different if they vary in at least one value of a contextual parameter. The notion of a contextual signature provides means to discuss and handle metadata tagging of content in a more condensed way - rather than digging into the details of all the contextual parameters they are made up by, as has been done in the previous chapters.

So, in CM-WLOD, the life cycle of content material can be described as consisting of a process of ever changing subsequent attributions of contextual signatures to the content. In the conceptual discussion of the K-nugget approach (especially chapter 4.2), as compared to IEEE's LOM model the first attribution of a contextual signature to a K-nugget most likely derives from the content itself, more or less devoid of context information about its usage in an organization. Or, it derives from creation and usage in a first original application domain in an organization. Then, later on, during further phases of the K-nugget life cycle, the contextual signature is modified, or, additional contextual signatures are successively attributed to the K-nugget to identify its reuse, repurposing, or referencing in other application domains of the organization. CM-WLOD has introduced the concept of multiple context information sets (chapter 4.3.2.2), necessary for modeling the existence of more than one contextual signature for content material. This concept is one of the contributions the CM-WLOD approach has brought to the underlying K-pool system, as another offering for generalization and function-enrichment for enterprise knowledge management.

In the real world, as an example, a K-nugget containing minute descriptions of essential features in a new product of an automobile company can be “learnt” by employees and by other people, most of them involved in rather different application domains. It can be used, for example, in typical trainee programs for new employees, to update employees in the marketing and sales department, to brief management, to inform dealers at trade shows, to provide background material for prospective customers, etc. This means the content material - “the new car” - will have more than one contextual signature, and more than one context stub accordingly, uniquely being attributed to “trainee program”, “marketing and sales update”, “management briefing”, “dealer material”, and “customer teasers”.

From the technology side in Lotus Notes, the mechanism of implementing more than one contextual signature to one content field is to create additional separate context stub documents which are, transparently for the user, linked to the first K-nugget document. In other words, by this principal one content field can have an unlimited number of contextual signatures. As shown above, comment threads can be attributed to each context-stub. Other advantages of implementing the contextual signature mechanism by relating it to one content field are that this is serving the obvious need to maintain just one physical copy of the content material, especially for integrity reasons in updating the content materials. Furthermore, similar to supporting independent comment threads, independent and different workflow processes (e.g. for learning, training, project management, routine processes, etc) can be separately embedded into their respective fitting context stub, while sharing the same content materials. Altogether, this allows a compact, flexible, versatile, process-centered and easily manageable coordination of data and information as well as collaborative communication focused on one related set of content materials. This is a completely different approach as compared to the currently widespread use of file-folders on shared network directories containing unrelated files of digital materials. It is also completely different from the naïve approach of posting digital materials in an intranet or on websites, and relating this to “e-learning”.

In the organizational memory, by the use of multiple contextual signatures content material can be retrieved by completely different settings of contextual parameters. This means, for the automotive case, content can be accessed by different contextual signatures, reflecting different mindsets of people, respectively involved in “trainee program”, “marketing and sales update”, “management briefing”, “dealer material”, or “customer teasers”.

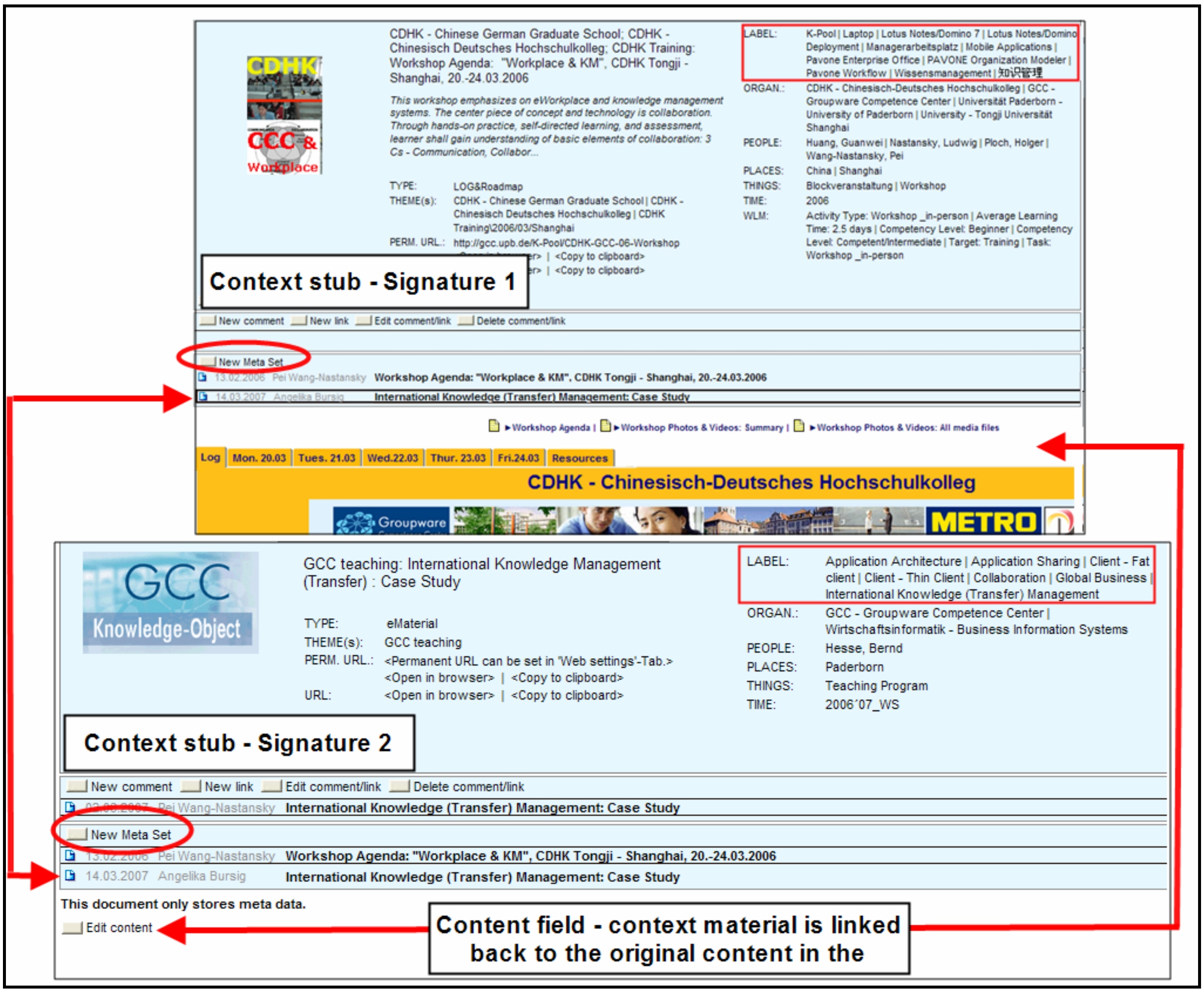

Figure 5-18: Example of multiple contextual signatures

The practical implementation of this principle will be demonstrated for the CDHK showcase. In Figure 5-18, the contextual signature #1 of the CDHK workshop logbook nugget shows a different collection of context information compared to the context stub for contextual signature #2. Specifically, in the contextual signature #1, the keywords “Laptop”, ”Lotus Notes/Domino 7”, “PAVONE Organization Modeler”, etc. in the keyword-class LABEL are different from the values in contextual signature #2 which contains the keywords “Application Architecture”, “Application sharing”, “Collaboration”, etc. in the LABEL keyword-class. From the use of the “Title” contextual parameters it becomes clear that contextual signature #1 (“Title” = “Workshop Agenda ...”) is attributed to the specific and technical prerequisites of the workshop project instance of March 2006. Whereas, contextual signature #2 (“Title” = “International Knowledge …”) is denoting the more timeless characterization of the content as related to “GCC Teaching …” material. Contextual signature #1 will be (re-) used to (re-) contextualize the K-nugget within the framework of the workshop 2006 project, together with flight plans, hotel and ticket reservation, project budget data, etc. On the other hand contextual signature #2 holds contextual parameters which allow bringing the K-nugget together with other K-nuggets containing training and background materials which relate it to the knowledge domains being covered in the workshop.

5.2.10 Summary

Chapter 5.2 denotes how the seven contextual parameters for contextualizing K-nuggets in the CM-WLOD approach are prototypically implemented via the K-pool state of the art knowledge management system. Each parameter can be considered as an individual contextual dimension which denotes characteristics relating the K-nugget to application domains. This is completely different from the one-dimensional “tag cloud” technique (Figure 2-16) providing no structuring means. The individual specifics of the dimensions: “Themes”, “Keywords”, “Categories”, “Access control parameters”, “Workflow parameters”, and “Miscellaneous other parameters” allow to organize and structure context information according to different but interwoven organizational needs. This approach empowers employees to systematically explore information and gather knowledge in the workplace setting. At the same time, the technical prototype of CM-WLOD, being embedded in an e-collaboration platform, supports the needs of maintaining the complex communication network for bottom-up collaboration driven by individual learners/groups. Learners are given contextual parameters like “Categories”, “Keywords”, or “Ad-hoc workflow” to personalize K-nuggets at an ad-hoc, on-demand fashion. This is possible without disrupting organizational processes which in turn are based on complied context information, predominantly defined e.g. by the “Themes”, “Keyword-classes”, “Predefined workflows”, or “Access control” contextual parameters.

This approach makes a big difference to the classical physical office. There, each piece of context information is separated from the other, and, whatever has been contextualized - e.g. by annotation, highlighting or classifying - is not shared or is only difficult to share in a team or in a wider organizational context (5.1.1). These challenges are being resolved in CM-WLOD. Particularly, the seven contextual parameters are implemented as contextualization tools for linking context information from different application domains spanning an organizational level. Sharing of content by use of independent, different and multiply assignable contextual signatures taps the whole bandwidth of employees' skills and mindsets for building organizational competence and knowledge. Pushing and pulling information by means of workflow through team-centered communication networks ad-hoc, in an on-demand manner, enables collaboration and team-centered knowledge gathering attitudes.

The technical implementation of CM-WLOD approach also takes the end-user at its heart. The intuitive process of generating context information, manually or again a list of already existing contextual entries, decentralizes the process of managing and organizing context information and the perpetual creation of new sets of context information. Rather than a hierarchical approach, often employed for corporate knowledge management or organized learning, individual learners/employees from the bottom up are given the control to pull information and knowledge for their own workplace domains with or without a trainer/learning facilitator/coordinator's help.

Additionally, without any programming skills, the employee/learner/knowledge workers are given tools to assign context information in the form of iconographic images ("thumbnails"), permanent URL addresses, or to visualize personal categorized K-nuggets in a rich graphic presentation, complementing a one-dimensional, flat outline structure.

5.3 Employee/Learner-Driven Contextualization of K-Nuggets

The previous chapter 5.2 presents the essential building blocks of the implemented CM-WLOD prototype. It has a methodical focus on how to separately handle the seven contextual parameters as tools in tagging, linking, and re-assigning context to content material in a knowledge management system. Complementarily, this chapter will reveal the daily utilization, by comprehensive and interwoven application of all these tools in the workplace learning on-demand scenario. Again, as mentioned at the beginning of the previous chapter, the arguments will follow a more narrative form, presented on a show-case basis.

5.3.1 Application Scenario

Continuing on the annual METRO CDHK workshop case, at GCC, personal changes are as common as in all research institutes or today's workplaces. So, the subsequent derivation of many applications facets of the CM-WLOD prototype application will be implemented under the following conditions: (1) the project coordinator of the 2006 workshop is not available anymore, thus, a new one had to be identified in the GCC Team for the year 2007 workshop event; (2) the new project coordinator did not participate in any project, at CDHK, Shanghai, so far.

As new CDHK workshop coordinator and workshop facilitator, Tim Smith is assigned to prepare and manage the CDHK workshop in Shanghai, China for the year 2007 event. (As already mentioned, Tim is chosen as an incarnation of a prototypical project coordinator, following the idea of the "persona" approach referred to in the introductory chapter 1.3 on methodology.) Although much context and content information related to the workshop persists from the year 2006 to year 2007, Tim, as a new project coordinator, faces many challenges:

1. From the personal learning perspective:
    - He has to learn about the CDHK project background, team members, and many of last year's details because he is new to the assignment.
    - He must find his own ways to study the project because there are no training courses or text books available regarding the project.
    - He is assigned to coordinate the project while working parallel with other daily tasks at GCC.
    - He has little knowledge about Shanghai, nor of the Chinese language.
2. From the job tasks side:
    - He needs to identify work processes for updating the workshop materials among subject-experts in GCC. Since spring 2006, there are changes and updates in the knowledge domain and technologies, such as further development of concepts of virtual workplaces, advances in collaboration technology tools, and new benchmarks for assessment at the end of the workshop. All the material pertaining to this information is stored in K-pool, but not picked out for the 2007 CDHK workshop instance.
    - He needs to monitor the workshop preparation process to ensure that the material and agenda are going to be ready on time.
    - He needs to put all the material in a shared office environment so that all his team members may have access to them.

In one word, Tim, like many other employees at knowledge-intensive workplaces, must identify an on-demand learning/working process, study the related information, the people, the workshop setting, and create knowledge by himself in order to fulfill his job assignments effectively and efficiently. Nevertheless, the picture is not all too gloomy for him; Tim has many advantages to accomplish his job as well:

1. He is aware of that all content and context information and knowledge about the workshop are stored in the GCC K-pool system according to the CM-WLOD approach.
2. He is familiar with knowledge management technology.
3. He is a great team player within a supportive team environment.
4. He is motivated to learn.

To start this on-demand learning/working process, Tim will take advantage of the contextually driven knowledge nuggets environment and the available tools to accomplish his learning and working tasks.

In this thesis, the author has applied Alavi's (1997) distinctive four stages model as the theoretical ground in exploiting the characteristics of an individual employee's learning/knowledge management process at workplace. This means for Tim, his learning and working outcomes are from: (1) discovering and acquiring, via searching ("Themes", "Keywords", etc.) and communication with peers; (2) organizing, via contextual tools, such as "Categories", "Keywords", and "Contextual template", etc.; (3) disseminating and distributing, via embedded workflow processes; (4) applying, K-nuggets to the workshop in 2007.

As Tim's title suggests, his main task is to learn the project's context and gain knowledge for effective coordination of the process for the 2007 event, rather than generating content. The following will reveal how contextual parameters and other innovative intelligent tools (e.g. contextual templates, contextual profiling) are utilized in accomplishing this job assignment by on-demand learning and knowledge contextualization.

5.3.2 Discovering and Acquiring Knowledge via Themes and Keywords

Tim may take advantage of the "Themes" contextual parameter to discover K-nuggets that are tagged relating to his project assignment. As discussed in chapter 5.2.2, the "Themes" parameter is especially adapted to specify strongly-connected context information in concordance with terms or phrases agreed upon to use for describing application domains in an organization. Utilizing the "Themes" contextual parameter in this way facilitates team-oriented knowledge discovery and sharing. So, the "Themes" contextual parameter space will not be new to Tim because it follows organizational compliance and is generally used for information classification.

Moreover, it is possible to tag the content material with multiple “Themes”. In the CDHK workshop scenario, Tim has discovered that the project team of the year 2006 has defined three concurrent themes (Figure 5-19): 1) “CDHK Training\2006/03/Shanghai”, 2) “CDHK – Chinese German Graduate School” and 3) its corresponding German version. Collected under these themes, Tim has discovered 47 K-nuggets in total, both about the specific workshop material and other background or related information he would like to learn about CDHK. Examples are: the “METRO-sponsorship” nugget, the “Contacts” nugget, and information about how the CHDK project was managed last year, etc. All these K-nuggets are strongly-connected, structured under the three domains denoted by the three “Themes”.

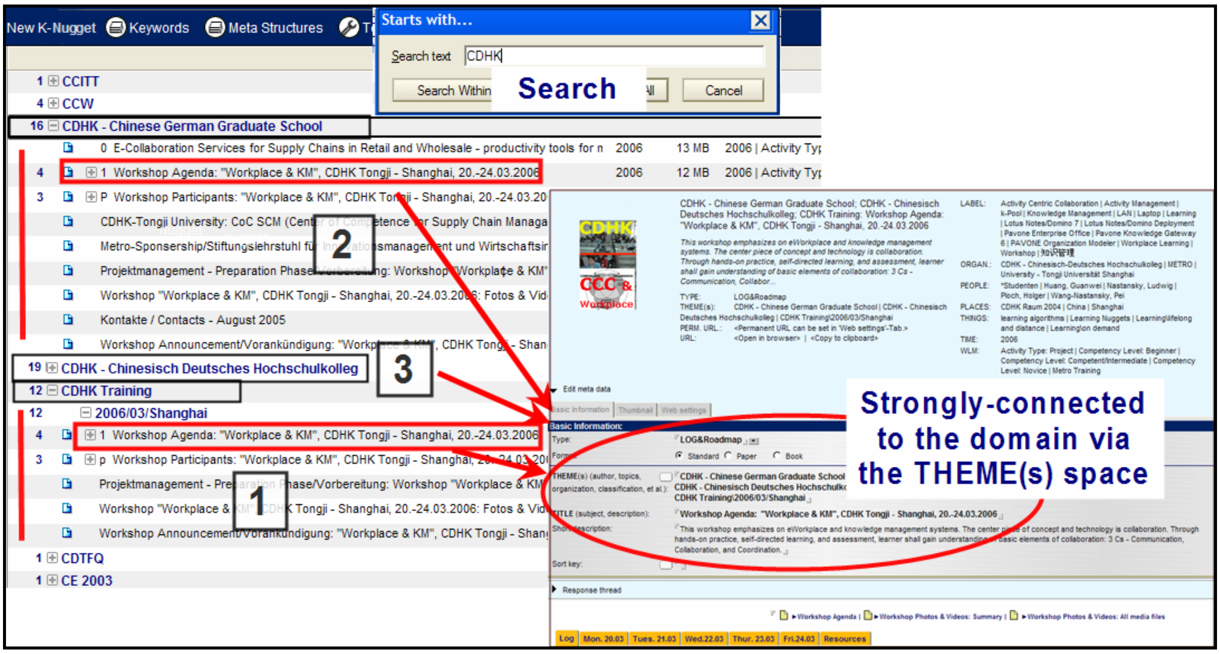

Figure 5-19: Find nuggets belonging to domains as denoted by the “Themes” parameter

In each K-nugget, Tim has also found a set of keywords that are used as detailed meta descriptors about the application domain of the content material. When Tim opens the K-nugget with the theme tagged “Workshop agenda …”, he takes notice of the assigned keywords within their keyword-classes, such as “Shanghai”, “China” in PLACE; “Holger Ploch”, “Ludwig Nastansky”, “Pei Wang-Nastansky” in PEOPLE; “CDHK”, “Metro” in “ORGAN.”, etc, as circled in Figure 5-20.

While the “Themes” parameter has served as a first entry point, the “Keywords” contextual parameters can be employed as starting points for many discovery channels[38], which can be systematically explored, keyword after keyword, in further digging desired content via the

[38] The term „channel“ denotes a path on following up a search for related K-nuggets starting with one specific value of a contextual parameter, here „Keywords“.

contextual information contained in the K-nugget. Displayed in Figure 5-20, for example, the keywords have pulled lists of nuggets relating to topics: 1) “Activity-Centric collaboration”, 2) “CDHK”, or 3) “Shanghai”. Additionally, whether Tim is looking under the “Themes” or “Keywords” K-nugget collections, he sees that every K-nugget is consistently accompanied by a list of context information, which helps him, as a first indicator, in determining the relevance of the nuggets to his learning or working needs.

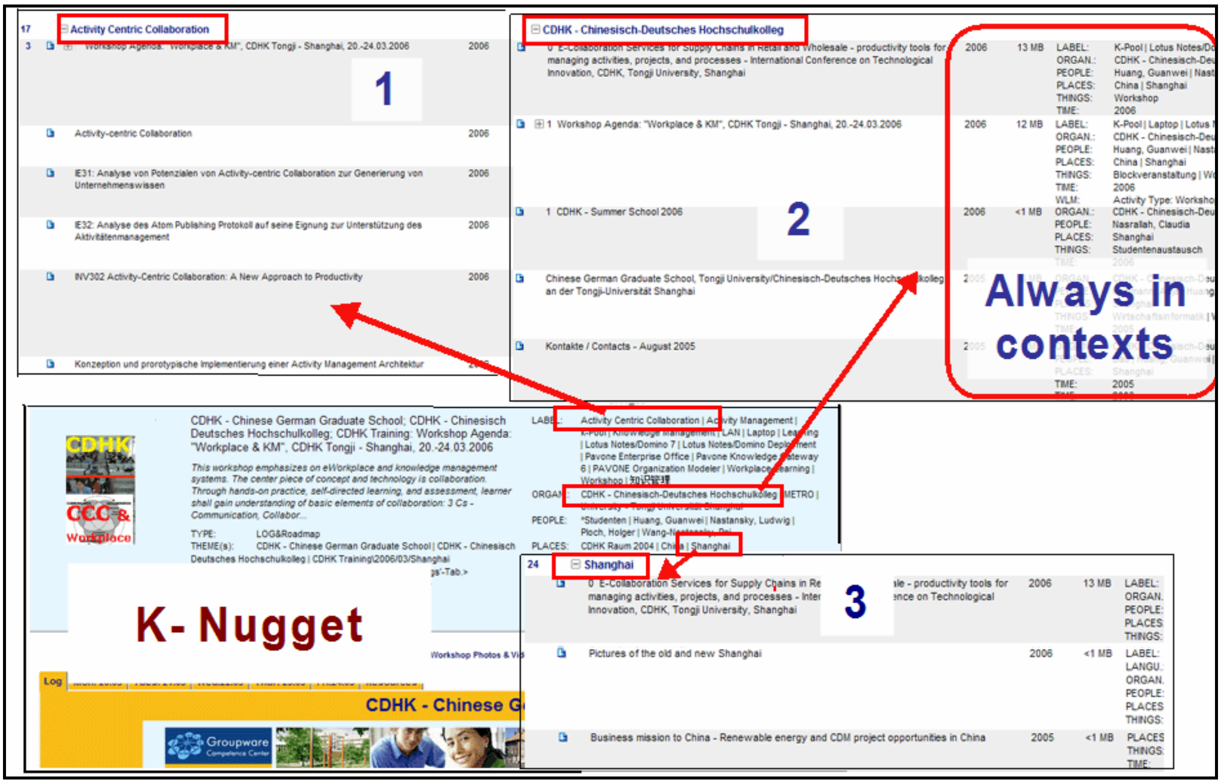

Figure 5-20: Keyword discovery

5.3.3 Organizing and Linking Knowledge Nuggets for Personal Application Domains via Categories

Again, the ultimate goal of learning at the workplace is for better fulfilling Tim’s job assignment. This implies that his activities in organizing, filtering, and linking K-nuggets are related to both, Tim’s personal learning needs and the preparation of the 2007 workshop.

So far, all nuggets Tim has collected are for the whole GCC team, and not dedicated to his personal needs. But, the job assignment of coordinating the CDHK workshop for 2007 demands collecting more K-nuggets, this time supporting Tim’s individual and personal learning needs in an ad-hoc fashion. To achieve this, Tim turns to the “Meta Structures” tools for tagging of personal “Categories”, for collecting and structuring the K-nuggets he employs for his personal use.

Figure 5-21 illustrates the personal categorization process that Tim has gone through this way. First, Tim selects desired nuggets for his own learning endeavor which he has discovered following the keyword channel “CDHK – Chinese German Graduate School” (area 1). Then, activating the “Meta Structures” (introduced in chapter 5.2.5), he realizes these nuggets have already been personally tagged in different categories by his colleagues (area 2). Tim’s access right allows him tagging in his own category as “TIM’s Learning”, which serves as an umbrella for all the knowledge nuggets he would like to study. While the four selected K-nuggets have a strongly-connected relation to the application domain “CDHK – Chinese German Graduate School”, they are rather loosely-coupled information for “Tim’s Learning” personal domain. The loosely-coupled relation between the nuggets and the application domain is because “Tim’s Learning” is added in an on-demand, ad-hoc fashion unlike the “CDHK” domain which is pre-defined. Secondly, Tim might not necessarily study all K-nuggets under the “Tim’s Learning” category in a dedicated learning mode. He might simply use this category to collect information and knowledge. Thirdly, “Tim’s Learning” reflects a rather spontaneous and casual wording that is meaningful only to Tim as an individual employee. On the contrary, the contextual parameter value “CDHK – Chinese German Graduate School” is an officially agreed term designated to the school in the Tongji University, Shanghai, China.

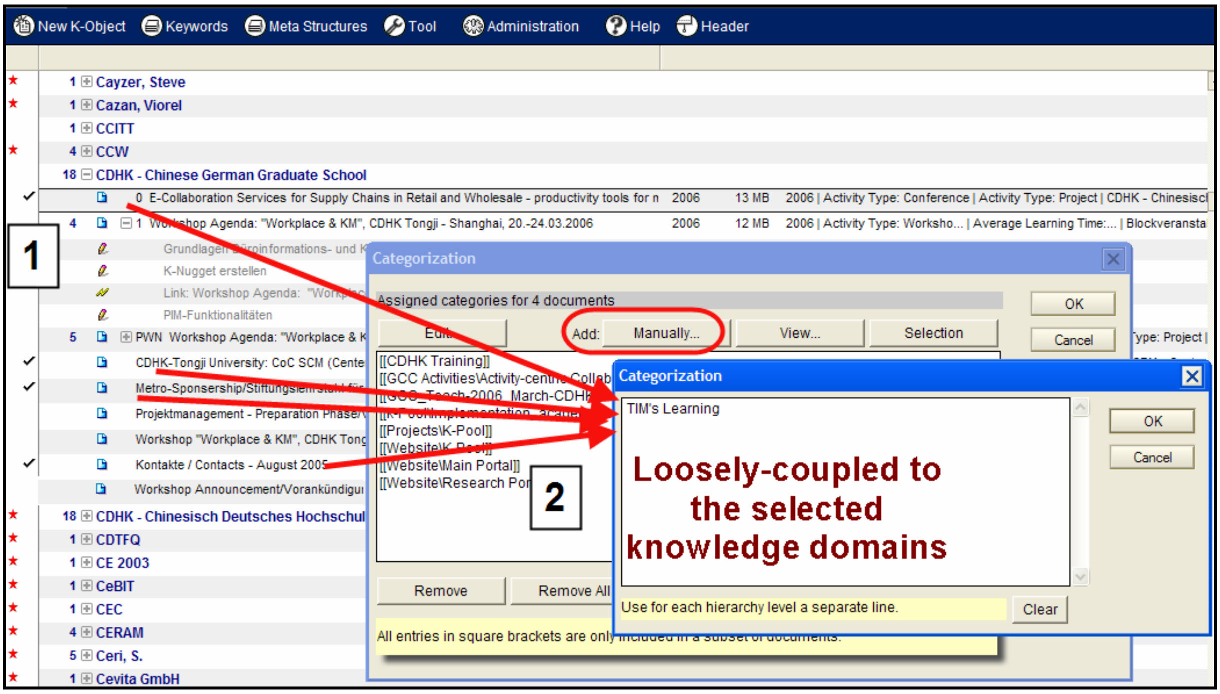

Figure 5-21: “Tim’s Learning” as the personal contextual category

Because the “Keywords” contextual parameter can be applied to tag both official and personal application domains, the practical use must be based on individual agreements in the organization. In GCC, the tagging mechanisms used for “Keywords” and “Keyword-classes” are semi-structured. This means, only people who are assigned “author” or “editor” access to K-pool’s Settings Database may add new “Keyword-classes” or edit existing ones. Meanwhile, every member of the GCC team may contribute “Keywords” at their will to classes which do not have restricted keyword lists (chapter 5.2.4). This has resulted in thousands of existing “Keywords” in the GCC’s central K-pool, accumulated over the years. These “Keywords” are more or less conformations or hard-defined descriptors used to describe the wide bandwidth of organizational application domains and knowledge areas. They are part of GCC’s collective memory. Under this circumstance, Tim has decided to keep it simple and consistent by collecting personal learning materials under only one “Categories” contextual parameter – “Tim’s Learning”, though he has the access right to add more “Keywords” in the context stubs of the collected K-nuggets. In doing so, he knows where exactly to retrieve his personal learning material, and at the same time, it avoids muddling together with other organizational “Keywords”.

Two remarks shall round up Tim’s personal and individual tagging. While assigning his own “Tim’s Learning” folder for collecting his personal learning materials Tim is pointed to his peer’s folders (area 2 of Figure 5-21). He could easily follow up on inspecting his peers “Categories” analogously to following up a keyword channel. Thus, he might have the opportunity to identify K-nuggets his predecessor as project coordinator 2006 had used in the same situation he is right now. This would allow easy re-tagging for his own use. Conceptually, this would be a piece of reusing knowledge having been created/gathered by others, the peer would fulfill the partial role of a learning instructor (albeit without knowing), the whole personal “Category” serves as part of bottom up created organizational memory. These powerful mechanisms for context distribution have to be contrasted to the inefficiency, lock-in and sheer inability of transferring personal contextual information at the traditional paper dominated office desk (compare chapter 5.1.1).

The second remark pertains to the number of keywords, or in general values for contextual parameters, accumulated over time, in GCC’s case, plentiful. The K-pool system provides easy to use tools for CM-WLOD in consolidating terms used as tag names. The “Glossary Database” (Figure 5-2) serves as this environment. It offers a set of tools for consolidation of contextual parameter values, like management of synonyms (instead of blowing up the number of terms) or mapping of keyword variants onto one agreed-upon keyword. The use of these tools is not so much a technical issue but rather relates to the spirit of bottom up and decentralized tagging. The CM-WLOD approach offers many levers to balance the used name space of tags, one of them applying tools for glossary management. It is not possible to define here general rules. The application of these tools has to be decided case for case, on the basis of the compliance policies of the individual organization. For details on using these glossary management tools the reader is referred to Huang (2004); this issue will not be further elucidated in this thesis.

5.3.4 Organizing and Linking Knowledge Nuggets for Organizational Application Domains

5.3.4.1 Via Contextual Templates for the Content Part

On-demand workplace learning regularly involves activities which organize, reuse, and/or repurpose existing knowledge for another application domain, as pointed in chapter 1.1 e.g. by Smith (2000). This is especially true in Tim's on-demand learning endeavor in which he learns from last year's processes and activities in discovering and acquiring appropriate K-nuggets. But more importantly, he reuses last year's experience, even some materials, by re-contextualization and updating for the 2007 workshop. Again, Tim is not going to generate the workshop content by himself. Instead, as a coordinator, his main task is to bring pieces together under one organizational scheme, a business more context-driven than content-centric.

When it comes to contextualizing K-nuggets for usage in an organizational application domain, firstly, Tim needs to communicate and synchronize issues regarding the presentation, layout, format and structure of the content material with his team members. Obviously, consistency of materials radiating corporate identity is more important in enterprise application domains than for personal application.

For the organization of the CDHK 2007 workshop material, the project team has decided to be consistent with the look-and-feel from last year's experience. Hence, instead of creating a new layout with different color, font, or template schemes, Tim must carry on the material structure as well as its layout (e.g. icons, colors, tables, etc.) from K-nuggets in the 2006 event.

One common practice normally involves copying the full content material in the content field of a K-nugget from the year 2006 workshop, then paste it into a new K-nugget tagged as "CDHK workshop logbook 2007", for example. Yet the tedious work of deleting and choosing what content is needed and what is not has made Tim turn to another more elegant solution – pre-loaded contextual templates.

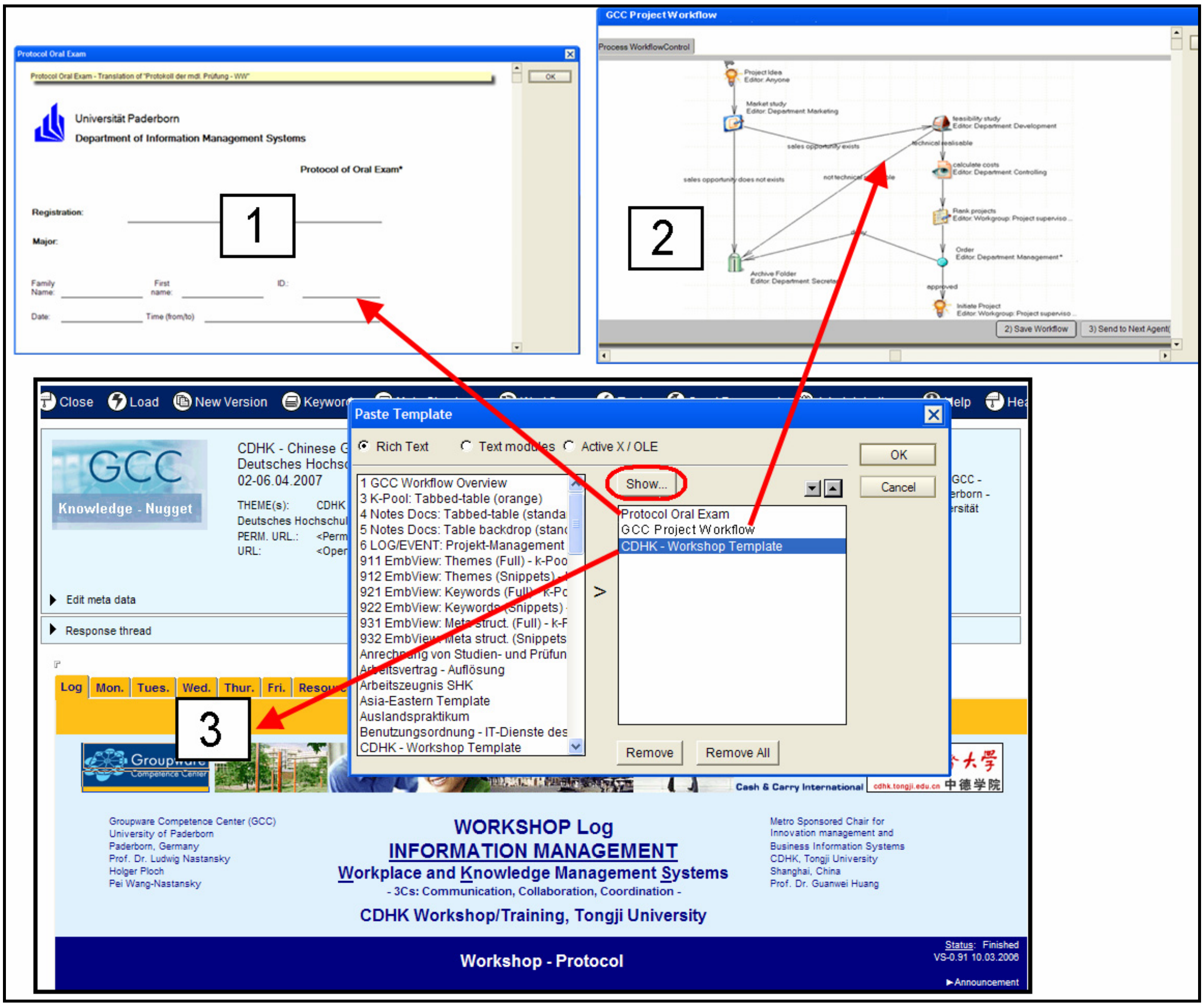

Figure 5-22: Examples for contextual templates

Presented in Figure 5-22, Tim exercises the “Load” function on the navigation bar, which allows to pull a pre-loaded contextual template chosen out of a variety of offerings, ranging from static tabbed-tables (e.g. used by the content presentation of the CDHK workshop), to dynamic workflow processes, and to dynamical context-filtering templates based on computed values for K-nugget selection via “embedded views” (this be explained in the next chapter).

In Figure 5-22, Tim can not only pre-view existing contextual templates, but also select more than one template for his task as well as sorting them in a desired order. Area 1 of Figure 5-22 shows a protocol template for oral examination that the examiner (e.g. as trainer, teacher, professor, facilitator) may use. Area 2 displays a pre-defined workflow template with all basic contextual workflow information already specified and offered for customization (e.g. the tasks, the process, and the routing directions). As shown in area 3, Tim has selected the standard “CDHK - Workshop Template” to organize the content materials for the 2007 CDHK workshop. In this way, he adheres to the same contextual outlines of the year 2006 event with the same icons, logos, color scheme, font style, as well as maintaining the day-by-day (as a table-in-table format) arrangement of workshop materials.

These pre-loaded content material templates are pre-deposited in the K-pool's "Settings Database" (Figure 5-2). Only people with sufficient access rights can add or modify templates for pre-loading in the back-end "Settings Database". Although, with only "author" right, Tim cannot change anything of the pre-loaded templates in the back-end database, he may customize the template once it is loaded in the front-end, into the rich-text field of the K-nugget. This architectural design tends to the requirement of maintaining organizational standardization while being flexible to the end user's individual contextual needs.

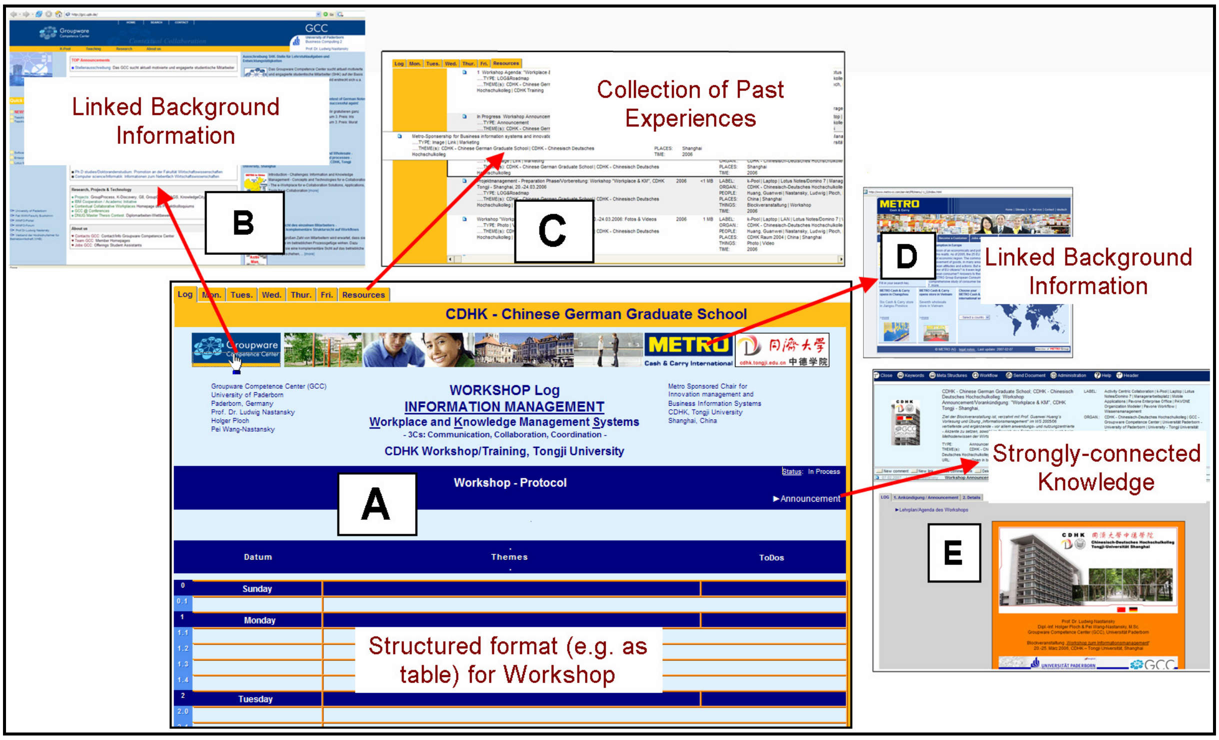

Figure 5-23: Contextual template – "CDHK –Workshop Template"

In more detail, the "CDHK-Workshop Template" (area A of Figure 5-23) contains diverse pieces of contextual information itself. The template consists of both static and dynamic data. It preserves active image links about organizations, such as GCC's website and METRO's site (B and D respectively). It has a "Resources" container, as the last tab in the table, automatically pulling a list of knowledge nuggets filtered through categorizations (C). Additionally, E is a strongly-connected knowledge nugget named "Announcement", which is connected to the web-posting of the workshop schedule nugget. Certainly, Tim has to add some data for the 2007 CDHK workshop domain (e.g. the materials for the 2007 workshop announcement). However, utilizing this pre-defined contextual template saves Tim's time and resources as compared to starting from scratch in structuring and organizing workshop materials.

In knowledge management, reusability is not limited to reusing content. Researchers have also been advocating sharing context information in a collaborative workplace environment, in a way that the context can not only be reused but also repurposed as well (chapter 3.4.4). The contextual template approach displayed above is a versatile technical prototype of this concept. Additionally, the application allows not only static data (e.g. text, table, image, layout structure, etc.) to be deposited as templates, but also embedded objects to interact upon, like links, computed forms (e.g. via embedded views) or work processes (e.g. workflows).

Here, the mechanism of pre-loaded contextual templates is a pragmatic approach in enhancing reusability of contextual information, particularly, the contextual structures/outlines in a shared workplace environment. In GCC's annual workshop scenario, Tim, as project coordinator, reuses the contextual template as an effective tool to get the job done. The obvious advantages are, amongst others, reducing repetitive work across the organization, avoiding errors by reuse of proven material, following compliance rules – and thus increasing efficiency at the workplace.

5.3.4.2 Via Contextual Parameters for the Context Stub

The next procedure, after reusing the contextual template, is that Tim has to define the context information in the "Context stub". For the reuse of contextual parameters from already existing K-nuggets a variety of options is available for him. In principal, these options provide mechanisms to mark existing contextual parameters for reuse as source(s) and then accomplish the inheritance process by "infusing" them in empty or already pre-populated K-nugget(s) as target(s). Depending on the specific working environment (i.e. user interface) the user is actually working in, the gestures and user interactions for the transfer process are accommodated accordingly, for ease of use. For instance, contextual parameters can be inherited from a user selected collection of several K-nuggets, or the transfer of contextual parameters is intended to take just one K-nugget as source. User gestures might vary between simple "point-and-shoot", or dialogue boxes offering a comprehensive list of options the user has to work upon in a detailed fashion.

Here, an example is given for inheritance from one K-nugget to another. Tim's new K-nugget tallies the three "Themes" contextual parameters already assigned to the previous workshop's K-nugget, thus stabilizing the common name space used organization-wide as an important structuring means. So, "CDHK - Chinese German Graduate School" and "CDHK - Chinesisch Deutsches Hochschulkolleg" can be collected from the list of already existing "Themes" via point-and-shoot gestures, without typing. Theme "CDHK Training\2007/04/Shanghai" has to be adapted to the new event by keying-in. The new title has to be keyed-in accordingly: "Workshop Agenda, CDHK Tongji - Shanghai, 02.04.-06.04.2007". After already manually keying-in some context information in the new (target) K-nugget, Tim can certainly continue in manually tagging the other remaining contextual parameters. However, K-pool provides Tim more intelligent tagging tools to reuse contextual parameters by inheritance from already existing parameters, making only modifications necessary at places where applicable. So, the contextual signature of the CDHK workshop logbook nugget 2006 is replicated and used as template for 2007.

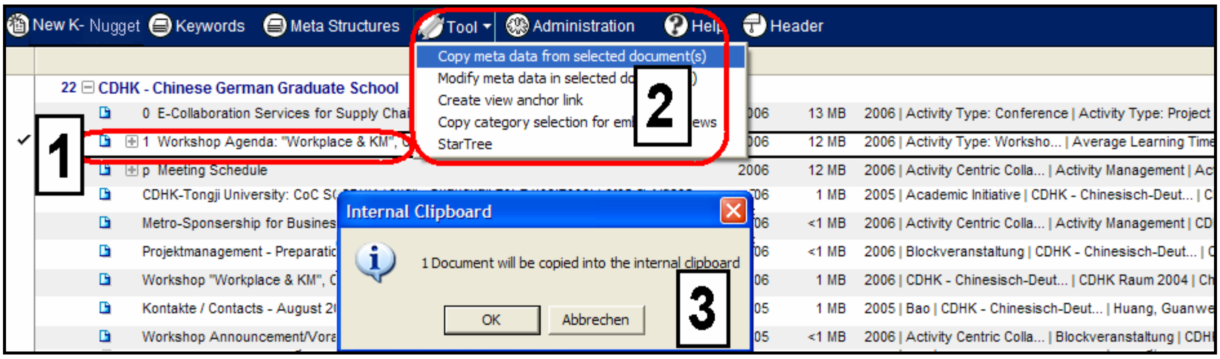

Figure 5-24: Copy context information

Figure 5-24 and Figure 5-25 exhibit the procedures in achieving this process of reusing and repurposing contextual information between different K-nuggets. Figure 5-24 exemplifies the first inheritance step for transmitting a contextual signature, defining the source K-nugget: 1) selection of K-nugget "Workshop 2006" as source, 2) selection of "Copy meta data …" functionality, and 3) user acknowledgment. After this, all existing contextual parameters of the source K-nugget are rendered to the clipboard. To complete the transmission of contextual parameters, the target K-nugget "Workshop 2007" has to be selected and consecutively populated with those contextual parameters which Tim chooses to be inherited. Figure 5-25 exemplifies this second "infusion" (i.e. "adding tags") step of transmitting contextual signatures.

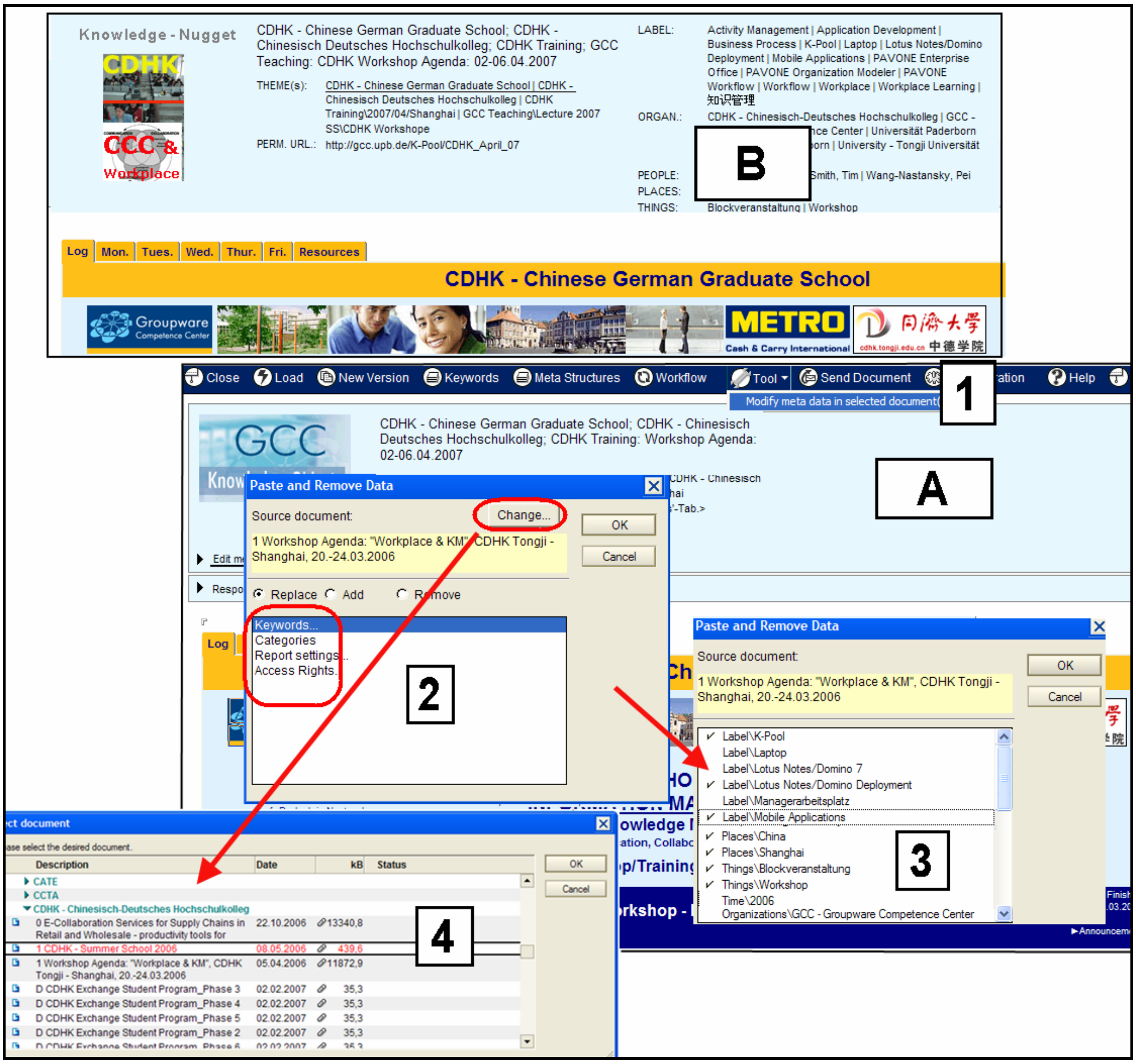

Figure 5-25: Reusing contextual information with contextualization tool

Tim continues his work in the "Workshop 2007" document and selects the "Modify meta data …" option (area 1). Note that the context stub area of the "Workshop 2007" K-nugget showing the "Keywords" contextual parameters is, still, empty (area A). Then, Tim selects the type of the contextual parameters to be transmitted. Amongst others, the options are "Keywords", "Categories" and "Access Rights" contextual parameters. He chooses "Keywords" (area 2) and "Change", while the source document "Workshop 2006" is presented for clarification (area 4). After this, Tim is offered a list of the existing "Keywords" in the "Workshop 2006" K-nugget. He selects all the entries to be inherited for the new "Workshop 2007" (step 3). After acknowledgment the selected "Keywords" contextual parameters are infused into the target K-nugget "Workshop 2007". As shown in area B, the "Workshop 2007" K-nugget is now fully populated with the inherited "Keywords". Other contextual parameters, e.g. “Categories” or “Access Rights” can be transferred by Tim accordingly.

The advantages of this contextual tool are three-fold. First, as an employee pressed by time and multiple job assignment, Tim saves time by not tagging each piece of context information manually. Especially, in the CDHK annual workshop case, when there are a number of contextual similarities between the year 2006 and 2007 events, this is very efficient. Secondly, as in the case of using a pre-loaded template, Tim is enabled to easily maintain the consistency of the name space used, via carrying on the conventions of last years' organizational structure and context. Thirdly, the very activity of selecting and choosing context information is a re-enforcement of the employed general learning contexts by handily picking necessary data. Obviously, the current technology development offers a variety of automatic metadata tagging engines, which might be useful in certain repetitive application domains or more anonymous KM-environments. Earlier, Cirilab's Knowledge Generation Engine™ was referenced as such an example (chapter 4.3.2). However, in a dynamic knowledge-intensive working (and learning) environment, currently machines cannot replace humans, especially for contextualization and structuring endeavors which are at the core of this thesis. But, without question the future will be the middle point between the two extremes, i.e. a combined automatic and manual tagging process as implemented above, balancing the ever growing needs in work efficiency and learning effectiveness at a 21st century workplace.

5.3.5 Organizing and Customizing K-Nuggets for both Personal and Organizational Application Domains

5.3.5.1 Constructing Embedded Views

Now, Tim has been learning about the CDHK project by discovering and categorizing existing and rather easily identifiable K-nuggets via contextual tools. At the same time, he also started to create a new logbook nugget for the year 2007 workshop. Till this stage, Tim is learning-by-doing and working-via-learning. Whatever information and knowledge he has studied and created are aimed at fulfilling his job tasks planning the new project. The line between his personal learning needs and work is blurred.

According to CM-WLOD conventions in the CDHK scenario, the “Themes” and “Keywords” contextual parameters are used and reused for contextualizing K-nuggets in the organizational domain as intended, while the “Categories” parameter (denoted mainly as “Meta Structures” in K-pool) can be utilized for tagging in an individual learning domain. Although the contextualization tools are quite sufficient in their respective domain usages, different K-nuggets of different domain applications have to be collected in separate virtual spaces. The change to another virtual space, say from “Categories” to “Themes”, is accomplished by switching the user interface from one view to another and selecting the aimed-at value of the respective contextual parameter using keyboard and/or a pointing device (e.g. mouse). In other words, Tim has to navigate to “Tim’s Learning” after entering the “Categories” view to check his personal learning status, or, to the “Agenda workshop logbook 2007” value of the “Themes” view to see what has been done by his team colleagues. Given this, for a better compact information interface, Tim now desires one integrated space to merge information and knowledge from different application domains without being forced to perform the type of manual interaction shown above to change views. In this integrated space, he could monitor not only what he has done, learned, or created for the project, but also track the project workflow and what other team members have generated related to the CDHK project - everything at a glance. This integrated space in CM-WLOD is named “Personal Workplace Learning Dashboard” where employees are enabled to customize an individual workplace based on their respective job and learning profile, including their current project assignments, etc.

Translating Tim’s wishes to a technology implementation, the individual workplace customization and profiling process turns out to be a contextualization task. The information and K-nuggets that Tim would like to see must be “pulled” via respective contextual parameters from different application domains in the same or different databases. In addition, these collected pieces of separate information must be assembled together in an easy to understand and suggestive user interface, the “Personal Workplace Learning Dashboard”. For the assembling part of creating the dashboard user interface, tables in rich text fields of K-nuggets are utilized.

For the collecting part of the different dashboard pieces, in CM-WLOD the general architectural feature of creating an “embedded view” in the IBM Lotus Notes middleware layer is applied. Additionally, K-pool provides a set of tools to simplify handling of embedded views (unfortunately, the handling of embedded views natively in Notes does not match the simplicity of end-user handling provided in Notes otherwise). “Embedded views” provide a very flexible, elegant and effective functional concept of collecting selected parts of a view context. Exactly this mechanism is needed in CM-WLOD to pull-in just the K-nuggets of a view precisely pertaining to desired contextual parameter values. The concept of embedded views has appeared a couple of times in previous chapters, e.g. as the “Resources” tab in both Figure 5-3 of chapter 5.2.1, and Figure 5-23 of chapter 5.3.4.1.

Taking a closer look, Figure 5-26 focuses on the last “Resources” tab from the content field of the CDHK workshop logbook nugget. The collection of contextual parameter values presented in the “Resources”-tab are populated via an embedded view which pulls-in all K-nuggets that are contextualized under the category "GCC_Teach-2006_March-CDHK” in the “Categories” view. The rows in the embedded view provide an active document link to the underlying K-nugget. For example, when Tim would like to view the photos and videos captured during the 2006 CDHK workshop in Shanghai, he just clicks the nugget link in area A, and then will be brought to the video and photo nugget shown in area B.

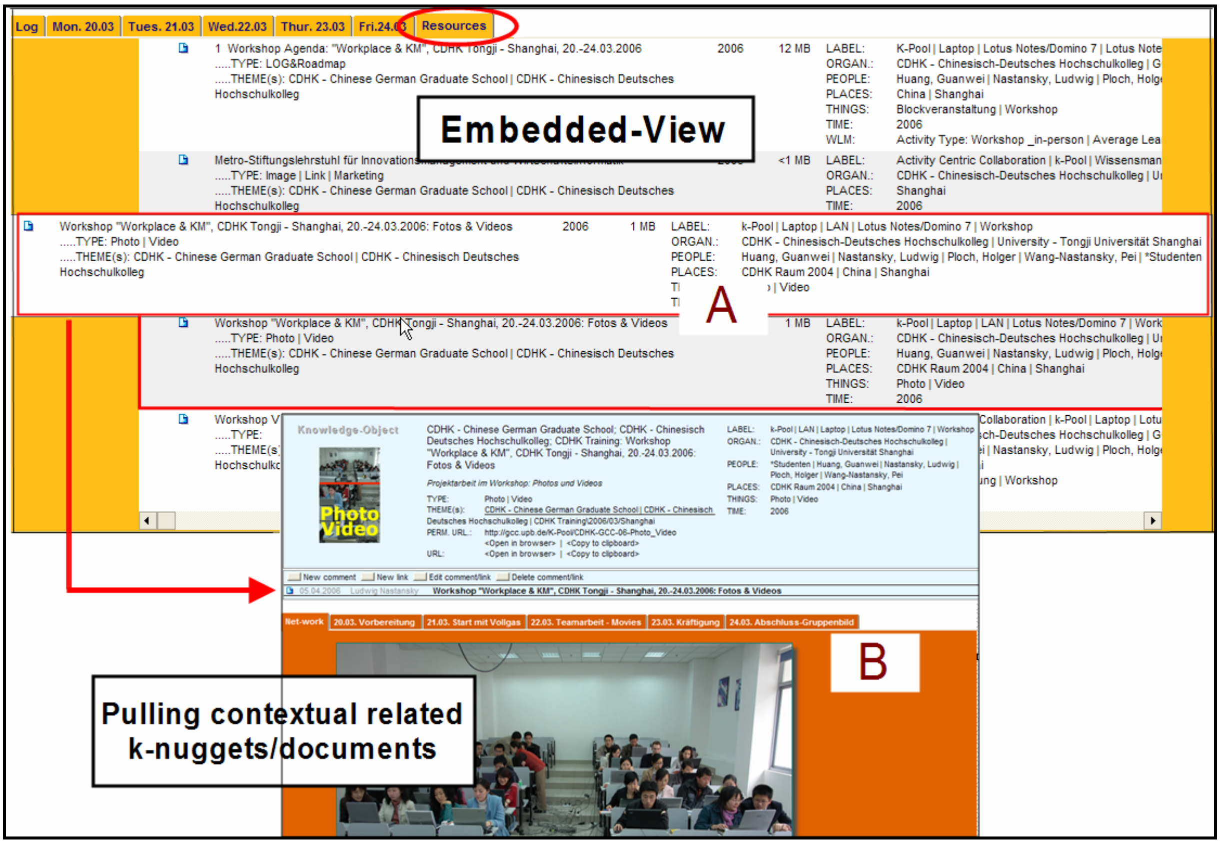

Figure 5-26: Contextualizing with “embedded views”

Technically, the “embedded view” in principal provides mechanisms to present desired knowledge nuggets via filtering, lookup of contextual parameters, parsing through contextual parameter collections, and more. Subsequently, three methods to initiate filters or lookup processes are shown:

1. In the K-pool environment, the construction of an “embedded view” can be achieved by directly selecting desired contextual parameters, i.e. “Themes”, “Keywords”, “Categories”, etc. Here again, K-pool’s “Settings Database” is employed, where

prefabricated embedded view objects according to the contextual parameters are stored and thus can be selected for inclusion in a rich text field container (e.g. the “Resources”-tab as mentioned).

2. Based on the first method, users can filter the K-nuggets to be collected according to filters on contextual parameter values. Like for method 1. K-pool directly supports the copy-and-paste mechanism necessary in Notes to define the filter via the “show single category” option for embedded views. So, K-pool provides menu options to select the desired contextual parameter values for the copy-and-paste user gestures. For instance, instead of showing all nuggets for all “Themes”, an embedded view presents only the K-nuggets filtered by “CDHK”, i.e. all K-nuggets belonging to the “CDHK” theme.

3. Instead of assigning a fixed value for embedded view filtering, contextualization can be done in a more general, flexible and sophisticated way by employing the Lotus Notes formula language. Clearly, the first and second methods pose tremendous advantages for the end-user who does not have any computer programming skills. The third option opens more doors and controls for managing information and knowledge. But, there are the usual trade-offs: Either the user is required to have a certain degree of know-how of the Notes formula language to accomplish more complex filtering, or, customized filters are provided by experts for direct and easy end-user application.

Practical applications of these three methods are exemplified in the following sections.

5.3.5.2 Constructing the Personal Workplace Learning Dashboard - Overview

The construction of Tim’s “Workplace Learning Dashboard” is a sophisticated CM-WLOD customization, pulling in relevant data from different application domains via the embedded view mechanisms. The dashboard is constructed in a portal fashion, including several portlets (i.e. smaller window rectangles) on the portal page. Illustrated in Figure 5-27, Tim’s dashboard portal consists of three areas: “Personal Contexts”, “Team-based Contexts”, and “Team-Calendar”. Altogether, these areas offer a comprehensive contextual picture of K-nuggets related to the CDHK project.

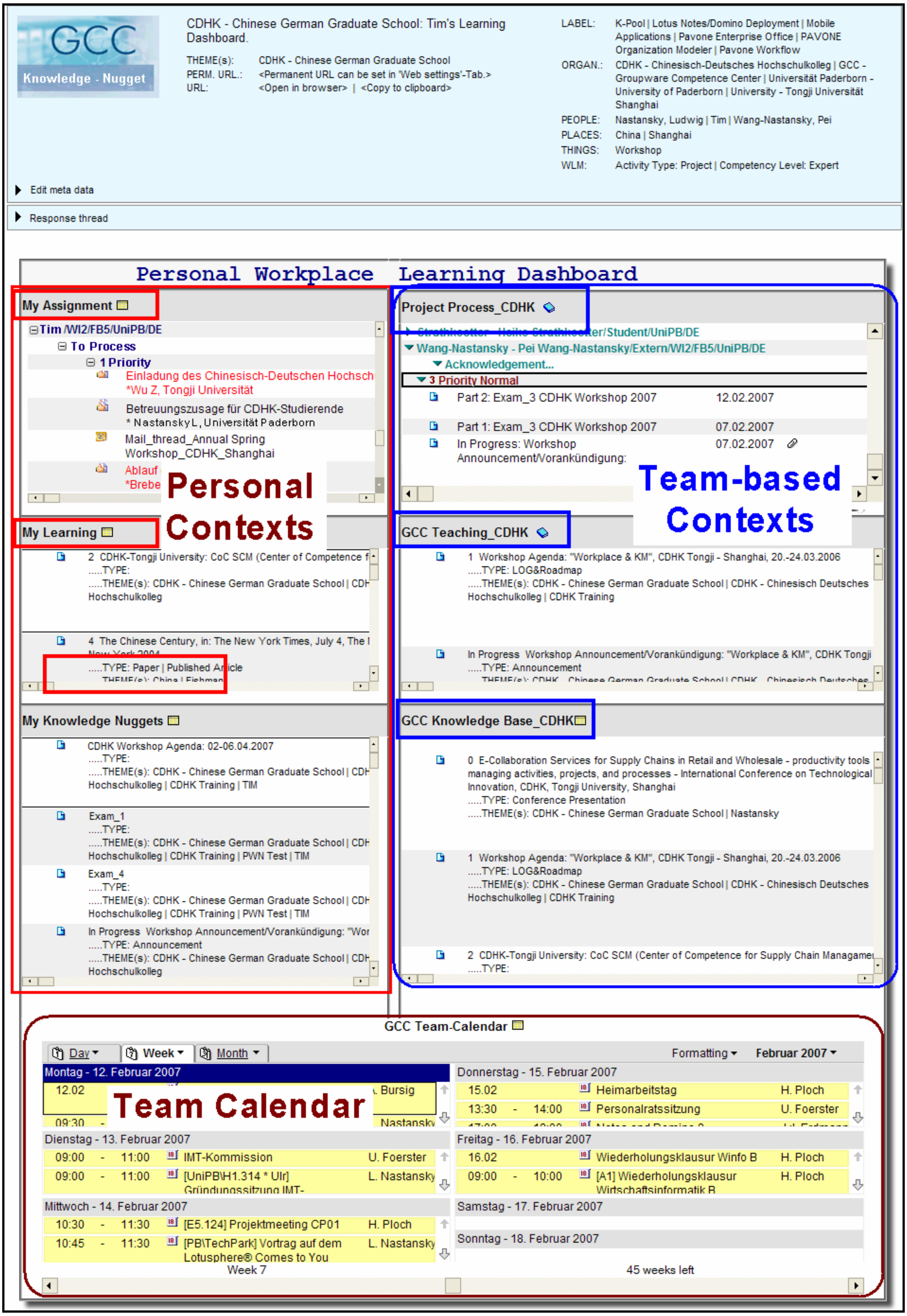

Figure 5-27: Tim's workplace "Learning Dashboard"

On the left-hand side of the dashboard, a personalized contextual space is provided, listing three embedded views as portlets for “My Assignment”, “My Learning”, and “My Knowledge Nuggets”, all customized by Tim. Under “My Assignment”, Tim has a list of tasks rated as “priority 1”, for processing K-nuggets related to the CDHK project. For instance, he is assigned to read/acknowledge some incoming mails or communication threads between GCC and CDHK. So far, Tim has two open tasks to finish, related to the CDHK project (highlighted in red). The next portlet, “My Learning”, pulls in only knowledge nuggets that are categorized under “Tim’s Learning”. It includes K-nuggets about workshop events, background information related to CDHK at Tongji University, as well as reports about Shanghai or China (e.g. the article “The Chinese Century”). The third portlet, “My Knowledge Nuggets”, is for collecting all K-nuggets generated by Tim for the CDHK workshop 2007 project. Apparently, Tim has contributed in making the workshop agenda, the two exams, the announcement, etc.

Turning to the right-hand side of Tim’s “Personal Workplace Learning Dashboard”, there are three corresponding portlets, each providing an embedded view in the team-based environment. These portlets, containing team information, are complementing the portlets on the left for personal contexts. Next to “My Assignment”, the “Project Process_CDHK” portlet records all workflow processes relevant to the CDHK project. For example, here it shows “Pei Wang-Nastansky” has to “Acknowledge” (i.e. read and/or attribute) the exams and workshop announcement before they are posted to students in Shanghai. The corresponding space to “My Learning” is a set of K-nuggets specifically categorized under “GCC Teaching_CDHK”, revealing chronically all K-nuggets used for CDHK teaching events by the GCC team. The next portlet, opposite to “My Knowledge Nugget”, is the “GCC Knowledge Base” focused on team-based context, gathering all nuggets tagged by the “CDHK - Chinese German Graduate School” value for the organizational “Theme” contextual parameter.

Last but not least, at the bottom of Tim’s learning dashboard in Figure 5-27, there is a team-based, shared calendar view, presenting GCC employees’ appointments, vacations periods, meetings, etc. Via this portlet, Tim can easily discover availabilities and schedule meetings or appointments with his project team members at a just-in-time fashion.

Tim’s “Personal Workplace Learning Dashboard” is individually constructed as a collection of embedded views, comprehensively drawing K-nuggets into a portal-like interface via a variety of contextual parameters out of the CM-WLOD knowledge repository. In addition, some of the portlets in the dashboard also pull in information from other repositories in the enterprise workplace environment. Examples are: the group calendar database at the bottom, or, the top two portlets denoting process information provided by the organization's workflow system(s), here workflow enabled GCC office databases. Again, all entries seen in Figure 5-27 are active links to the K-nuggets residing in their respective repository.

Evidently, Tim's "Personal Workplace Learning Dashboard" integrates his personalized learning contexts parallel with team-centered workplace processes, knowledge, and scheduling. It maximizes flexibility as well as facilitates workplace learning on-demand in context. With respect to the introduced CM-WLOD concept of strongly-connected and loosely-coupled contexts (chapter 4.3.2.4), the two workflow-related portlets on top e.g. clearly relate to strongly-connected information, whereas the two corresponding portlets in the second row denote rather loosely-coupled contexts. If Tim chooses so, he might assign the user-interface accordingly, e.g. by using bold-face or a highly noticeable color scheme for the strongly-connected portlets in his dashboard.

The next question is whether a non-technical employee, like Tim, is capable of composing this type of a highly individualized workplace learning dashboard in an on-demand fashion. The answer is a definite yes. On the one hand, he can construct the dashboard in a way explained subsequently. On the other hand, the K-nugget embedded dashboard can be easily reused, like all K-Nuggets. So, a dashboard of a previous similar project environment or the previous CDHK workshop of 2006 might be directly reused by just patching up the parameters spelled out subsequently.

5.3.5.3 Constructing the Personal Workplace Learning Dashboard - Details

Tim has built his dedicated and personal dashboard all by himself, utilizing standard end-user tools directly provided by the K-pool platform and the Lotus Notes layer. The first thing to do is to create a new K-nugget for his dashboard. In the rich text field of the dashboard nugget he includes two tables, a 3-by-2 table on top as container for six portlets (three for "Personal Contexts" and three for "Team-based Contexts" respectively), and below, a table for embedding the "Team Calendar". After this, the second thing is to consecutively fill the portlets with their respective embedded views. Two examples for this process will be given, a simple straightforward one, and a more complicated case.

Taking the second portlet from the personal context place in Figure 5-27 as the first example, Tim has used the methods 1. and 2. outlined in the previous chapter for constructing the embedded view "My Learning". First, Tim goes to his own learning category - "Tim's Learning" - under the "Meta Structures" view, selecting one of his nuggets. Then, by choosing “Copy category selection for embedded views”, as displayed for step 1 in Figure 5-28, he defines the filter as being “Tim’s Learning”.

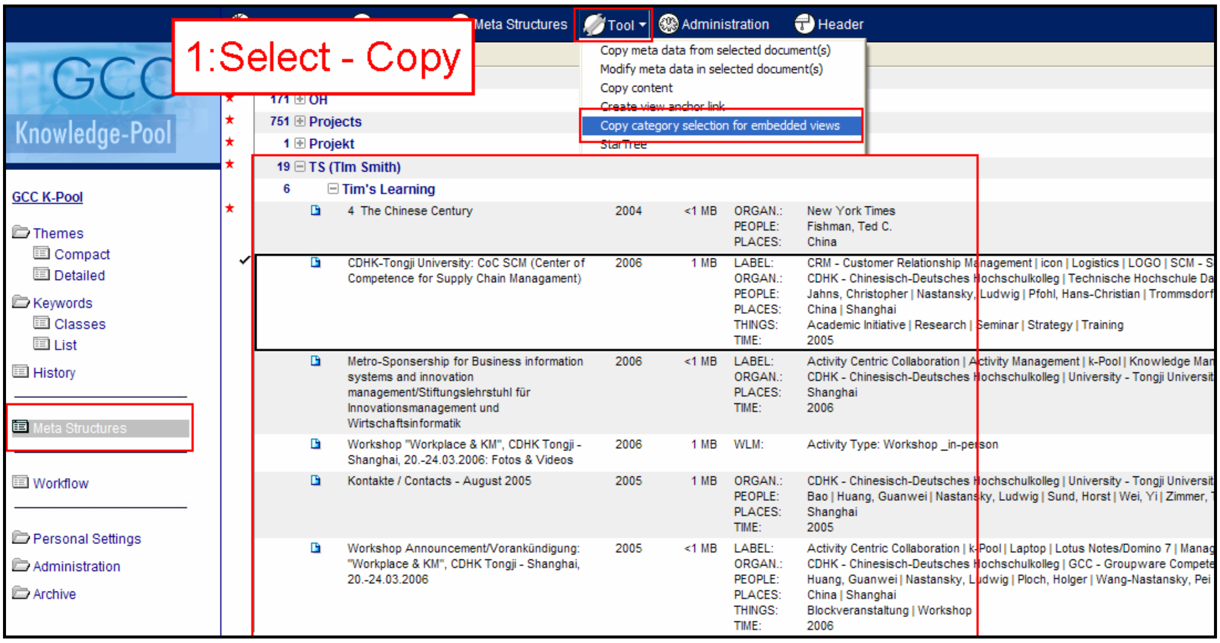

Figure 5-28: Tim’s “Personal Workplace Learning Dashboard” construction_01

Next, step 2 of Figure 5-29, is a case of re-using an “embedded view” template that will pull all K-nuggets having values for the “Categories” contextual parameter (called “Meta Structures” in the underlying K-pool system). However, this is an intermediate step that takes a standard organizational template without Tim’s own personalization. Thus, the next step 3 is using the “Edit Embedded View” function (marked in area 3) to open up another panel at the bottom of Tim’s dashboard (marked in area 4). In the editing panel of area 4, Tim may customize the contextual parameters to filter K-nuggets. Tim picks the “Show single category” option that restricts the selection of K-nuggets, drawn into the “My Learning” Portlet, to K-nuggets tagged “Tim’s Learning”. This tag was already copied in step 1, Figure 5-28. Consequently, only K-nuggets contextualized under "Tim’s Learning" are gathered together in the “My Learning” portlet.

Context filtering for the “Themes” or “Keywords” contextual parameters are achieved accordingly.

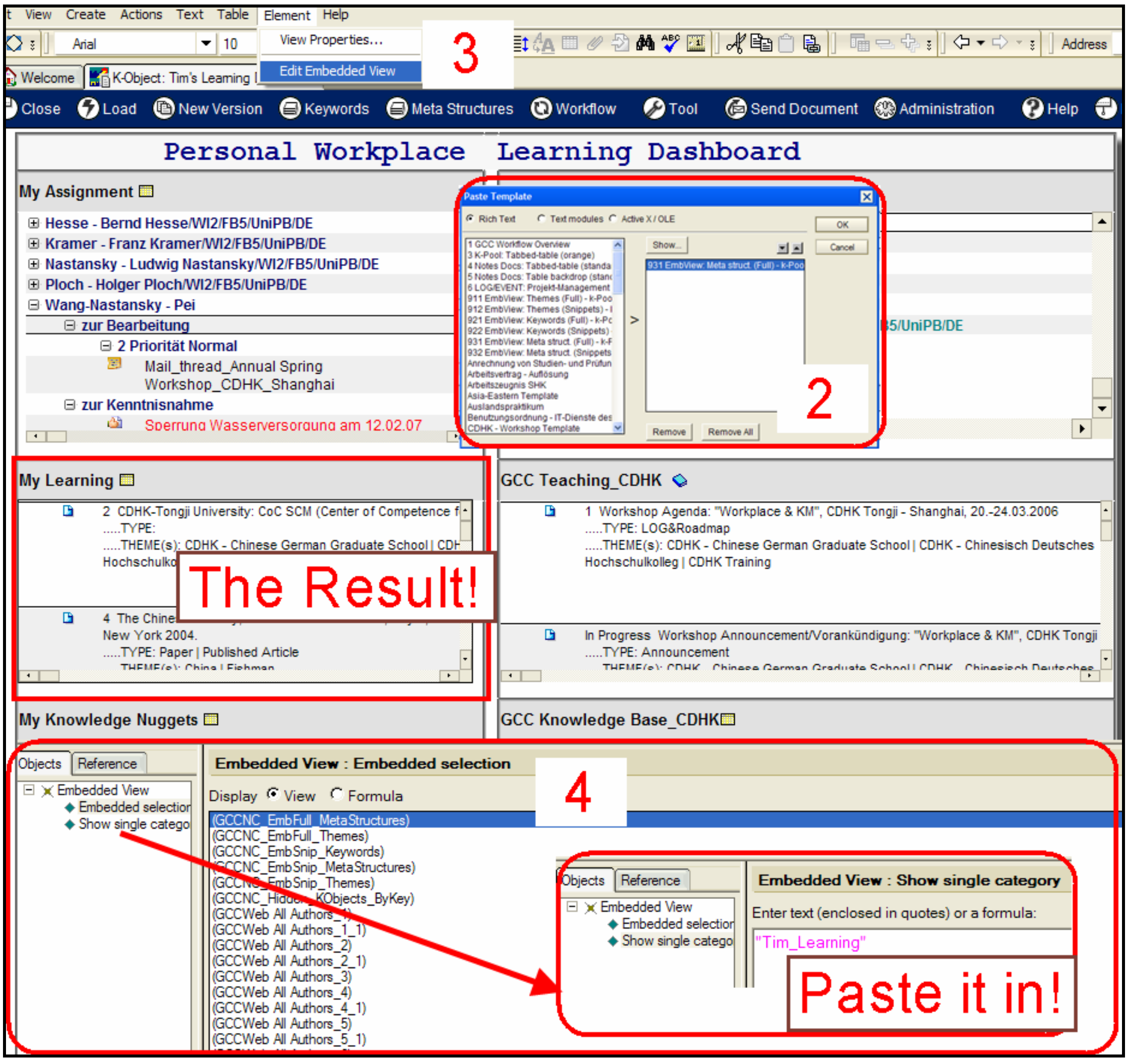

Figure 5-29: Tim's "Personal Workplace Learning Dashboard" construction_02

As a second example, an application of the more complex method 3. mechanism, outlined in the previous chapter, will be given for constructing a portal which shows only K-nuggets valid "today". In the CDHK scenario, Tim is assigned to survey question material and students' answers for four assessments, Tuesday to Friday, during the workshop week at CDHK 2007. To achieve this, he creates a "Test" portlet that presents the different assessments according to the specific date of the week (area C in Figure 5-30). Clearly, this reduces the redundancy of simultaneously paying attention, during each assessment day of the workshop week, to all the K-nuggets pertaining to the four different assessments, with all their details related to security, access rights, and possible version conflicts, say a wrong assessment question being delivered by a wrong click.

Tim learns some pieces of the formula language to achieve this goal (asks the "Help" system, or consults one of the "power users" normally available in all organizations [like the author did at GCC]). Figure 5-30, area C, shows the embedded view used for the "Test" portlet that spells out the current day's assessment nuggets based on the formula given below. Area A denotes the categorization for the different assessment days. The basic logic is to show examination nugget(s), from the “CDHK Assessments …” categorization for the “Themes” contextual parameter, only for the current date due to the following @function formula:

Day := @Word(@Text(@Today;"D0");".";1);
Month := @Word(@Text(@Today;"D0");".";2);
Year := @Word(@Text(@Today;"D0");".";3);
Date := Year +"-"+ Month +"-"+ Day;
"CDHK Assessments~"+Date

As shown in Figure 5-30, 2007-02-12 was used for one of the assessment days, a date when Tim did pilot testing of this embedded view. The formula automatically adjusts the selection filter, day for day, such that the filter for the embedded view in the “Test” portlet collects only the current day’s K-nuggets. In the example these are K-nuggets tagged “CDHK Assessments\2007-02-12” for the “Themes” contextual parameter. Area B denotes the inclusion of the above shown @function filter formula. The outcome of Tim’s customization displays a four nuggets view in C that corresponds to the four (test) documents listed in area A under date 12.02.2007, or, more precisely, under the sub-theme “2007-02-12” for “CDHK Assessments” when Tim did pilot testing of this embedded view.

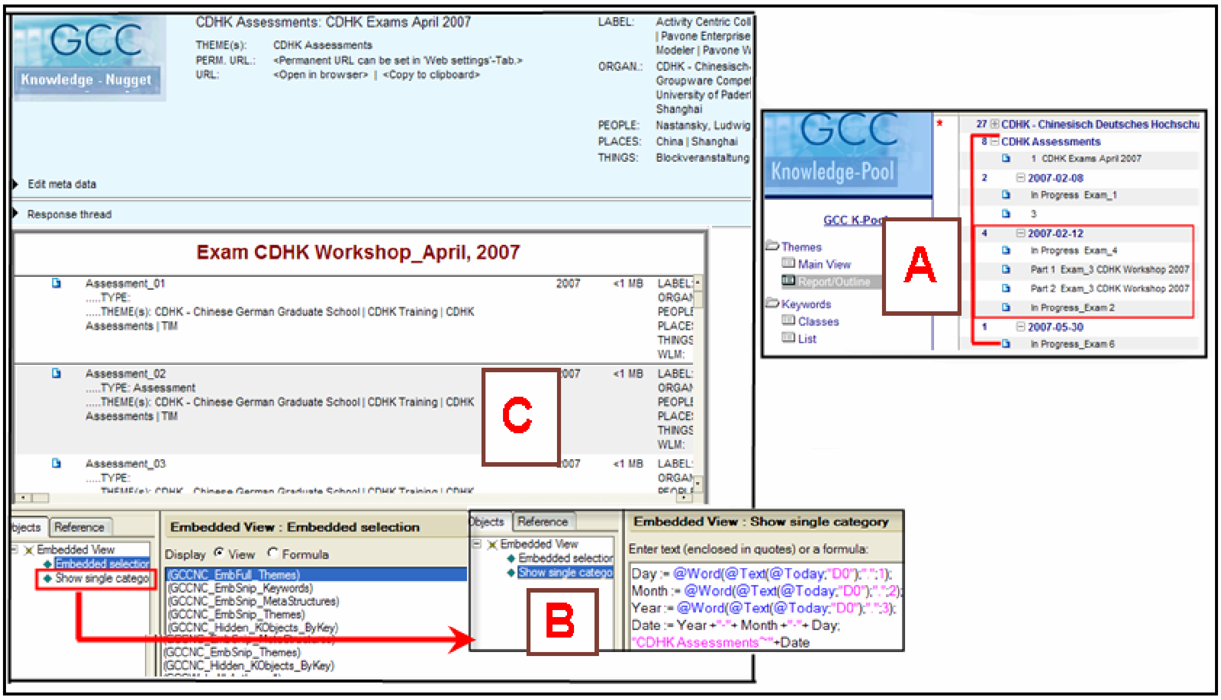

Figure 5-30: The assessment interface

Based on the individual work and learning profile, Tim’s “Personal Workplace Learning Dashboard” pulls K-nuggets out of organizational domains as well as personal learning domains via contextual parameters. Tim’s learning dashboard is a pragmatic implementation of integrating the personal contextual layer with the team-based work into one virtual space. In this contextualized space, Tim is able to seamlessly learn while working, or work while learning on his coordination job for CDHK workshop preparation.

During the process of customizing the dashboard, the user interactions necessary for Tim were basically selecting, copying, and pasting via given tools, not involving development of any line of program code. This is pointed out here, because - given the current state of technology - generation of a customized dashboard portal with all the rich functionalities presented here for the “Workplace Learning Dashboard” is usually a task for software developers, and not end-users. But, given the layered approach of CM-WLOD, based on K-pool and Lotus Notes, Tim, as a normal user, is empowered to subtly contextualize knowledge for both his learning and work needs in an on-demand fashion.

The more complicated case presented in Figure 5-30 is to exemplify the more or less completely open options for fine-tuning contextualized dashboards in the CM-WLOD approach. Again, re-usage of the results developed this way is foreseen by the system architecture. So, knowledge and acquired know-how in CM-WLOD can be contextualized and reused too when the content is not plain passive digital material, but rather it consists of business logic in the form of program code or a complex collection of customized objects. The dimension of reuse is here, that adoption of this type of business logic for later reuse is rather simple because generally only some of the parameters have to be updated.

5.3.6 Dissemination, Collaboration and Application

Strengths of the Notes technology are the ability to distribute to predetermined groups or generally disseminate information objects, by simultaneously supporting the related knowledge gathering with its integrated communication and collaboration functions in a team-based workplace environment. The prototypical implementation of the CM-WLOD model leverages basic information and knowledge distribution features of the Notes middleware layer. In addition, the K-pool system layer adds more tools and functions in knowledge dissemination embedded in business/organizational workflow processes.

However, no matter how advanced information technology has been developed in the last years, the reality of technology adoption is widely divided by many influential factors, like differences in the skill sets and age group of workforces, locations, or infrastructures. Today, e-mail systems still “push” around a large amount of information (not least spam) and are (mis-) used for knowledge management processes in an organizational workplace. But, teenagers and a growing body of the employed workforce in developed countries consider e-mail as an inadequate communication channel for information distribution. Ray Ozzie, the creator of the Lotus Notes platform and current Chief Software Architect of Microsoft, claims that "e-mail is where you get messages from people you don't want to talk to - parents, teachers, coaches" (Ozzie, 2005a, section: Tomorrow, para. 2). Some even consider e-mails "…for my grandpa's generation" (Rhodin, 2007). The next generation workforce is growing up today with instant messages, online meetings, blogs, wikis, Podcasts, and tools like Google, Flickr, Second Life, etc. They will carry this habit of sharing and collaboration into their workplace tomorrow.

Although the new Web 2.0 collaborative technologies are mainly from the consumer market, collaborative sharing and creating knowledge is decisively gaining momentum with enterprise business users as well.

Against this mixed landscape of technology adoption, the distribution and dissemination of K-nuggets, as designed in the CM-WLOD approach, definitely must take user environments and infrastructures based on different technologies into consideration. The next chapter will present issues in knowledge dissemination and sharing from a bottom-up, employee/learner-centric point of view at the workplace. It covers both ends of low-tech (e.g. e-mails) and high-tech. (e.g. embedded workflows) technologies.

5.3.6.1 Direct Messaging and Web Publishing

Based on the CDHK workshop scenario, Tim's learning outcome is stimulated and driven by the team-based job assignment. The state of his project planning is that he has contextualized the new knowledge nugget, the "CDHK workshop logbook 2007" nugget for 2007. Precisely, he has created the context information in different contextual parameters, and generated a logbook, the tabbed-table in the content field for collecting workshop materials. In addition, he has also generated a couple of related assessment nuggets.

At this stage, Tim needs to validate the content materials with his colleagues, such as the topics of "Activity-driven computing", "Notes application development", "e-workplace", etc. Moreover, he would like to gain feedbacks from his colleagues from GCC, Paderborn in Germany and CDHK, Shanghai in China. The challenge for Tim is how to share and disseminate knowledge to people in Germany and China. In the GCC Knowledge Pool platform, Tim is presented with different tools to disseminate information. First, he chooses the traditional method of e-mail and direct web publishing to distribute information and knowledge to other colleagues in different continents.

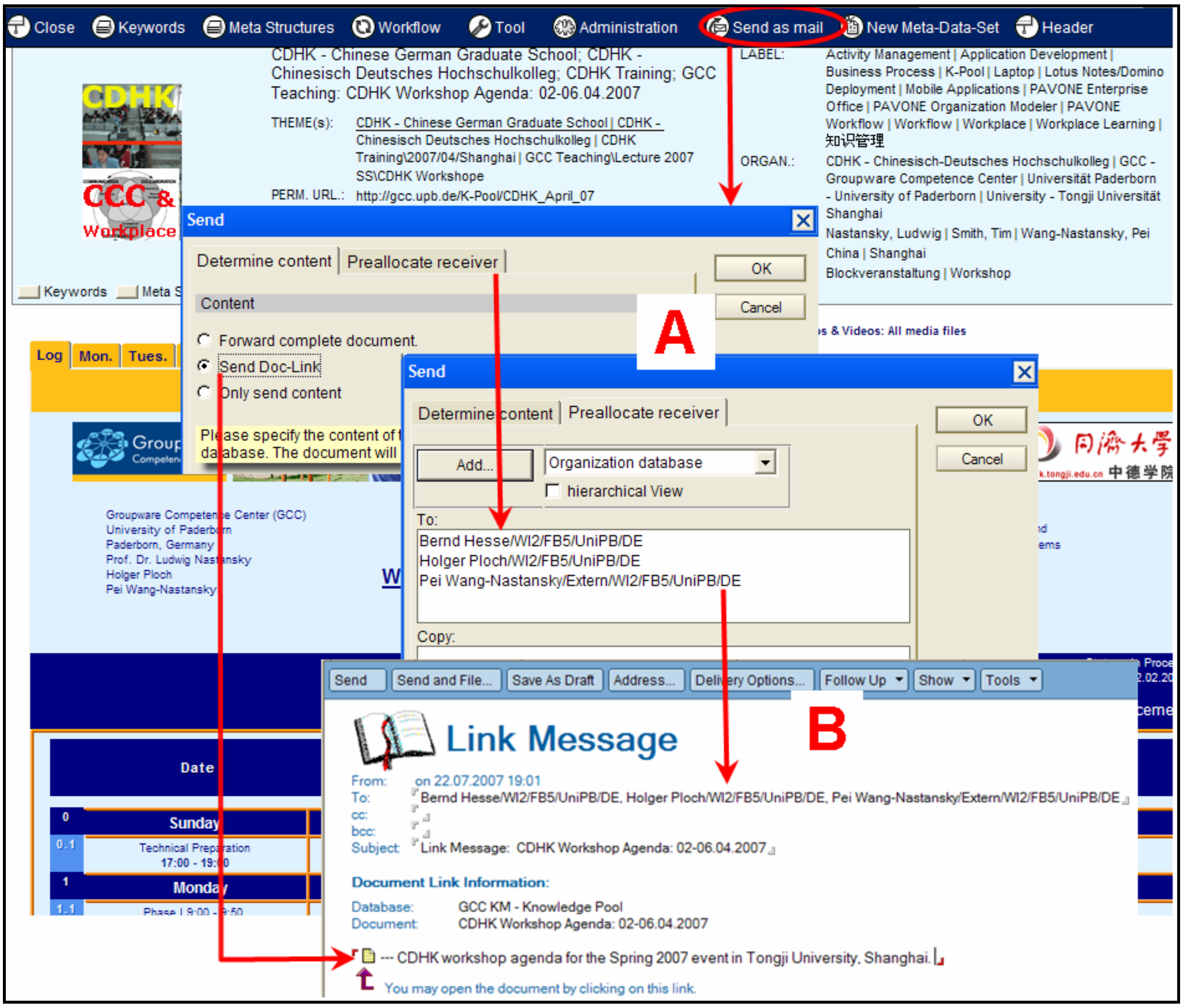

Figure 5-31: Direct messaging of K-nuggets

Figure 5-31 shows that in the collaborative environment of K-pool Tim is given three options to send the K-nuggets to his team members via e-mail. He may choose among forwarding the whole K-nugget including the contextual information stub and the content field, or sending it as a Lotus Notes document link, or only send the materials in the content field of the K-nugget. In area A, Tim decides to send this nugget as a Notes document link because it generates the smallest footprint, measured in physical document size. The link occupies the minimum disk space on the enterprise server, especially, when he intends to send the K-nugget to many people/receivers in the team. Additionally, he semi-automatically can fill the receivers' addresses by person or by group name. The use of group names is a normal mechanism for e-mail distribution lists. But here, not only these centrally managed distribution lists from the organization's name & address books can be used, but also group structures from CM-WLOD as individually and bottom-up maintained in K-pool's Organization Database. Area B displays the link-message in the receiver's e-mail inbox containing the link to the CDHK logbook nugget for 2007. The direct "send" mechanism is the most convenient way for the purpose of directly notifying peers inside the organization for sharing of knowledge, via Notes client and push to the workplace.

When Tim would like to ask his Chinese colleague's opinion from CDHK, Shanghai, he applies the direct web publishing tool, if necessary combined with security or privacy mechanisms to restrict access. Chapter 5.2.8 has described how an end-user is empowered to publish a K-nugget directly on the web via the "Web settings", an incidence of the "Miscellaneous other parameters". Chapter 5.2.6 has outlined the "Access control parameters" for fine-tuning security and privacy aspects. The direct web publishing feature is good at distributing knowledge to people outside the organizational technology infrastructure. For example, Tim's Chinese colleagues have neither the right nor the need to access all CM-WLOD content, except those K-nuggets related to CDHK. Figure 5-32 displays that Tim is able to publish the knowledge nugget on the web simultaneously as he creates it. In area A, Tim enables this K-nugget to be directly accessible from the web in addition to the Notes client environment. Next, following the K-Pool home address "http://gcc.upb.de/K-pool/", he keys in "CDHK_April_07" as the permanent URL address for this nugget. Now, Tim can simply mail the web address, and if necessary, include login information to his peers at CDHK without worrying about security issues or notes client access to K-pool installations for all his CDHK Shanghai colleagues.

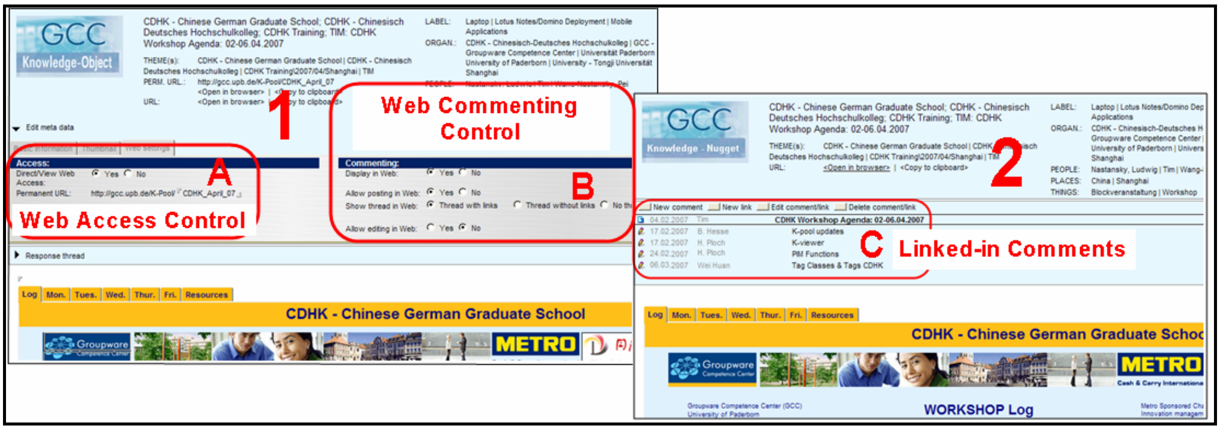

Figure 5-32: Direct web publishing

"Commenting parameters", area B of Figure 5-32, allow Tim's colleagues from both continents to post comments, feedbacks, and share ideas about the K-nugget. After Tim has published his nugget on the web, people have started posting comments about some topics of the workshop agenda, like "K-pool updates", "PIM Functions" (personal information management) or "Tag Classes & Tags CDHK". All these comments posted over the Internet via web-browsers are enlisted and accessible on the Notes client environment.

As already explained in chapter 5.2.8 commenting allows contextual conversations related to the specific content placed in the K-nugget. So comment threads are not posted more or less context free, like in forum systems, but are strictly bound to a K-nugget. The use of this feature via web-browser is depicted in the Figure 5-33. Area 1 denotes the current state of the conversation. Area 2 demonstrates the web user-interface of how to post feedbacks. From the upper right corner, Pei Wang-Nastansky has logged in and she is able to give feedbacks about one assessment. Further, she may attach a PDF-file to her commenting entry. The "Access control parameter" is implemented on the web-front application as well. Here, Pei may decide whether her entry can be accessed by other web users. This offers privacy to the employee/learner while posting exclusive or private information via web browsers. Pei has chosen not to give access to others viewers on the web because her works and comments are about the assessment materials of the workshop.

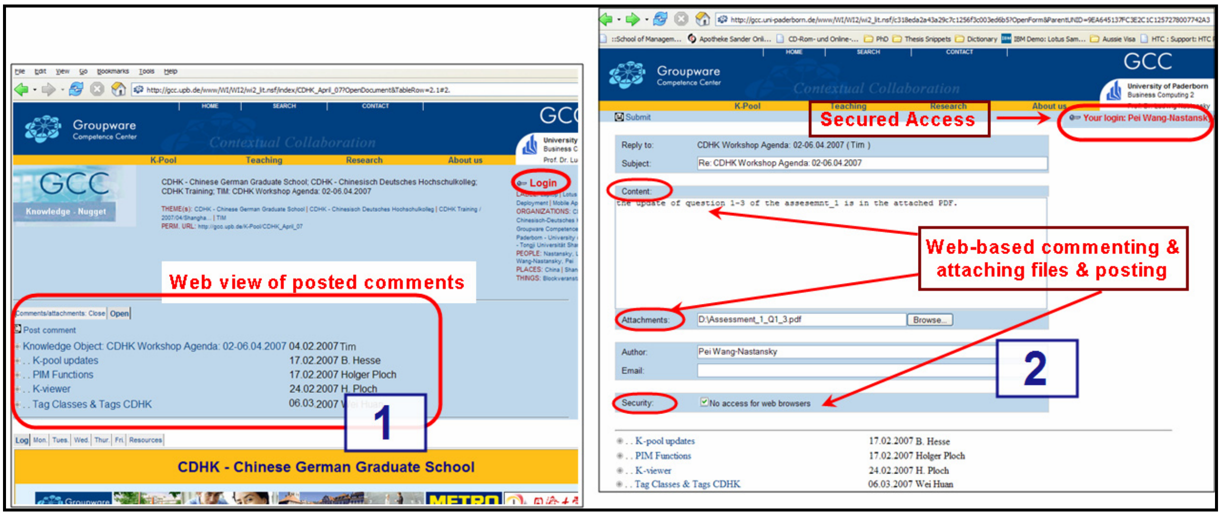

Figure 5-33: Secured feedback posting via web-browser

5.3.6.2 "Ad-Hoc Workflow" - Learning and Work Process Integration

At the workplace, especially in a project environment, there are often processes for specific just-in-time, on-demand tasks, which do not follow a repetitive pattern like standard workflow processes based on daily workplace activities. In the CDHK workshop case, using web posting and commenting is a discrete and polite way of collecting input from Tim's colleagues.

However, a project will run its course with a due date, so does the CDHK project. As a project coordinator, Tim has to ensure that everything has rolled out before April 1st, 2007. Therefore, all experience shows that it is not sufficient to only rely on the passive methods of disseminating knowledge by posting nuggets on the web, or by using the unstructured and especially process-free approach of e-mail. Methods providing more means of commitment as well as process structure of pushing the work process forward are provided by the "Workflow parameters" (see chapter 5.2.7).

For the 2007 CDHK workshop project, Tim has decided to create an „Ad-hoc workflow" process to ensure his team members reviewing his creations, the "CDHK workshop logbook 2007" nugget, as well as updating on time topics and assessment questions in their respective expertise areas. For this process, Tim adds a new table "Topic Updates" in the agenda nugget, which collects all inputs and suggestions from his colleagues (Figure 5-34). Next, Tim takes advantage of the integrated workflow engine for "Ad-hoc workflows" which automatically tags the K-nugget with the appropriate "Workflow parameters" in the K-pool platform.

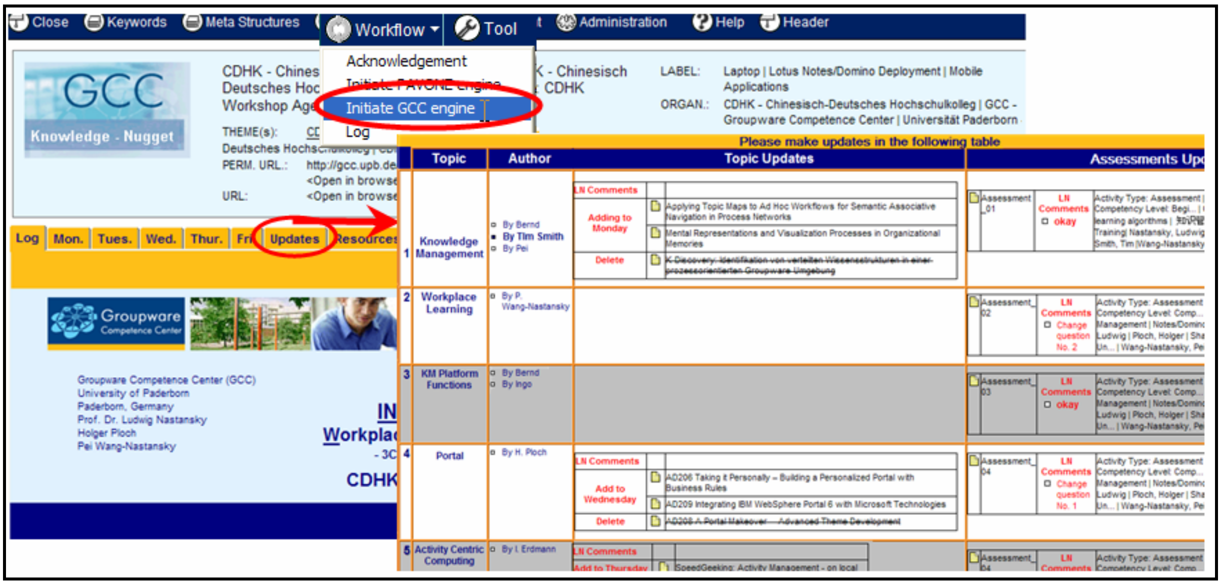

Figure 5-34: Initiate „Ad-hoc workflow"

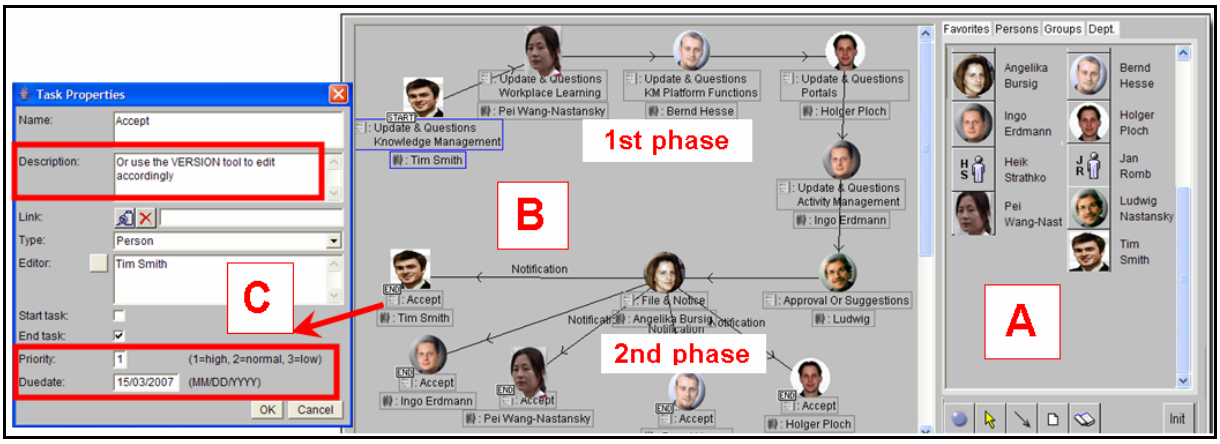

Figure 5-35: Designing an „Ad-hoc workflow" process by the employee / end-user

Featured in Figure 5-34, the „Ad-hoc workflow" engine is activated via the "Initiate GCC engine" tool that brings up a graphical modeler for mapping out the intended workflow process as displayed in Figure 5-35. Using the modeler is a simple activity based on intuitive gestures common for graphical modeling, like point-and-shoot and drag-and-drop. So, team members to be included as agents in the workflow are selected from the given list of people represented by their photos and names (area A of Figure 5-35); the list of possible agents (“Persons”, “Groups”, “Departments”) is automatically drawn form the K-pool “Organization Database”. The agents are positioned on the process pane (area B) according to their involvement in the successive phases of the workflow. The workflow sequence is modeled by drawing directed arcs between the different agents. Task descriptions are included (area C). With this intuitive interface, Tim has designed his two-phased workflow: (1) the “updating” and (2) the “reviewing” processes for the 2007 CDHK workshop materials.

Because Tim’s colleagues have different expertise in different knowledge domains, Tim’s coordinating task is mainly to bring their knowledge together to update the workshop material collaboratively. Hence, Tim starts the first workflow phase by handing over the workshop nugget to Pei, then she to Bernd, and Bernd to Holger, and so on. One by one, the designated persons edit/update the content materials in the “CDHK workshop logbook 2007” nugget. Then, the K-nugget is routed by the workflow engine to the team workplace of the manager who will approve it and add his suggestions on top of the previous editing.

In the second workflow phase, the team secretary is in the center to distribute the updated content, including the manager’s suggestions, to the rest of the team members. All these process steps are assigned their respective “Due date”, implanted in the set-ups of the task (area C of Figure 5-35). The workflow engine controls the schedule of the task sequences accordingly to ensure the editing/updating/reviewing process being ended by March 15, 2007. The routing part of the workflow engine ensures that the K-nugget is delivered to the workplace of the next agent. There, it shows up in an organization provided user interface at the agent’s workplace, or, in an individual contextualized dashboard like the one designed by Tim for himself (i.e. top row of Figure 5-27).

The process of updating and reviewing CDHK workshop materials is a typical „Ad-hoc workflow“ in a project environment. The CDHK project is not a repetitive process on a routine and daily basis, but involves a joined process situated in a team environment that is contextually specific. By applying the „Ad-hoc workflow“ tool, Tim has seamlessly integrated his on-demand learning outcome with workplace processes, achieving the job assignments collaboratively with the rest of his team members.

Because Tim is a great team player, he designs this simple workflow as a reusable structural pattern, i.e. a workflow template which is stored - including necessary adaptations - in the K-pool “Settings database”. This way, next year and the years to come, he or other team members may reuse the two-phased workflow process in updating CDHK workshop materials without starting from scratch.

In real world collaboration, a typical question to be resolved in this type of ad-hoc process is the possibility of version conflicts during the second phase of the reviewing process where the agent assignment is allowing parallel work for speeding up the process. As the graphical model shows all team members need to accept the 2007 CDHK nugget including also the manager's opinion. In case they want to have modifications reported they have to use the version management tool to avoid change conflicts if accidentally editing the same time at the same K-nugget(s). Technically speaking, this would generate document conflicts in the Notes-based K-pool platform. To solve this challenge, Tim has already clarified in the task descriptions of the workflow's second phase (area C of Figure 5-35) that he requires everyone to use the "Version management" tool accessible via the context stub when updating the K-nugget.

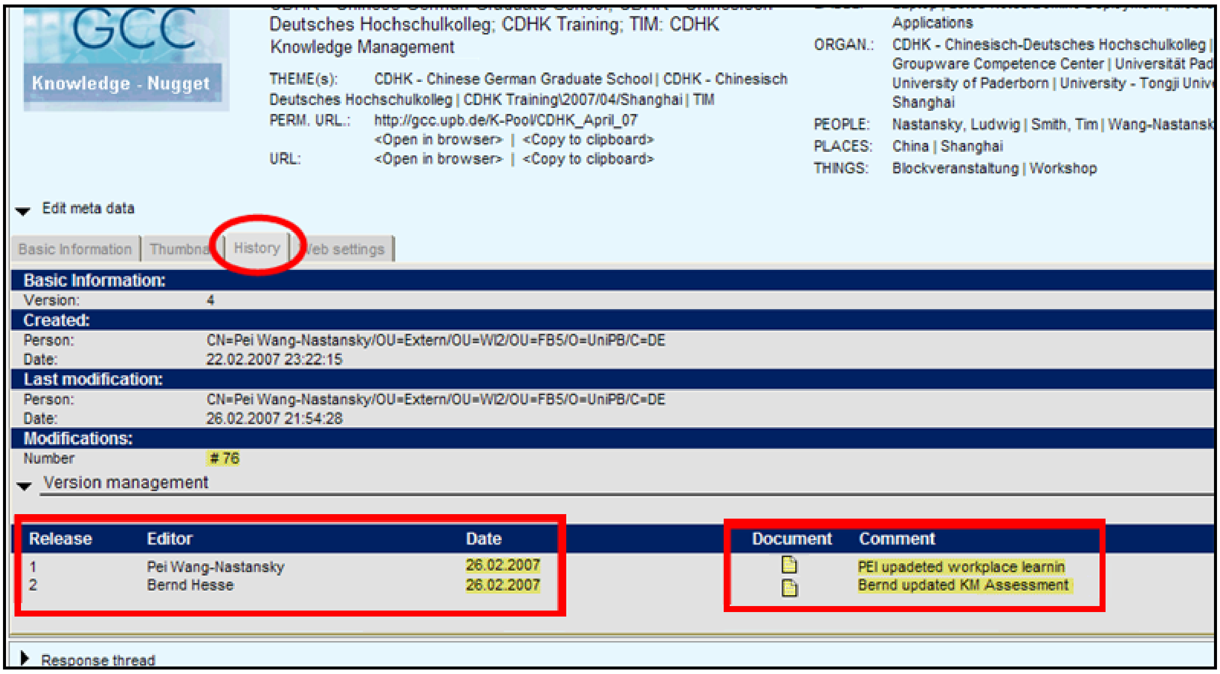

Figure 5-36: Version history

The "Version management" tool serves another "Miscellaneous" contextual parameter that catalogs all past editing records of one K-nugget in a "History" list. As indicated in Figure 5-36, Tim and all team members involved in the workflow realize in the context stub that two different records of the "Knowledge Management" nugget are added by Pei and Bernd. Their respective changes are summarized in a "Comment" area. The different versions of the K-nugget are all accessible via the included document links.

5.3.6.3 Asynchronous and Synchronous Contextual Collaboration

Knowledge seeking and resource sharing activities at the right time, with the right people, and in the right working process makes contextual collaboration "a cornerstone of knowledge management and enterprise learning strategies" (Gotta, 2004, section: Focusing on process and contextual collaboration).

In the workplace learning on-demand setting, contextual collaboration often involves collaborative interactions with individual persons, with resources, and with workgroups (as explained in chapter 2.4.1.2 & 2.4.2.1). There are no pre-defined classes or instructional materials for employees who work through their several projects and tasks at their respective ever changing and challenging workplace environments, though many of the projects necessitate knowledge acquisition. So, collaborating with people and resources becomes the most pragmatic approach to gain information to diligently perform in task assignments demanding knowledge an employee is not familiar with so far. Furthermore, these collaborative activities are all pulled and pushed by activities out of the several sets of context information reflecting the applications domain(s) the workplace is involved in, as in the example of the CDHK project. This pull and push comprises many activities where immediate reaction is necessary. Technically speaking, Gotta (2004) has summarized that contextual collaboration technology features both asynchronous activities among people to share resources (e.g. working with "teamware" or "groupware" on KM repositories, like in the CM-WLOD approach) and real-time, synchronous communication (e.g. instant messaging, video, audio conferencing, etc.).

In the CDHK project, Tim's coordination job is a typical scenario of learning on-demand at the workplace where support by asynchronous and synchronous contextual collaboration technologies is necessary. Till this stage of the thesis, the asynchronous contextual tools implemented as the teamware for the CM-WLOD layer stack, i.e. K-pool and Lotus Notes (Table 5-1), have mainly shaped the foundation of Tim's collaborative learning and working at the workplace.

To complement this, real-time synchronous technologies enhance the individual productivity at the workplace (unless people start to chit-chat in the instant messaging tool instead of getting their work done). More crucial, synchronous collaboration promotes immediate knowledge sharing within communities, workgroups or teams. A ground-breaking development of synchronous collaboration is the real-time "presence/awareness" feature - knowing who is available online - at the virtual workplace. When the "presence/awareness" feature is integrated with work processes, including the so far asynchronous world of K-nuggets, it becomes a powerful approach for initiating collaboration with colleagues and experts at the virtual workplace in a just-in-time fashion. For CM-WLOD this means, that availability information is context driven.

Back to Tim, the advancement of the Lotus Notes middleware platform has lead to integration of synchronous collaboration functionalities (via IBM Lotus "Sametime", as an example of synchronous collaboration technologies used in the corporate world). This technology enables secured real-time collaboration which embodies a range of communication tools. Available are functionalities like instant messaging, Voice-over-Internet-Protocol (VoIP) for audio communication, online conferencing including audio & video, group chat, whiteboarding, presentation sharing, screen sharing with remote control, polling, or synchronized web walks. More important, the "presence awareness" feature of the Lotus Sametime technology can be easily integrated or is automatically available for any Notes-based software application. So the layered approach of CM-WLOD leverages these functionalities included in the underlying Lotus Notes layer, and hence delivered to K-pool and CM-WLOD on top.

Tim also uses Sametime at his day-to-day virtual workplace for the synchronous parts of collaboration, working and learning within his workplace context. Figure 5-37 denotes a snapshot of the "Collaboration" part of Tim's virtual workplace in which three different applications are contained: A) his Lotus Sametime awareness window, B) his e-mail inbox-folder, and C) a contextualized view into materials of the K-pool repository he is currently working on. Currently, these applications are working separately.

In the awareness window A) Tim has grouped his colleagues according to their expertise areas (e.g. experts in Activity Management, KM, or Portal). This allows him to contact the right people in real-time easily whenever he needs some experts' opinion or help at work. So, the contact information is contextualized with respect to knowledge areas, or application domains respectively. Figure 5-37 depicts that Tim can see that Holger is online and also available for conversation. This is signaled by a small green icon and highlighted name, in the awareness window A (contextualized by peers' expertise), and in the e-mail inbox B as well ([automatically] contextualized by time sequencing of incoming mail). While reading Holger's mail regarding an online meeting plan with partners from CDHK Shanghai, Tim has some points to be further clarified. So Tim immediately starts to chat with Holger as seen in the instant message box of area A_1. After clarification, Tim adds the e-mail message and the chat-protocol as comment to the related K-nugget in C about the online meeting plan. As a result, the question raised in Holger's e-mail has been instantly solved in the right context and at the right time in the virtual workplace. Afterwards, the context-less e-mail message and the instant messaging protocol are contextualized as a K-nugget and available to all members of the CDHK team for asynchronous reuse.

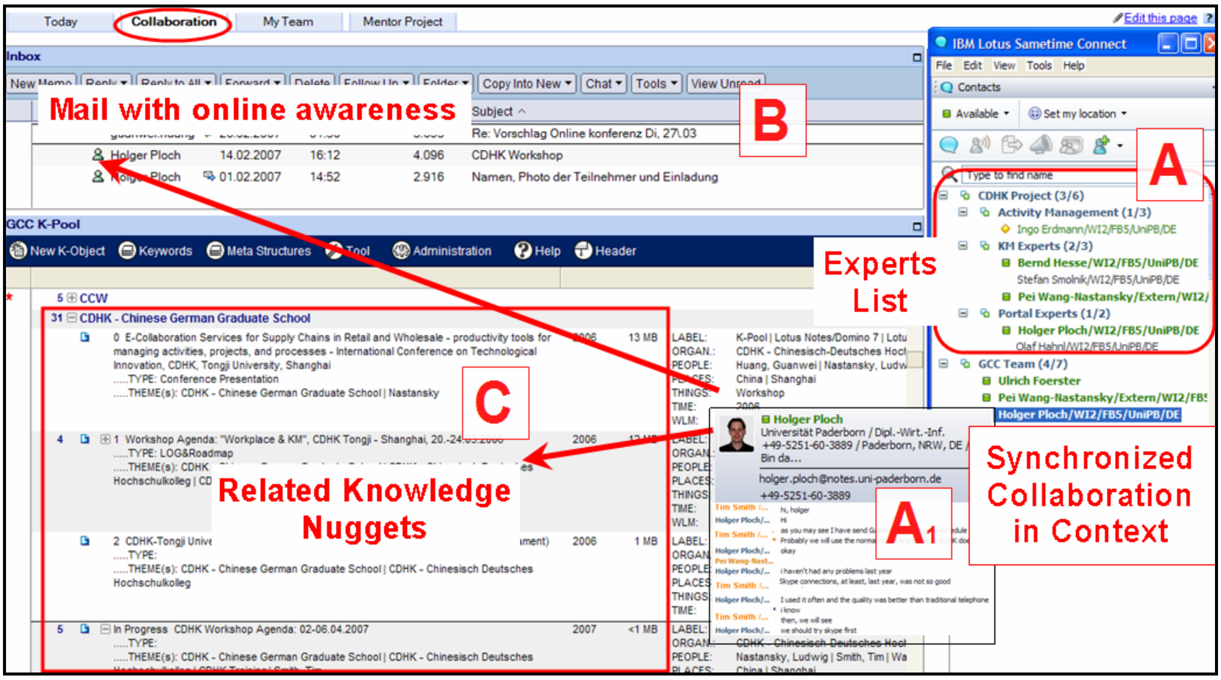

Figure 5-37: Synchronous collaboration in context

Till now, Tim has accomplished most challenges and tasks of his job assignment, yet he is still lacking information and knowledge about Shanghai and China. The project requires that he is going to Shanghai to conduct the workshop, but he has never been in China before. As a foreigner (being illiterate in the Chinese language), the most practical challenge for him is to find his way from the airport to the hotel, to the CDHK building at Tongji University, and get around in Shanghai. He would like to ask Pei (the author of this thesis) and Holger about their experiences last year.

Tim's concern can be helped by the "China_Shanghai_Travel Basic" K-nugget which has recorded online meetings between Pei and the other members of the CDHK team from last year. From the comprised context information in "Themes", "Title" and "Keywords", Tim guesses this K-nugget is not about the workshop material. Rather it seems to be is about how to apply for a Chinese visa, an English map of Shanghai, Tongji University's location in Shanghai, and other miscellaneous information about traveling to Shanghai. So he opens the content part of the K-nugget which proves his guesses being true (area A, Figure 5-38). In addition, to Tim's delight, his Chinese colleague, Pei, is available online (top left). Tim immediately invites her for another synchronized instant meeting, asking her directly about a couple of individual questions as a first-time traveler to China. Through the meeting, Tim has also learned how to pronounce a couple of simple Chinese words, for instance, “thank you - Xiexie”, “bye bye – Zai Jian”, and the most important sentence for a foreigner - “I don’t want it – Buyao”! (area C, Figure 5-38). He tags this conference protocol as information being available in the “My Learning” portal of his workplace learning dashboard (Figure 5-27).

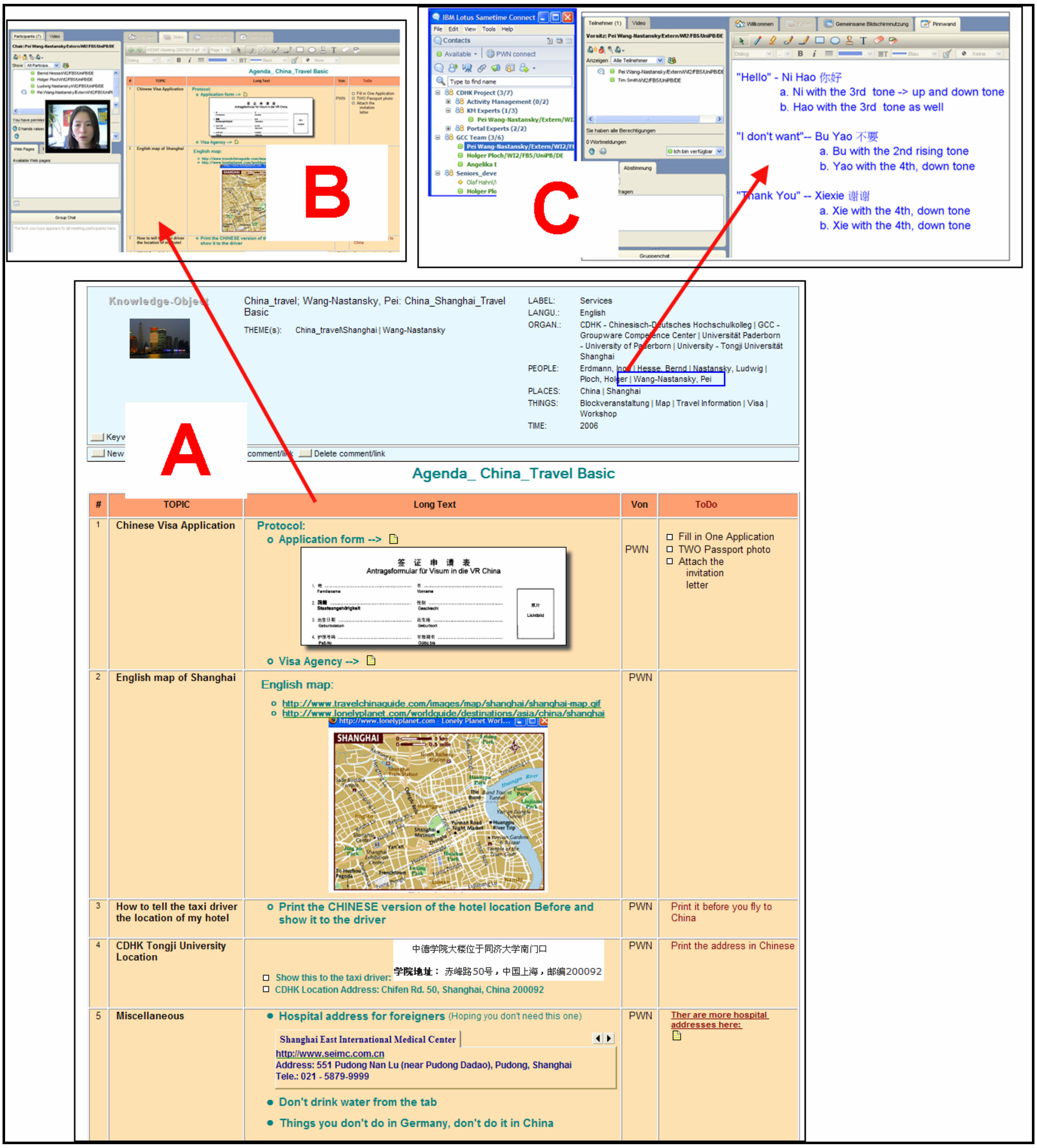

Figure 5-38: K-nugget and conversation for China travel project

The specific value of these shortly sketched means for synchronous and asynchronous communication in the CM-WLOD scenario is, again, the ability of contextualizing content and collaboration in an on-demand fashion and integrated way at the workplace. In the upcoming next generation of Lotus Notes technology, released in 2007, specific approaches have been taken to especially support contextualization at the virtual workplace. The underlying concept is to provide mechanisms for creation of "composite applications" which allow to contextually and dynamically bind together different application windows from separate application domains. In other words, when Tim selects the "CDHK workshop logbook 2007" nugget presented in a portal of his workplace dashboard, the content of the incoming e-mail portlet will be restricted to messages only from people tagged as contextual parameter in the K-nugget. Conversely, when Tim selects a message in his e-mail portlet a CM-WLOD portal will present only K-nuggets related to the message sender. So, a next step in CM-WOD will be to adopt these new technology options of "composite application" design for further improving the contextual provisioning of the right materials at the right time in collaboration mode at the workplace.

5.3.7 Summary

In a networked workplace, the employees as knowledge workers are having numerous channels to discover information and create knowledge. However, in order to acquire the precise information and knowledge they need, sometimes they must communicate with peers and experts in the classical way, by the water cooler or at the coffee table – but, "at other times they will rely on collective intelligence in the form of new filtering and collaboration technologies" (The Economist, April 22, 2006). Contextual parameters and adequate models for defining and managing context information are the driving force in this new form of filtering and collaboration activities.

Based on the CM-WLOD approach as derived in chapter 4, chapter 5 has presented many facets of CM-WLOD's prototypical implementation based on a layered system architecture. This architecture is using industry strength software systems specifically adjusted to integrate content management and collaboration at the workplace, asynchronously and more and more synchronously as well.

Additionally, the on-demand learning and working process is revealed from an individual employee's position, borrowing ideas from "persona" modeling in the software industry. In the roles of learners as well as the knowledge workers, employees are empowered to utilize the presented contextual tools to:

1. Discover information and knowledge via context information from the past experience of team members.

2. Categorize individual learning and working contexts on top of organizational ones at the workplace, without disrupting the formal structures of managing enterprise knowledge.
3. Connect single or multiply structured meta information about content with more than one application domain, by use of contextual signatures in context stubs.
4. Manage and reuse context information in manifold bottom-up and user-centric ways, e.g. by harvesting existing contextual signatures, modifying part of the underlying contextual parameters and infusing them in the metadata set of other content materials.
5. Streamline learning outcome with working processes via the workflow contextual parameters.
6. Share information and knowledge collaboratively with peers by using both synchronized and asynchronous contextual collaboration technologies.

On the organizational level, the important role of information contextualization is to encourage knowledge collaboration within working groups and teams. When an individual experience (revealed in the form of context information) is deposited in an organizational KM system, others can benefit from reusing or repurposing them in other application domains. In this way, the inexplicit personal knowledge materializes as well explicitly and can be shared and managed in the organization.

6 Benefits of Implementing CM-WLOD on a Knowledge Management System

In the setting of learning on-demand at the workplace, the compelling importance of context information has been emphasized throughout this thesis. In chapter 2.4.3., Scott (2006) confirms that e-learning and e-working are merging together pervasively in a knowledge workers' daily work process. From this perspective, context is the key to marrying self-directed and self-organized learning with changing workplace application domains (Siemens, 2006, p. 117-118).

The core value of the "Contextual Model for Workplace Learning On-demand" is an ontology-based approach to map out relationships among context information, contextual parameters, and application domains related to the content information. Chapter 5 delineates the implementation of the CM-WLOD approach on state of the art workplace technology in the organizational environment. Further, contextual tools and mechanisms are deployed to achieve individual learning and working goals in a real-world and team-oriented project scenario. Following the articulation of the concept and the subsequent prototyping, the next is to reflect and capture the outcomes of empowering the learners, alias knowledge workers, with contextualization technologies at the workplace.

The practical endeavor of this research work is going beyond the content-centric development of learning objects to a context-driven knowledge management approach at the workplace. Although the strategic thinking is beyond the classical instruction model of teaching and learning, the key objective of developing workplace learning on-demand evolves from the (r)evolution of learning object design. More precisely, both the content-centric and the context-driven approaches aim at increasing the knowledge sharing and reusability of digital resources in different contexts of different application domains. This is supported mainly by concepts of resource granulating, technology standards, sharing technologies and collaboration tools. By implementing the CM-WLOD approach embedded in a knowledge management system, the following will reflect and selectively demonstrate how each of the supportive mechanisms is practiced and achieved in reusing and repurposing digital resources at work.

To make a point: Most content and knowledge management environments do not provide structured mechanisms for context generation rendering content out of a content pool on-demand in the multitude of ways as achieved by CM-WLOD. This means: as flat list (this is what Google or full text search does), and/or as a process flow network (what workflow modelers and engines do), and/or as a strict sequence (what a book does), and/or tree structured (outline mechanism in categorized standard Lotus Notes views, or graphical rendering as hyperbolic tree), and/or rendering starting points for follow-up on investigation channels defined by contextual parameters. CM-WLOD can employ all these structuring mechanisms. Some of the possibilities and uses will be shown in this chapter, especially, comprehensively bringing together some aspects denoted only in an isolated fashion in earlier parts of this thesis.

6.1 Multiple Aggregations and Sequences by Granulating Context

The technical implementation of the CM-WLOD approach makes it possible to granulate every piece of context information into independent entities. Instead of trying to dice content, which is costly and requires expertise in doing, the contextual approach in this thesis decentralizes the granulation process to individual employees. It saves organizational resources while stimulating learning because the employee learns by daily enacting the very processes of personal contextualization and tagging at the workplace supported by the functionalities of a knowledge management system (as in Tim's case).

Unlike a cloud of tags without structure, context information is approached in a semi-structured way, treating context information separately from content. The advantage is eased and guided discovery of knowledge related to the respective job domain strongly defined by the organization's infrastructure. In self-organized learning at the workplace, the first step is to discover needed information, provide tools for generating knowledge, and connect to people related to the employees' workplace application domains. In the office or on-the road, with limited time, employees often search information and try to access actual knowledge according to the notes, snippets, and threads of their specific job tasks or projects. The search and retrieval pattern is guided by context information structured in respective contextual parameters of the CM-WLOD approach.

Technically, the prototype of the CM-WLOD approach fully leverages the ample variety of linking mechanisms in the virtual sphere. It means the individual pieces of context information, or the combination of contexts, or several sets of contexts are searchable and can be investigated in a connected and structured fashion – without the need to dig into content firsthand. Context information serves as starting point of threads - previously called "channels" as well, chapter 5.3.2 - to pull or filter out relevant domain information and knowledge accumulated in the organizational knowledge pool. Consequently, the outcome of granulating context information is that the K-nuggets are sequenced or aggregated multiple times and prepared for use in various and unforeseeable different application domains.

At this point, the analogy to the basic objectives of the "Semantic Web" should be emphasized again (see chapter 1.2):

> "The Semantic Web is about two things. It is about common formats for integration and combination of data drawn from diverse sources, where on the original Web mainly concentrated on the interchange of documents. It is also about language for recording how the data relates to real world objects. That allows a person, or a machine, to start off in one database, and then move through an unending set of databases which are connected not by wires but by being about the same thing."
>
> (Cited from the World Wide Web Consortium, W3C [39])

Against this positioning, CM-WLOD extends the current office world of scattered office documents in many formats by a contextual parameter model allowing *integration and combination* of information from different sources at the workplace. CM-WLOD provides a practical workplace-adapted *language* which *relates* content to application domains consisting of *real world objects*. The notion of ... *moving through an unending set* ... will be demonstrated subsequently in this chapter by following up on different contexts or a variety of "channels" opened by contextual parameter values. To be more precisely, *unending* in CM-WLOD does not imply infinite and accidental passing through an ocean of information but rather to follow on contextual parameters organizations choose to maintain for reflecting their respective goals and processes.

In practice, the K-nugget sequencing in CM-WLOD is achieved by contextual tagging mechanisms based on the seven contextual parameters as outlined for CM-WLOD in chapter 4.3.2.3, and as exemplified in 5.2. The contextual tagging mechanisms, employed in the GCC K-pool knowledge management system, add a versatile layer to flexibly aggregating knowledge nuggets in a variety of sequences. These sequences may range from the traditional book sequential structure (e.g. Figure 4-16), over individual content collections and organizational tasks, to on-demand sequencing for a knowledge worker's personal learning and working domain.

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[39] http://www.w3.org/2001/sw/

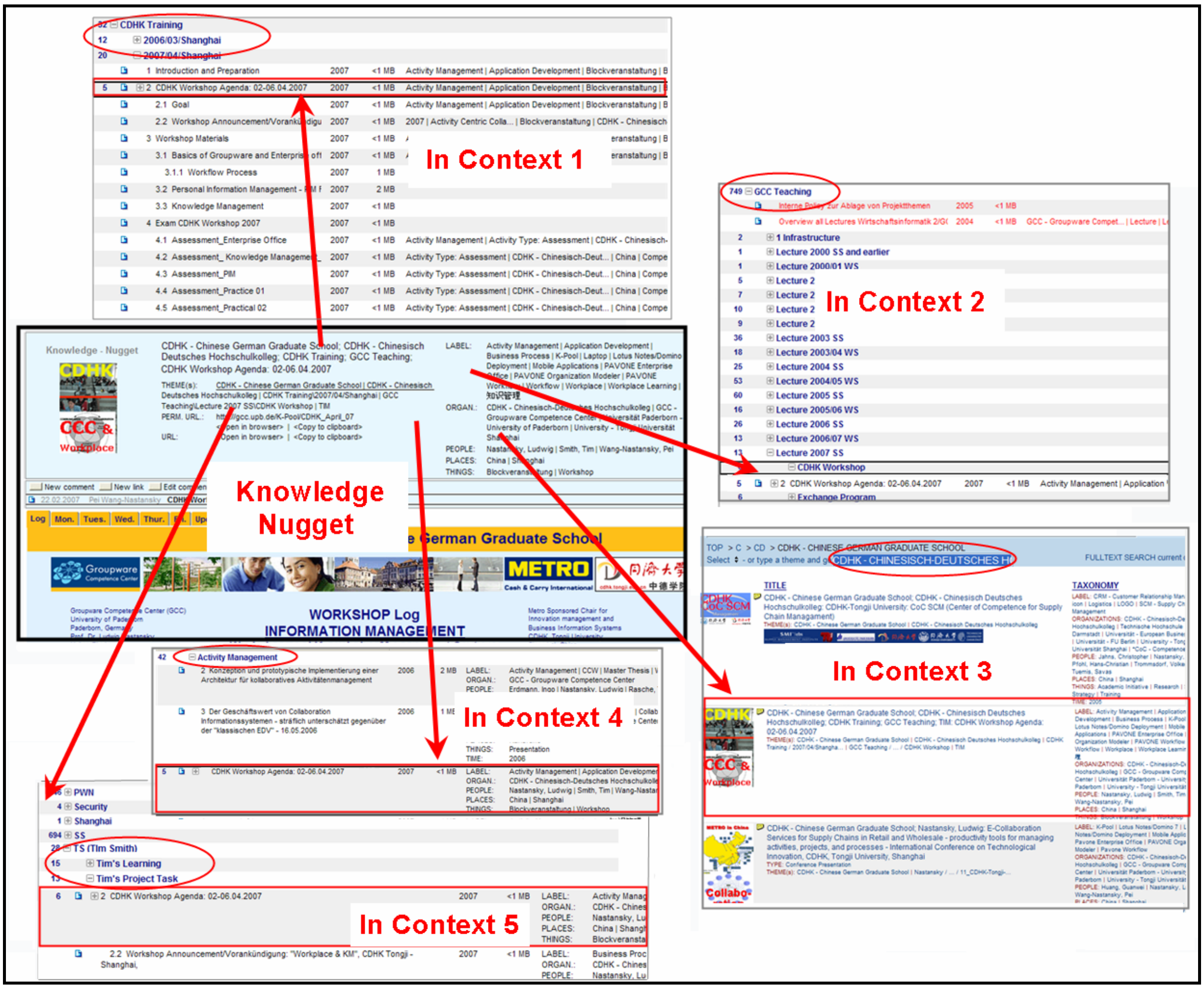

Figure 6-1: Multiple sequences and aggregations by granulating context

Again, the author uses the “CDHK workshop logbook 2007” nugget as an example. After being tagged, structured, and categorized, this knowledge nugget is aggregated multiple times under different domains. Figure 6-1 depicts an overview showing that the “CDHK workshop” nugget is sequenced differently according to the necessities of different application domains and presented in varying collections of other K-nuggets belonging to the respective context. Five different domains shall be revealed for this workshop nugget:

Context 1: “CDHK Training” from the "Themes” contextual parameter;

Context 2: “GCC Teaching\Lecture 2007 SS (summer semester) \CDHK Workshop” from the “Themes” contextual parameter;

Context 3: “Chinesisch Deutsches Hochschulkolleg (CDHK in German)” from the “Keywords” contextual parameter, keyword-class “ORGAN.”;

Context 4: “Activity Management” from the “Keywords” contextual parameter, keyword-class “Label”;

Context 5: “TS (Tim Smith)\Tim's Project Task” from the “Categories” contextual parameter.

The multiple appearances of the same knowledge nugget derive from the crisscross context information entries in the context stub of the “CDHK workshop logbook 2007” nugget. Technically speaking, each piece of context information (as the data entry) has a specific front-end view to exhibit the knowledge nugget in an aggregated structure and collection of other K-nuggets belonging to the respective contextual parameter, i.e. application domain. Additionally, the crisscross semi-structured tagging mechanism, implemented in this thesis, permits structured views showing the CDHK workshop nugget in different positions/sequences under different domains. The following will explain this in detail.

First, “Context 1” is the same as shown in Figure 4-16, there against the background of the tagging continuum model of chapter 4.4.3. It follows the classical practice of aggregating knowledge in the contextual format of book chapters, sections, paragraphs, etc. This is represented by the usual numerical descriptors: 1, 2, 2.1, 2.2, 3, 3.1, 3.1.1 etc. and implemented via the “Sort key” as one of many “Miscellaneous other parameters” in the context stub of the knowledge nugget pointed by the arrow in Figure 6-2.

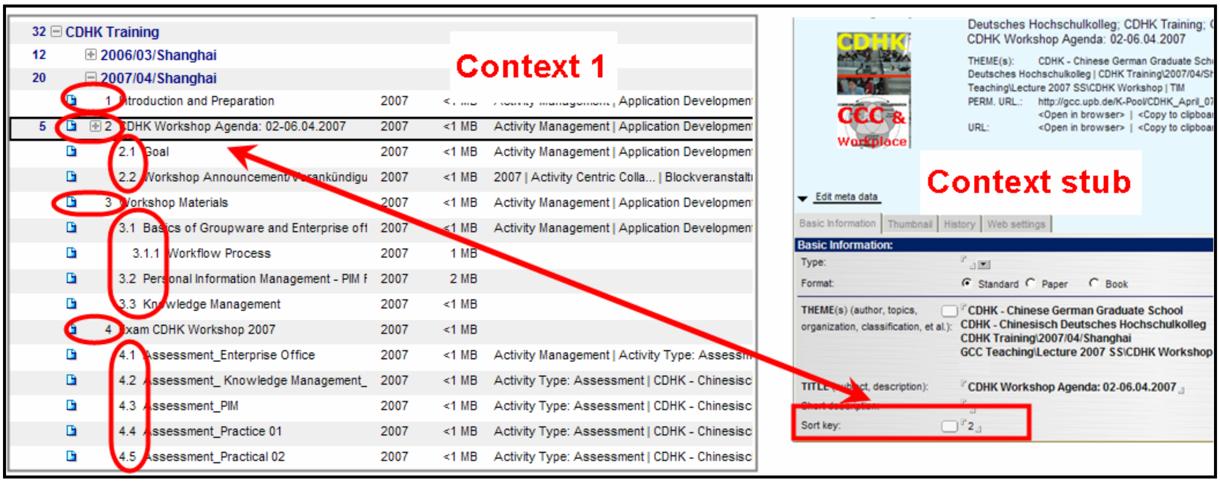

Figure 6-2: Aggregation and sequencing in context #1

In “Context 2” (Figure 6-3), the same K-nugget is sequenced under a cascading outline structure that is defined by the job tasks as the organizational application domain. Here, the domain is designed to suite GCC’s teaching context which contains not only lecture information, but also overviews of the study program, policies, thesis topics, etc. Within this domain, the “CDHK workshop logbook 2007” nugget is tagged via the “Themes” field as “GCC Teaching\Lecture 2007 SS\CDHK Workshop” defining a cascading tree structure following sub-categorization (see footnote 36). Once again, the “Themes” field can take more than one piece of context information, it is a multi-tagging space by itself. In the CDHK workshop scenario, the "Themes" parameter accommodates the different organizational working domains, and one is in different languages, serving the international nature of the project.

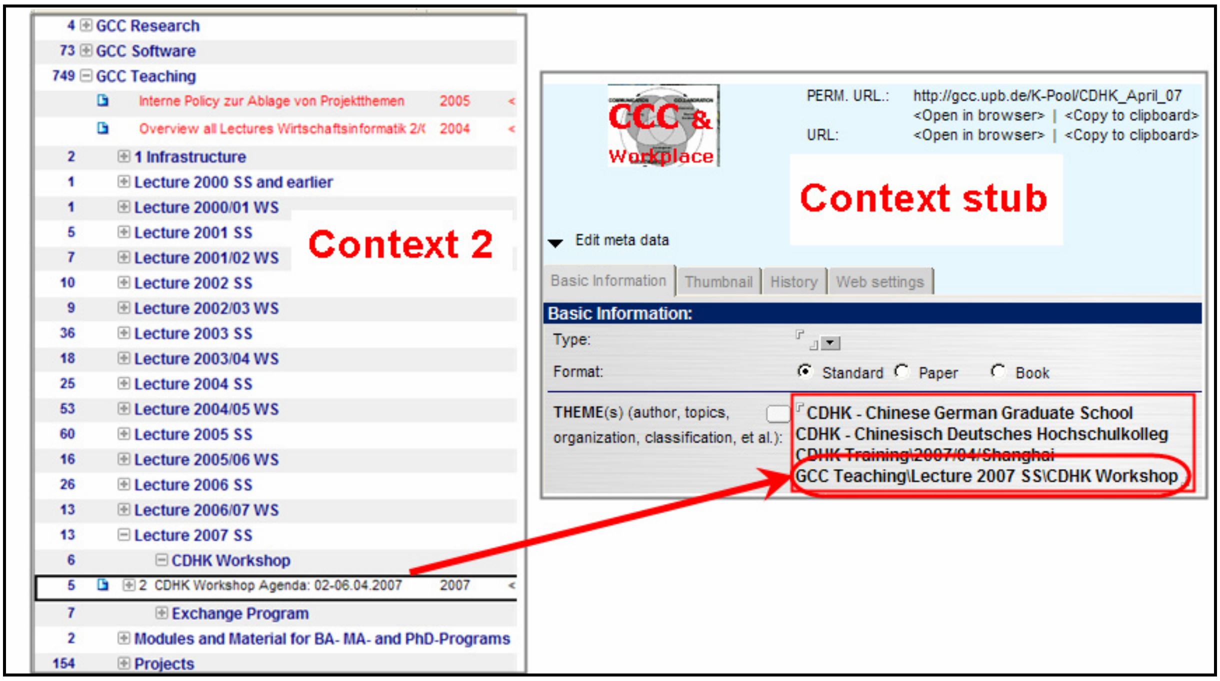

Figure 6-3: Aggregation and sequencing in context #2

In the demonstrated examples of Context 1 & 2, the "Themes" field exemplifies that the implementation of contextual parameters in CM-WLOD caters to different knowledge discovery entry points based on different organizational contexts (e.g. the CDHK project, or the teaching program), and employees, speaking different languages, are also able to find the information and knowledge they need in the right context with the apparent sequence.

The next two contexts are achieved via the "Keywords" space in the context stub. In context #3 (Figure 6-4), because the workshop participants from CDHK at Tongji University do not have access to GCC K-pool, one way to access workshop information in general is to search GCC K-pool's web front-end application. They may search through the keywords, select the keyword-class "ORGAN." and identify "CDHK …". Then, a list of nuggets is presented, each with a thumbnail and the full set of contextual parameters. All contextual parameter values are hyperlinks, opening investigation channels connecting the current nugget with other ones in different domains. So, by choosing "Workplace" in the "Label" keyword-class the "CDHK workshop logbook 2007" again will be presented in another group of knowledge nuggets assembled under "workplace", to be noticed, in another sequence pertaining to the current context.

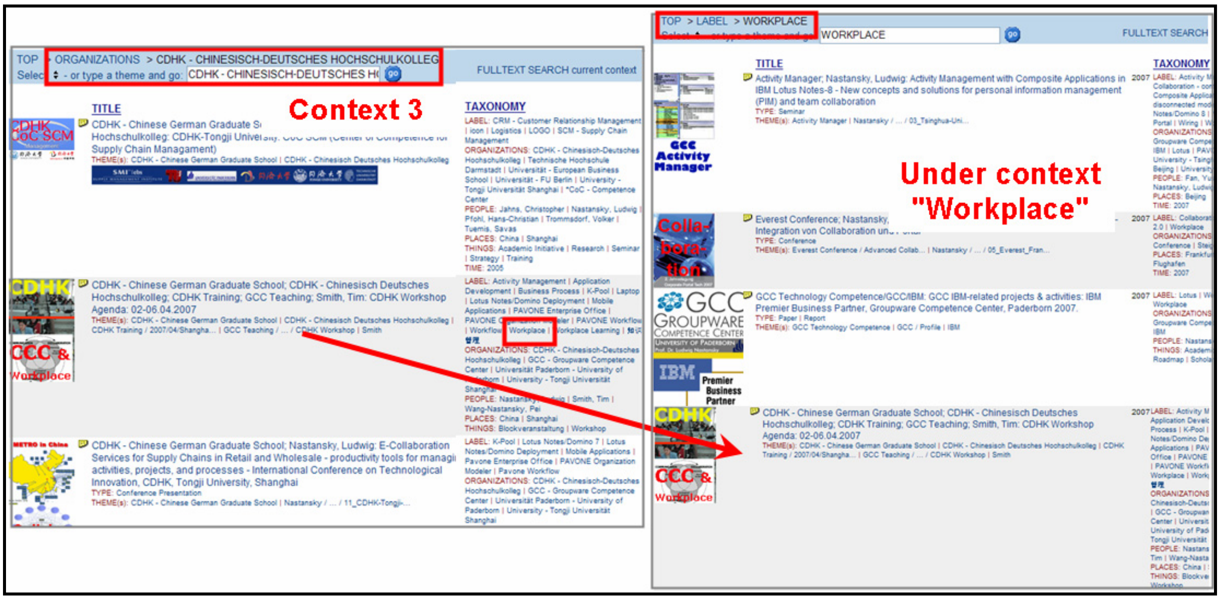

Figure 6-4: Aggregation and sequencing in context #3

Similarly, the employees from GCC may also discover the CDHK nugget under keyword "Activity Management", as denoted in context 4 (Figure 6-5). Here, the CDHK nugget is presented following behind the two nuggets with "sort key" values offered under "Miscellaneous other parameters". This sequencing takes precedence over the otherwise alpha-numerical automatic sorting.

Figure 6-5: Aggregation and sequencing in context #4

Context 5 (Figure 6-6) denotes an individual work and learning domain. As shown in chapter 5.3.3, Tim has collected all knowledge nuggets he needs for the CDHK project work and re-tagged them into his personal application environment into two categories: "TS (Tim Smith)\Tim's Learning", and "TS (Tim Smith)\Tim's Project Task". He has put what he has done for his job assignment in the second "Tim's Project Task" category to separate them from his learning materials. This is to show how - in addition to the previous four contexts - individual employees are empowered to add another layer of aggregation and sequencing without disrupting the official organizational domains.

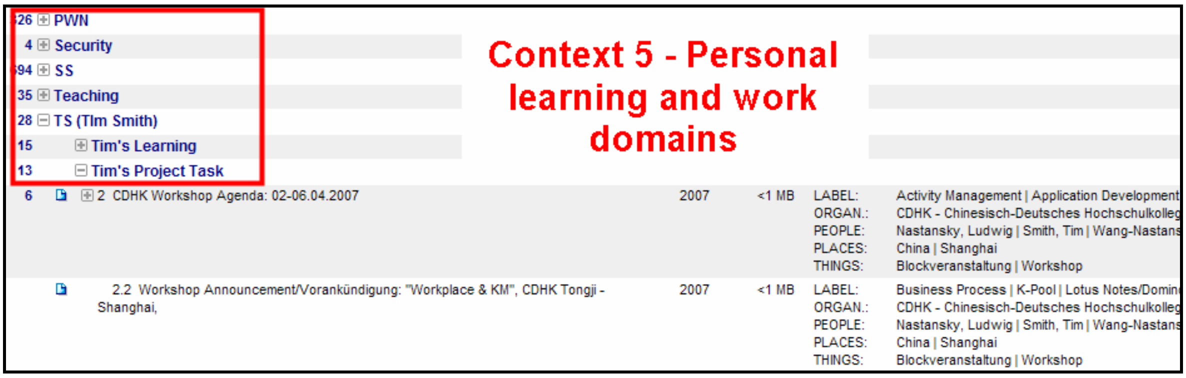

Figure 6-6: Aggregation and sequencing in context #5

The above five examples depict that a K-nugget can be sequenced differently according to individual context information drawn from its own context stub. The individual entries of context information in the “Themes”, “Keywords”, and “Categories” contextual parameters represent the smallest, granular context in CM-WLOD’s prototype implementation. These small contexts are independently helping employees in searching and collecting information and knowledge according to snippets of application domain information of their job tasks.

The other end of the granulated context is the whole set of context information in the context stub of a K-nugget. This defines a peculiar combination of contextual parameter entries, the contextual signature, which altogether more precisely define a particular domain, regularly matching the content of only one K-nugget.

In theory, contextual signatures could be identical for more than one K-nugget, for instance denoting a poor selection of values for contextual parameters not sufficient for discriminating the meta descriptors of one set of content material from another one. In practice, contextual signatures once in a while will be identical as well. This often denotes laziness in assigning enough discriminating parameters, or creation of context information made in great haste through work overload at the workplace. Rarely, insufficient competence in handling contextual parameters might be a reason as well. As mentioned in chapter 5.3.3, glossary management tools might be applied to achieve the precision level in value naming and management the organization needs.

The next figure presents an incidence of the middle granular level of context information, between the two extremes explained above. Shown in Figure 6-7 is the full text search user interface provided by Notes which can be used deliberately for arbitrary search patterns on contextual parameters. In this case, the logical “AND” combination of parameter values “CDHK”, “China”, “learning” & “Tim” defines a contextual criterion to filter out K-nuggets from the knowledge pool. The search outcome displays 24 K-nuggets related to the specific combination of contextual details. The “CDHK workshop logbook 2007” nugget is also pulled out among the 24 nuggets, and it is in a sequencing position according to “relevance” criteria of the full text search engine in Lotus Notes.

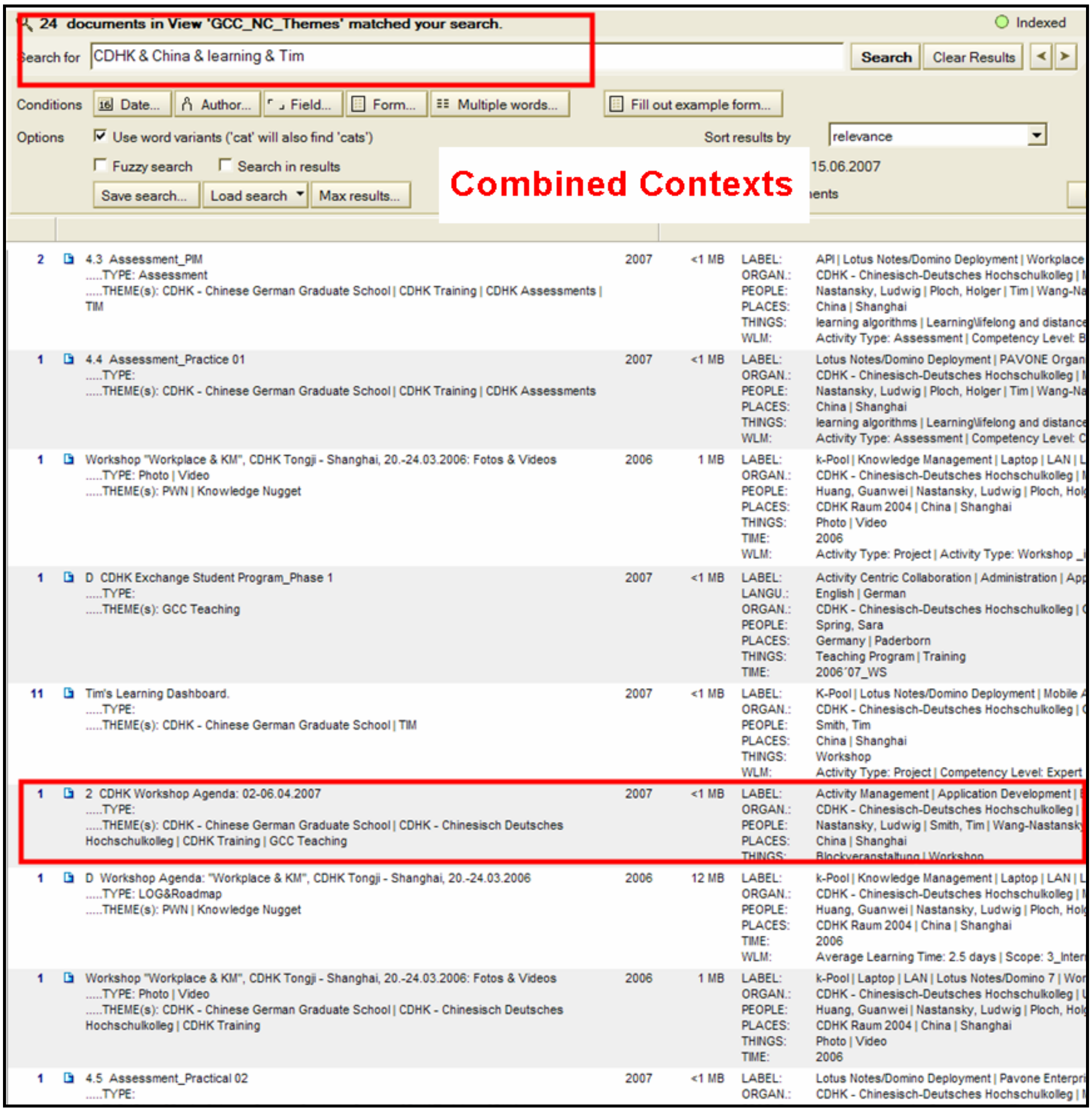

Figure 6-7: Aggregation and sequencing in combined contexts

But, to use full text search in CM-WLOD breaks the provided structural layers with a “dumb” search criterion, not taking into account any of the available structure information in the set of contextual parameters. Full text search makes sense for additionally digging into the content parts of K-nuggets maintained in the knowledge pool. There is another point: Full text search works transactionally as a response to only one specific query. All the other queries outlined so far for the CM-WLOD approach are based on embedded and explicated contextual information according to the CM-WLOD metadata model. This is not the case for full text search. The context as result of a full text search is only temporarily constructed and hence not persistent. There are some mechanisms though, provided by the Lotus Notes layer, to store full text search patterns constructed by combining several contextual parameters. But these mechanisms are rather clumsy to handle and definitely not provided for the type of collaborative usage intended in CM-WLOD.

Against this background the author has another suggestion for leveraging the profiling capabilities offered by the CM-WLOD approach in its definition of a flexible set of contextual parameters. Profile search like the one shown in the example of Figure 6-7, i.e. by combination of a sub-set of contextual parameters, is not directly available in the K-pool system yet. So, another contextual parameter should be introduced storing contextual profile information, i.e. being capable to collect an arbitrary subset of the actual available contextual parameter values in the context stub. Dwelling on the previous examples for pursuing one-dimensional context channels, the data format of a profile search could be like:

<u>Contextual parameter #8</u>: Contextual profile

Example:

Themes=”CDHK Training”; KeywordClass-Label=”Workplace”, “Activity Management”; KeywordClass-Time=”2006” ‘or’ “2007”; Categories=“TS (Tim Smith)\Tim’s Learning”

The “Contextual profile” contextual parameter serves as container for storing an arbitrary number of contextual parameter values out of a context stub including their logical combination (like in this example). The context stub would need an additional user interface for assigning, managing and selecting this set of different profiles. The K-pool system would need another view-analogous listing mechanism for automatically providing the K-nugget collection according to a given and selected profile. In addition, an agent would be necessary tagging all K-nuggets which fit an actual profile. The rendering of the K-nuggets collected this way could be implemented based on the extension options of Lotus Notes’ full-text search engine.

6.2 Reusing, Re-Purposing and Referencing

Once again, this thesis focuses on increasing sharing and reusability of information and knowledge that is driven by contexts. The design and implementation of knowledge nuggets on the GCC knowledge pool supports three types of reusability of contexts: direct reusing and indirect reusing, repurposing and referencing. Direct reusing means copying existing context information from one K-nugget’s context stub to that of another K-nugget. Indirect reusing refers to modifying or repurposing the selected context information to another application domain. Different from the previous two types of reusing context available in K-nuggets, the contextual referencing mechanism is implemented at the level of contextual parameters (e.g. “Themes”, “Keywords”, or “Categories”). In this way, the employee may tag context information against a list/index of relevant organizational contexts, following given structural information instead of starting anew.

6.2.1 Reusing

A straightforward understanding and application of reusability is to copy-and-paste existing context information from one K-nugget’s context stub to another K-nugget’s context stub without any modification.

Figure 6-8 displays the set of tools dedicated to the direct reuse of context information, which ranges from copying context (i.e. all contextual parameter values), content and/or filter categories for constructing the new K-nugget. Figure 5-24 and Figure 5-25 of chapter 5.3.4.2 have already depicted singular examples where employees may directly select suitable context information from different contextual parameters of available K-nuggets (e.g. keywords, categories, access rights control, and more) and paste/reuse them into new knowledge nuggets.

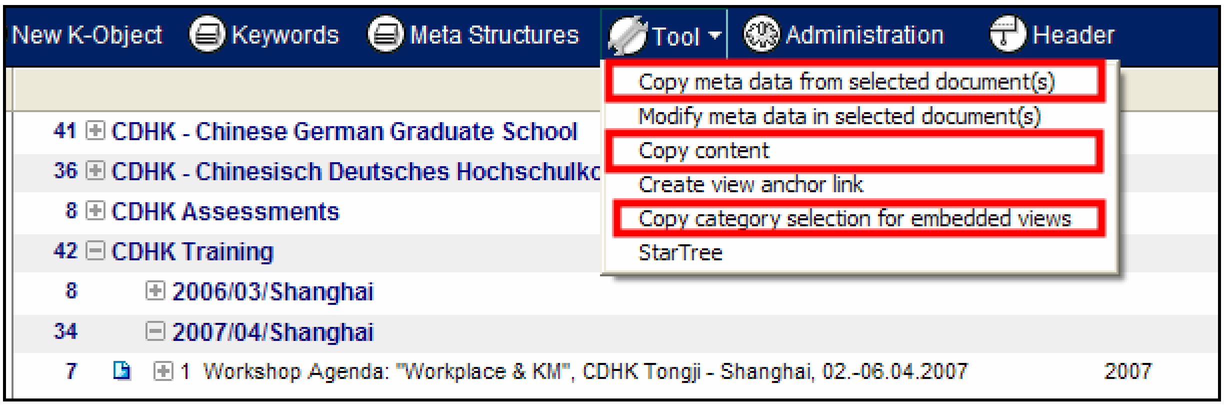

Figure 6-8: Direct reuse of context and content information

A more passive method of directly reusing context is reflected by the “point-and-shoot” mechanism for assigning contextual tags to the context stub. Under certain circumstances, the organization, the project manager or a data administrator pre-defines a list of context information so that they may have control on the application and the varieties for the name space of contextual tags. In this situation, the employees may only select by “point-and-shoot” gestures from the given list(s) of tags instead of freely creating context information (as described in chapter 5.2.4 in the case of assigning keywords).

In addition, in this thesis, the author has underpinned another pragmatic approach for reusing contexts via pre-defined templates. In chapter 3.4.4, researchers have pointed to the design of contextual templates as a tactic in standardizing contextual factors and context information in recurrent application domains. For example, filling travel reimbursement forms, generating meeting protocols or project proposals, executing workflow processes, etc., each of these activities frequently engages the same basic set of context information that can be reused directly in the specific organizational environment. Enterprises, for-profit or nonprofit organizations, often have pre-defined forms, protocols, and work process standards that are specific to internal organizational transactions or usages. The template blueprints can be drawn from these specifications for repetitive reuses inside the organizations. Certainly, the contextual templates approach of directly reusing context can also involve different industries and organizations, but this will be a future research point not under the scope of this thesis. In this research study, types of contextual templates have been implemented. For example, the template can be a specific project logbook (e.g. the CDHK- Workshop Template used in chapter 5.3.4.1), or a more sophisticated workflow process, or Tim's „Ad-hoc workflow" for updating workshop materials (as displayed in Figure 5-22 of chapter 5.3.6.2), or contextual information filters as the "embedded views" to dynamically pull desired K-nuggets (depicted in area C of Figure 5-23 in chapter 5.3.4.1). Each of these templates is shared via an organizational workplace for reusing in learning and working processes among knowledge workers.

Particularly, in the constructive and exemplary application of the CM-WLOD approach of chapter 5, knowledge workers in a research institute are empowered to reuse directly a pre-defined CDHK Workshop Template to jump-start the project, as well as copy-and-paste a set of contextual tags from the 2006 CDHK nuggets to the 2007 ones. The tools and template approach to directly apply context information from previous experience are shortening the learning curve while increasing the productivity at the workplace.

6.2.2 Repurposing

As in direct reuse of context information, repurposing contexts is also implemented in both the context stub and the content field of the K-nugget.

First, the contextual tool implemented on the K-pool system enables repurposing of context information in addition to simply copy-and-paste contexts among different nuggets. Figure 6-9 re-emphasizes the implementation of repurposing context information in addition to the practice pointed to for one example in Figure 5-25. It should be noted that the repurposing tool for context information can apply simultaneously to more than one K-nugget. Shown in Figure 6-9, four assessment nuggets are selected in area A, and the keyword "Blockveranstaltung" in keyword-class "Things" is added to the four selected nuggets as can be depicted from areas B and C. At one click, the result can be seen in area D, the four K-nuggets are tagged with additional context information. Certainly, the employee may select more than one K-nugget to "harvest" existing contextual parameter values out of a collection of K-nuggets in the "copy" phase. And, for the subsequent "infusion" phase, he can choose to replace or remove existing values altogether for selected K-nuggets. This toolset for repurposing contexts increases efficiency in updating or changing context information of a group of K-nuggets on-demand in a decentralized fashion.

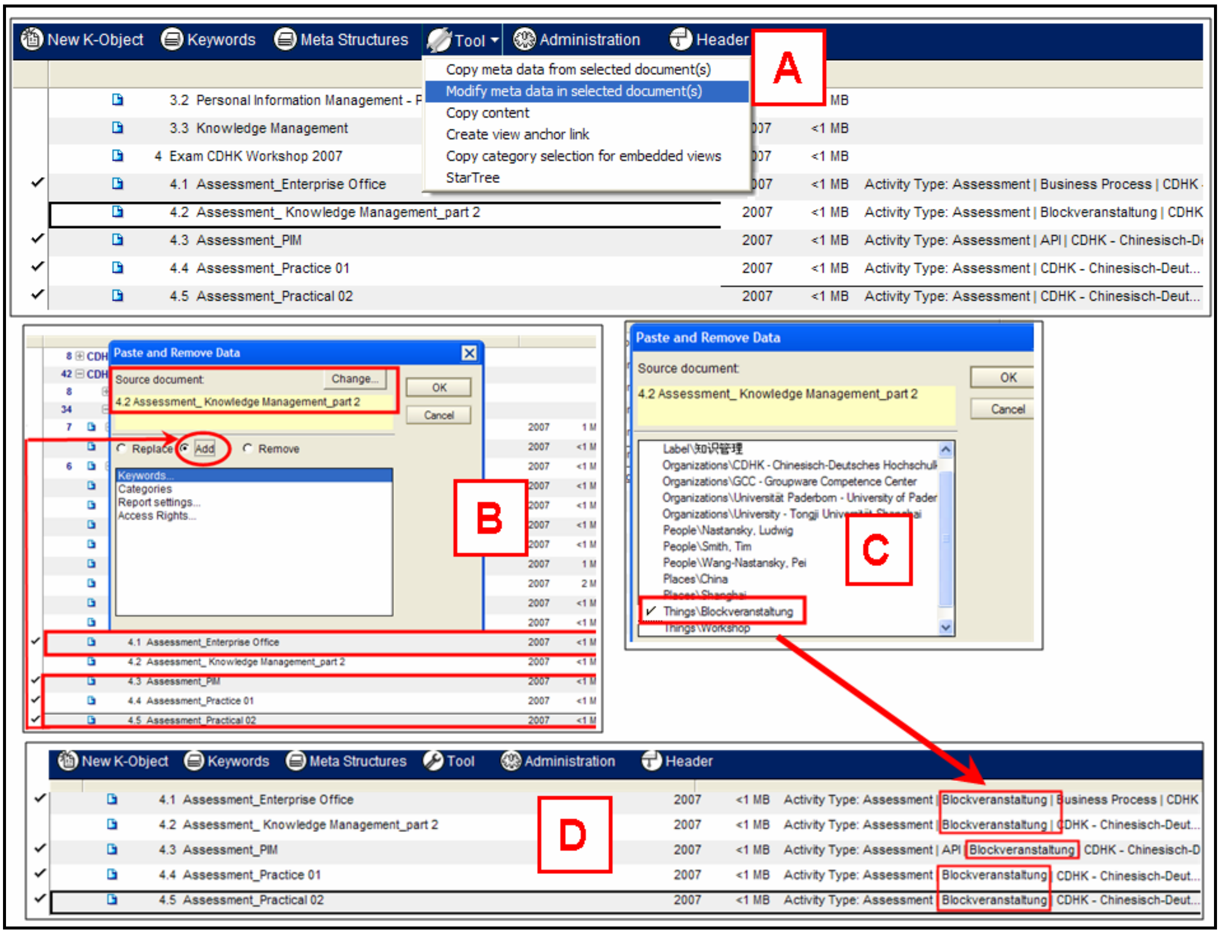

Figure 6-9: Tool for repurposing context information

For the purpose of constructively describing the practical application options provided by the CM-WLOD approach, the available mechanisms of reusing and repurposing have been denoted in a step-by-step fashion in chapter 5. Yet, in reality, the sequence of reusing and repurposing the contexts of knowledge nuggets is often mixed, depending on the individual scenario at a workplace setting.

With respect to contextual templates, chapter 5.3.5 presents a more advanced usage of repurposing context information and contextual parameters that are meshed under a template format. This time, the knowledge worker, without much programming skill, is able to repurpose a contextual template (as the “embedded view”) to a comprehensive “Personal Workplace Learning Dashboard” environment. The employee can profile his/her learning and working contexts in order to monitor personal learning progress while supervising the work progress at the same time. This workplace learning dashboard concept offers the knowledge worker a mixed contextualized environment, bringing personal and organization contexts under one place.

6.2.3 Referencing

Another layer of reusing context information is to assign tags against a referencing index. Each contextual parameter has a referencing index available for selections which enlist K-nuggets with existing context information of respective contextual parameters. This is revealed in previous examples, for instance in area C of Figure 5-4 for the “Themes” parameter, in Figure 5-9 for “Keywords” and in Figure 5-10 for the “Categories” personal contextual parameter. These context selections are especially usable in signing in existing organizational or group-based contexts. They provide reference lists for the knowledge workers who may simply pick or modify suitable contextual tags rather than define or deliberately re-name existing ones individually.

Other contextual referencing mechanisms are reflected in the context stub, such as the “Commenting” field as one of the “Miscellaneous other parameters” (chapter 5.2.8 and chapter 5.3.6.1), the “Version management” tool as shown in chapter 5.3.6.2, or the “Contextual signature” implementations referenced in chapter 5.2.9. In all these three practices, the referencing function spells out all activities related to the main content information in the K-nugget. This means, more specifically, indices in the context stub catalogue different comments and/or responses, the sequence of different versions, and sets of context information linked to the original content application. This practice not only reduces the physical copies of content information, but makes it easier to view the contextual history of the content materials. Furthermore, when different sets of context information are attached to one piece or a set of content information in the content field of a K-nugget, it denotes an activity of sharing domain experience which increases the reusability of the content.

6.2.4 Summary

One of the outstanding tangible benefits of a context-driven approach to knowledge sharing at the workplace is increased reusability of domain experiences. The CM-WLOD approach facilitates different levels of reusability of context information from direct reusing to repurposing and referencing. The layers of contextual reusing are practically applied in the research setting of this thesis, in a fashion of daily workplace learning on-demand.

All knowledge workers benefit greatly from contextual sharing and reusing not only by saving time and resources through recreating contexts, but also seamlessly integrating individual learning and working processes together at the finger tip.

6.3 Interoperability

Chapter 3.5 recaptures the resources and endeavor spent on developing standards and specifications for learning systems. A range of international organizations and researchers have tried to achieve technical interoperability in order to increase the reusability of learning objects or digital learning resources across the borders of organizations, industries, and even among different countries. As indicated above, there are enough voices to be heard criticizing the development of technical standards and specifications for LOs, from both the academic and the industry fronts. Because of the lack of pedagogical dimensions, academics regard the LOM standard and specifications as not very useful in classical education settings. From the industry point of view, the current standard and specifications are too costly to comply with. The presence of more than 70 metadata fields in the IEEE LOM standard, and 4 specification books (one book includes the IEEE LOM) to comply with the SCORM specifications turn industry adopters away.

In the history of technology, standardization is a power game, torn by regions, professions, politics, foul play, money, monopolies, and more. This is especially true for information and communication technologies. In many cases, standards defined by international standardization agencies were overtaken by the adoptions of an industry solution, i.e. “industry standards”. Interoperability for sharing digital resources adds another layer of complication regarding size, quality, and intellectual property issues that may hinder the wide-area adoptions of learning standards and specifications across organizations, industries, and countries. For now, the interoperability issue of learning objects remains largely a marketing message for learning software vendors.

In the setting of this research, centered at the workplace in an organizational environment, interoperability issues demand a much wider consideration than just the restricted dimensions of conveying traditional classroom education and training models. Accordingly, in this thesis workplace learning on-demand is positioned towards informal and formal knowledge management approaches driven by job tasks in an on-demand fashion. To facilitate this type of learning-by-doing, learning while working, and learning for working, the technologies used must be seamlessly integrated with business information systems. Learning is neither an island of activities separated from working, nor are the technologies used for learning an island of data fields, isolated from the people (the employees as users) and workplace processes.

Given the current state of unstable development of learning standards, this thesis proposes a flexible approach in adopting learning technology standard(s). Additionally, as noted in chapter 3.5.3, because a specification is an on-going evolution and process to become recognized by the industry, the following sections will concentrate on reflecting on the adaptation of two widely recognized standards in the learning and knowledge management fields. Namely, IEEE LOM, which is to be regarded as the only technology standard in the e-learning field, specifically the learning objects practice. And, the Dublin Core Metadata Element Set, which is used often in the wider arena of system approaches for knowledge management.

6.3.1 A Flexible Model of Adopting Standards

Adapting standards needs a pragmatic and flexible approach that should not destroy current infrastructures and data models while leaving space for later updating or re-adaptation.

One technical advantage of layering CM-WLOD on top of the system stack as shown in Table 5-1 is that all knowledge nuggets are stored as Lotus Notes native data objects. This is because the Notes-native data model, due to its document object orientation and messaging architecture, has been proven to be well-established for exporting data to foreign sources, as well as for importing data from outside repositories via standard rendering formats (e.g. XML or SOAP). These data and object connections can be used in a static manner (e.g. import on creation) or dynamically (e.g. maintaining link lists, lookup updates in external data sources, periodic export of fields performed by a process-driven agent). So, the interoperability of knowledge nuggets can be independently set up by these import and export mechanisms in order to flexibly adapt to standards.

IEEE LOM as well as the Dublin Core Metadata Element Set represents one single dimension of data mapping. However, the underlying data model of CM-WLOD is open for multiple taxonomies, multiple contextual parameter sets, crisscross referencing, workflow enactment, use for both rich client platforms as well as web-browser-based applications, and more. So interoperability can only mean simple exchange of selected parts of K-nugget data. In general, “import” and “export” mechanisms allow mutual exchange between CM-WLOD embedded nuggets and external databases (e.g. content repositories, knowledge management systems) without destroying the multi-dimensional contextual structure of the K-nuggets.

6.3.2 Metadata Mapping

Inheriting the Notes-native features, the contextual metadata based on the CM-WLOD approach can be exported to and data from external knowledge management systems that adopt either IEEE LOM or the Dublin Core Metadata Element Set can be imported.

Chapter 3.5.2 has pointed out that the 15 core metadata elements from DCMI can be cross-mapped to the IEEE LOM metadata elements. The difference between the two standards is that the 15 core DCMI elements due to their strict limitations provide a relatively stable data model for interoperating metadata in the areas of content management and knowledge management. On the contrary, the IEEE LOM is rather limited to the classical instructional design usage which traditionally separates learning from the workplace processes.

However, the Dublin Core Metadata Element Set as well as the IEEE LOM standard comprise a single dimensioned data model, just with different scopes. As a result, the mapping between the two standards as shown in Table 3-3 is a one-to-one relation. On the other hand, the CM-WLOD data model is a multi-dimensional approach to tag content information, especially the context information about the application domains defined in a workplace environment. The name “contextual parameters” in CM-WLOD denotes the term “metadata elements” according to the two standards. The CM-WLOD approach umbrellas both aspects and dimensions covered by the two standards, and it is also flexible and open to other models at the same time. Consequently, the mapping structure between CM-WLOD and the two standards is not only a one-to-one relation of metadata mapping, but incorporates also one-to-many and many-to-many relations as denoted in Table 6-1.

In technical detail, the data exchange mechanisms work as following: (1) On export of K-nuggets to the other databases, the CM-WLOD “export” feature will render the contextual metadata from K-nuggets to the Dublin Core Metadata Element Set or the IEEE LOM format at choice, depending on the preference of the external KM system. (2) For import from external standard resources, the CM-WLOD "import" function will re-assemble the imported metadata according to the definitions of contextual parameters in the CM-WLOD approach.

CM-WLOD Contextual Parameters	**Dublin Core Name**	**IEEE Learning Object Metadata**
Themes & "Keywords, being organized in separate and independent sets of keyword-classes" (e.g. PEOPLE)	Creator	lifecycle.contribute when lifecycle.contribute.role has a value of "Author".
	Other Contributor	lifecycle.contribute with the type of contribution specified in lifecycle.contribute.role. lifecycle.contribute can be repeated.
Title & Short description	Title	general.title
	Description	general.description
Keyword, being organized in keyword-classes	Subject and Keywords	general.keywords. For those wishing more specificity of Subject, a category of classification can be used with a purpose of "Subject". classification has elements for description, keywords, and taxonpath(s) that are specific for the purpose.
	Language	general.language
	Relation	relation.kind, relation.resource
	Coverage	general.coverage
Categories	[Not included]	[Not included]
Access Rights	Rights	rights.description
Workflow	[Not included]	[Not included]
Miscellaneous other 1. Literature details_**Publisher:**	Publisher	lifecycle.contribute when lifecycle.contribute.role has a value of "Publisher".
2. Literature details_**date:**	Date	lifecycle.contribute.date when lifecycle.contribute.role has a value of "Publisher".
3. Basic information_**Type:**	Resource Type	educational.learningresourcetype.
4. Basic information_**Format:**	Format	technical.format
5. Literature details_**location**: Literature details_**Catalog_ID**: Web settings_**Permanent URL**:	Resource Identifier	general.catalogentry. greneral.identifier is currently a RESERVED term, as there is no specified method for creation of a GUID.
6. Literature details_**...in**:	Source	relation.resource when the value of relation.kind is "IsBasedOn".

Table 6-1: Data mapping between CM-WLOD and IEEE & Dublin Core metadata standards

Figure 6-10 depicts an example for metadata export implemented in CM-WLOD based on the mapping in Table 6-1. For instance, the contextual metadata of the "CDHK workshop logbook 2007" nugget can be easily exported by the user, on-demand according to the Dublin Core Metadata Element Set, by activating the provided export agent, as shown in area A of Figure 6-10. Area B shows the snippet of exported context information to the Dublin Core Metadata Element Sets in XML format.

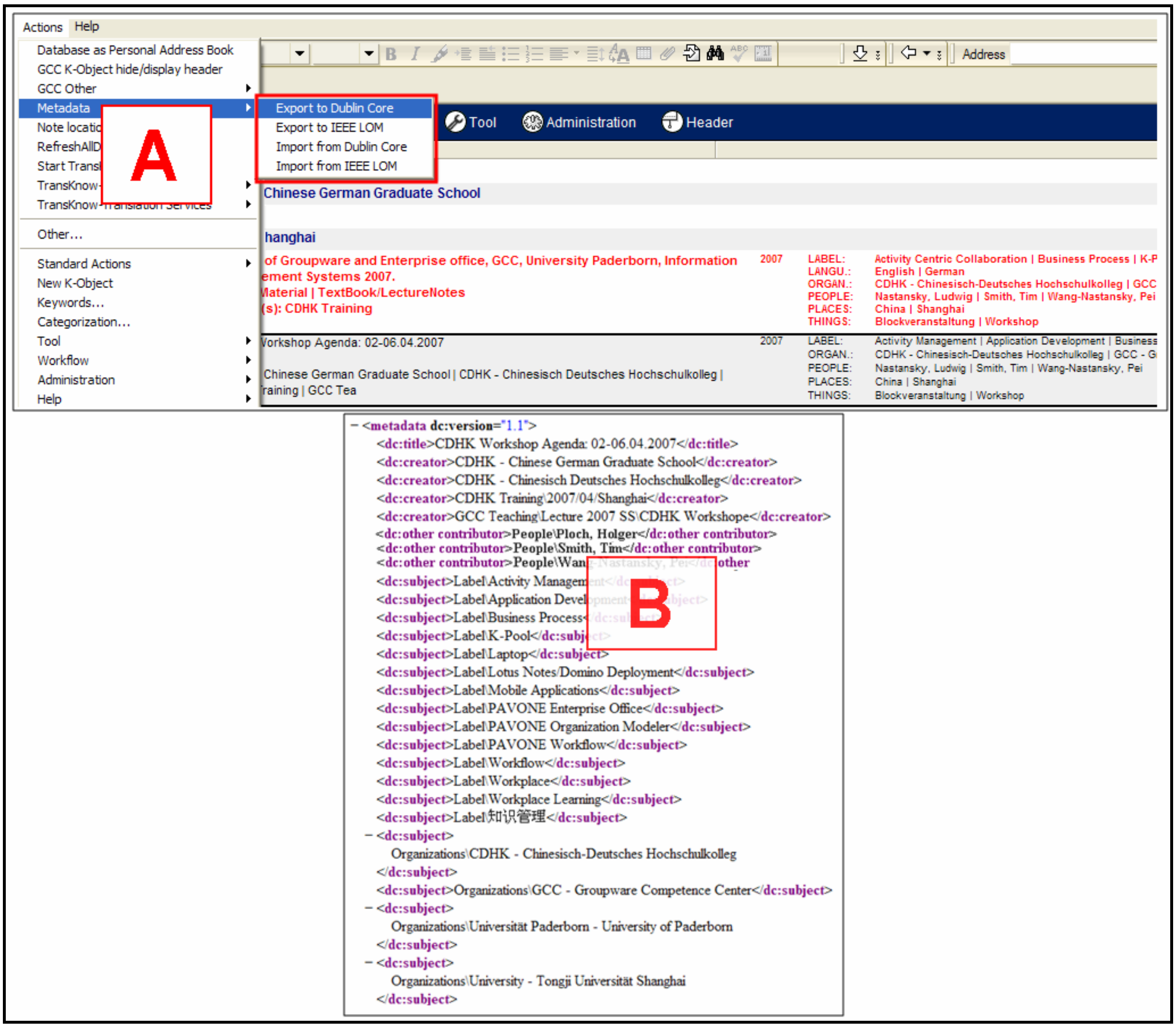

Figure 6-10: Export of CM-WLOD context information to the DCMI Element Set

In the case of metadata elements which appear in the two standards or other metadata models, but are not explicitly provided in CM-WLOD, the "Keywords" contextual parameter mechanism is flexible enough to take them in at once. One way to include other necessary context information from external sources can also be done directly by the knowledge worker, the employee who is in the role of an end-user of the KM system. Depicted in the Figure 6-11, with sufficient access rights, the employee may add any needed metadata elements at an on-demand, just-in-need manner. For example, the needed data elements may be edited directly under the "Keywords" contextual parameter set in the "LOM" keyword-class. This "LOM" keyword-class is specifically included for handling exchange of contextual parameter values, alias metadata.

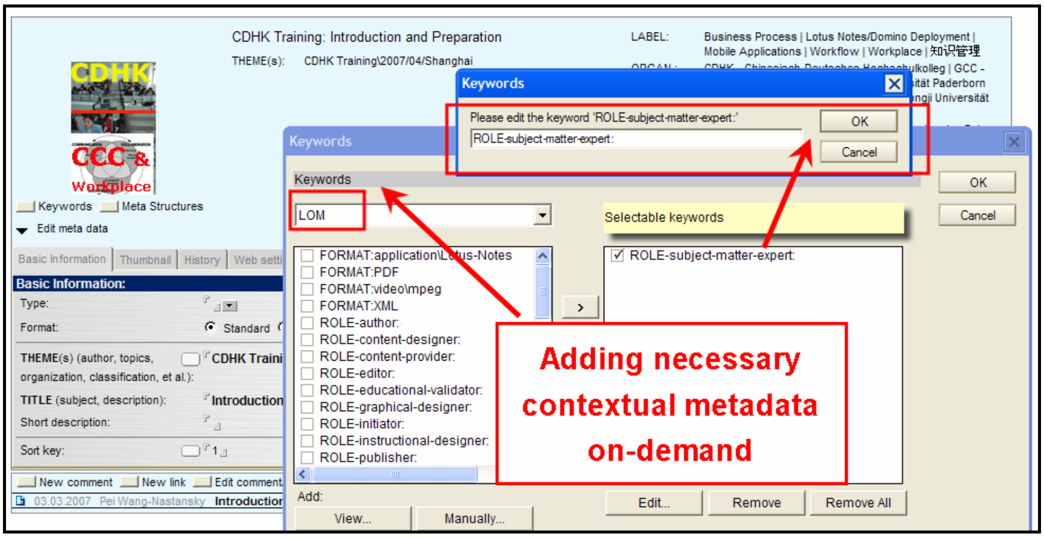

Figure 6-11: On-demand editing of contextual metadata elements

In general, the implementation of export and import mechanisms for metadata among different standards as prototyped in CM-WLOD is to be regarded as a pragmatic approach regarding the issue of adopting standards. In the current state of CM-WLOD, it serves as a proof-of-concept and feasibility study rather than as an efficient operational functionality. It leverages the multi-dimensional data model of CM-WLOD in which more than one standard and/or set of specifications can be seamlessly integrated for learning purposes or workplace applications. At the same time, this import/export application approach may save resources from both the organization and employees side by leveraging employees' existing skills and experience of their own business information system. This is, because employees can employ the user interface and functionalities of their workplace system where they are accustomed to. When needing information from external sources compliant to the two mentioned standards they may import this information and map it onto K-nuggets rather than work in another dedicated system.

At the end, the metadata standards and technical interoperability issues shall be kept at the back-end. A car driver should not need to know how different engines of different types of cars work under the hood. System and user-interface design shall take the burden off the shoulders of the busy knowledge worker.

6.4 Facilitating Bottom-Up Collaborative Learning in the Workplace Context

In the past, people have practiced, most of the time subconsciously, workplace learning informally at the water cooler or around the coffee table (Davenport & Prusak 1998). The frequency of changes has increased dramatically in the global business sphere of the upcoming 21st century. So, information technology has become an inevitable lifeline and medium for individuals to learn collaboratively with peers and experts in a globally connected workplace. People must learn for lifelong, and they have to learn collaboratively lifelong to survive.

While merging learning with work aided by technology, most developments and studies in the past have been concentrated on the top-down instruction model and centered on the learning content. So, as shown above, established learning management systems as well as the development of learning objects both tend to follow the process of classroom instructional design. More precisely, learning content is pre-defined, the context of learning is often pre-assumed, and the process is pre-outlined. All these three cornerstones are separate from daily workplace conditions and tasks being the focus of this thesis. Pre-packaged learning and learning processes hold certain truth, and they are applicable to stable expertise areas and invariable processes at the workplace. But changes in different aspects of personal and professional life have predominantly taken hold in the 21st century. The boxed learning, isolated from the working context, cannot satisfy the demands of adult workers' who are pushed and pulled to organize their own learning because of pressures from different corners of life. On the other hand, learning at today's workplace does is not to be understood as revolutionary acquirement of new knowledge (this might be fun, if it really happens), but more of fast learning cycles of evolutionary skills and knowledge from previous experiences.

Furthermore, the content-centric, and pre-packaged design of learning, typified by the development of learning objects (as discussed in detail in chapter 3), is also not suitable for the workplace learning on-demand. This is because the workplace context or job context pinpoints what ought to be learned and this type of contextual information cannot be predicted beforehand. The Internet and information technologies have freed content information from being scarce and sacred sources to a degree rarely anybody has anticipated. Nowadays, instead of lacking information, people are living with "information-overload", a term best describing overflowing, freely accessible and all too often context void content on today's corporate intranet and the open Internet. Hence, after information and communication technologies have given millions of people free access to content, the CM-WLOD approach is a step further for sharing and accessing of complementary context information at the workplace. The basic approach advocated throughout this thesis is a bottom-up, decentralized collaboration attitude that empowers individual knowledge worker to learn collaboratively via a set of tools according to the context of his/her job task. This key concept has been reflected and verified by prototypical implementation.

From the broader aspects of IT development, pushed and pulled by the Web 2.0 technology conglomerate, the notion of user-generated content is being extended to user-generated contexts, via ample communication means which support collaboration at their heart. In this thesis, chapter 2.4.1.2 & 2.4.2 review the concepts, patterns, and tools applied to workplace collaboration. The seven types of contextual parameters of CM-WLOD of chapter 4 are implemented for both formal and informal collaborative activities in learning and knowledge management.

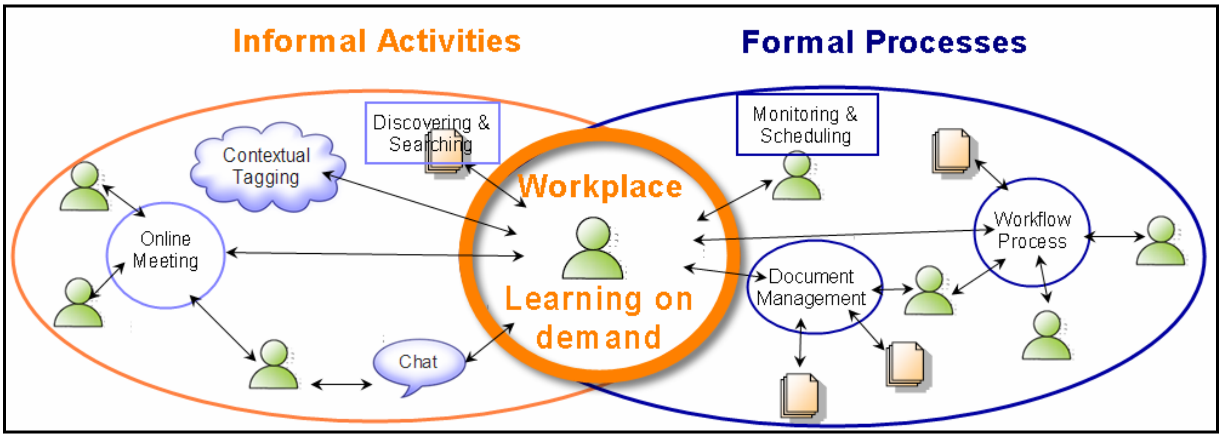

Figure 6-12: Activities for contextual collaboration in workplace learning and knowledge management

Figure 6-12 summarizes some of the essential building blocks applied to formal and informal knowledge collaboration at the workplace. Basically, the employee in the center of learning collaborates with colleagues, peers, and digital resources to fill the knowledge gaps at work. In chapter 5.3, the CM-WLOD model implemented on the K-pool system has facilitated both collaborative informal learning activities and formal working/learning processes, integrated in one virtual workplace. Using the collaborative tools, employees are enabled to acquire knowledge just-in-time contextualized for workplace domains, while accomplishing the job assignment simultaneously.

Informal contextual collaboration is often achieved by activities in searching, managing, and acquiring information and knowledge, consequently, applying them immediately to the job. These aspects have been constructively reflected in chapter 5.3.2 – 5.2.6. Particularly, in chapter 5.3.3, the “Categories” contextual parameter accounts for supplemental personal management of K-nuggets, parallel to the organizational contexts at the workplace. The previous chapter 5.2.6 shows that based on CM-WLOD’s prototypical implementation, the individual employee is enabled to collaborate peer-to-peer in teams or working groups via the “Access control” contextual parameters. The collaboration comprises activities like co-authoring and modification of knowledge nuggets in a team-oriented workplace setting. This decentralized, bottom-up and highly networked approach complements the hierarchical working structures defined on the organizational level.

Moreover, the decentralized and informal collaboration also evolves around tools for reusing and repurposing and referencing contextual information tagged by other colleagues at work as explained in chapter 5.3.4.2. Further, informal collaborative activities depend on real-time communication tools, such as the instant messaging (e.g. chat), synchronized online meetings, or awareness indicators. These online communication tools help resolving relatively small knowledge gaps and problems at work efficiently, not least, adding more direct human contacts (sight and sound for better hopefully) in the virtual workplace as well. As denoted in chapter 5.3.6.3, Tim Smith, the key persona of the prototyping scenario in this thesis, has chatted online with his colleagues to solve a scheduling issue, and also learned simple Chinese through an online meeting.

The "Formal Processes" side of Figure 6-12 presents a set of formal working processes for collaboration. In this aspect, chapter 5.2.2-5.2.4, chapter 5.3.2, and chapter 5.3.4 have delineated how the contextual parameter of "Themes", "Titles and short description", and "Keywords" can be applied to formally managing documents, the K-nuggets, on an organizational domain level. A semi-formal "Personal Workplace Learning Dashboard" space in chapter 5.3.5 is made for monitoring the personal learning outcome and the formal work process simultaneously. The "Workflow" parameters, particularly, the „Ad-hoc workflow" parameter is utilized in chapter 5.3.6.2 to process job tasks on-demand within a project team or workgroups setting.

The evolution of collaboration and knowledge sharing at work shall go beyond the simple understand of putting content online to the practices of sharing context information. It is the context that gives the life of content information.

6.5 Summary

At the modern workplace, knowledge workers learn for on-demand job requirements that evolve around a mixture of formal and informal learning activities, all driven by the context of work domains. The CM-WLOD approach is a multi-dimensional data model for reusing and sharing context information at the workplace. Why take so much energy in contextualizing digital resources? Again, comparing information and knowledge contextualization via physical tools like paper folders, Post-it, highlighters, the prototype in this thesis manifests the following advantages for learning on-demand at the virtual workplace:

1. The context information is searchable and recorded for permanent retrieval in the organizational workplace instead of being lost when depending on paper.
2. All contextual information is crisscross linked so that one context may lead to more than one set of information and knowledge instead of a one-to-one relation in the physical office. Both context and content information can be tagged for organizational and personal domains parallel to each other;
3. Reducing physical copies of content information because the concept of “Contextual signatures” enables different sets of context information for one set of content materials.
4. Content is easily maintained because only one copy of content remains in the system.
5. Learning and knowledge management technology is integrated with the enterprise office system, seamlessly embedding learning in the working contexts.

Overall, the outcome of the CM-WLOD approach derived in chapter 4 and further on implemented on top of a business information system is two-fold. Via seven contextual parameters, it builds a contextual collaboration platform for facilitating individual knowledge collaboration formally and informally, with peers and digital resources in work context. Additionally, for the benefit of the organization, the platform stores outcomes of learning and knowledge collaboration that stimulates sharing as well as supplies applied and explicated knowledge, in form of contextualized content, to the organizational pipeline for the next generation of knowledge workers. After all, the personal learning outcome at the workplace is a gain for both the individual and the enterprise, and this approach leads to a healthy cycle of organizational knowledge sharing and management.

GCC’s K-pool knowledge management system, on top of which CM-WLOD is implemented, has been deployed not only at GCC, but also in other knowledge intensive research institutes and industries:

1. At the Strategic Integration Management Center (SIM) at Tsinghua University, Beijing, China, ranked the number one university in China
2. At the Groupware Competence Center on the Bocholt campus of University of Applied Sciences Gelsenkirchen, Germany
3. In the Research and Development Department of Henkel KGaA, Düsseldorf, Germany
4. In the Research and Development Department of Hella KGaA Hueck & Co, Germany

5. In the Faculty of Business Administration, Information Management Systems, and Economics at the University Paderborn.

7 Summary and Conclusion

7.1 Focal Point of this Thesis

The purpose of this thesis is to contribute to an all important environment of current day learning – the workplace. Regularly, workplaces are part of organizations, for profit and non profit, which do not have their organizational goals and operational focus on learning endeavors. Rather these organizations are positioned in a worldwide competitive environment where they struggle for their very own competitive edge. This competitive edge is mainly comprised of the combined skill set of their employees for successfully offering services and products on the markets – notwithstanding their ability to use technical equipment to efficiently multiply these skills. Against this background, means of improving, developing, maintaining, and smoothly as well as efficiently bringing the skills into operational use is an all important task. This type of task has been the focal point of "knowledge management", an organizational discipline being aloof and yet intuitively evident at the same time. For all its remoteness, it is immediately apparent that "learning" defines an important part in the whole body of knowledge management in an organization. But, this kind of learning is different from many aspects otherwise related to "learning".

To mention some of the differences: The learning process does not need to be institutionalized, nor is not institutionalized by its very nature, in a separate learning-only environment. Rather learning is an integrated part of work processes. This leads to another difference. Most of the learning content is not prepared by professional instructor driven corporate training infrastructures, or by independent learning institutions. Rather the context characteristics of unknown content appear all of a sudden in the flow of repeating work duties or new projects at the workplace. Information has to be gained about this unknown content area. Thus, learning has to take place in an on-demand fashion, immediately at the workplace, and not in seminar rooms. The question is anyway where to draw that important line, between the operational side of successfully performing in a new project on the one hand, and the preparation and enabling side on the other hand by collecting new information to be capable of pursuing the required project tasks. Or, maybe this line is not at all important? Anyway, in the context of this thesis it does not make much of a difference, whether strong criteria helping to define precise borders between operational tasks and learning tasks are established, or whether they are not.

So, an employee's individual learning process at the workplace is characterized by investigation phases of searching around and identifying material rendering the content being regarded necessary, by subsequent studying phases of identified relevant materials, and by contextualization phases for efficient integration in the organizational processes. In addition, peers play an important role in all these three phases. Hence efficient supportive means of communication and collaboration are necessary as well. This is what takes place at the workplace, and this is what is taken as a pragmatic approach to what establishes the "learning" side of work at the workplace in this thesis.

Following prevailing schools of knowledge management research, this type of learning approach specifically pertains to the side of making knowledge "explicit" in an organization. In a rather puristic formulation this process would consist of the steps of using information, e.g. rendered as digital assets, afterwards internalizing it in the context of the actual work determined learning goals, and finally making it explicitly visible as accordingly contextualized information materials in the organization's information and communication system. Following this puristic view, "knowledge" cannot be stored as digital assets, because it is restricted to being a mind internal process. But, for ease of writing the terms "information", "knowledge" or "learning content" for addressing knowledge related content in corporate information and communication systems have been used interchangeably in the course of this thesis.

Some may maintain that the above summarized approach is an all too simplistic way to deal with complex and well researched entities like "learning" and "knowledge management". But, as has been shown manifold in the course of this thesis, there are many unknown and not researched yet challenges to be tackled even on this simplified ground. Definitely, these challenges have to be resolved before a possibly more pedagogically inspired approach to the integrated learning side at organizational workplaces can be successfully pursued. Especially, granuralization and contextualization of information and knowledge for practical learning purposes at the workplace determine a widely open field, which has been addressed in this thesis.

7.2 Summary

This chapter presents a brief summary of the thesis.

The opening of the thesis brings forward the research setting of this thesis. In the 21st century and beyond, technology advancement has been pushing and pulling employees in the global workplace to change the way they work and they way they learn. Against this backdrop, this thesis is aimed at the enablement of sharing knowledge contextually via IT, knowledge which is available at employees' finger tips in order to adjust and adapt changes of job tasks.

Chapter 2 investigates the next stage of e-learning development at the workplace, i.e. "Workplace Learning On-demand" (WLOD) as a steady evolution with respect to the increasing demands on just-in-context and just-in-time knowledge and skill update. In this evolution, contrasting the traditional classroom instruction, learning is a decentralized sharing and collaboration endeavor. Moreover, WLOD is a self-organized and self-managed process by individual employees at their desktops. Another important effect of IT is that access to content has been set free or is enabled with tremendously reduced costs. To establish organizational value of information, free floating on the intra- and Internet, comes down to knowing and sharing, when, where, and/or how to use the information. Precisely, managing organizational contexts rules the emergence of workplace learning on-demand.

The literature and problem analyses in chapter 3 are on the subject of the "learning objects" (LO) approach to digital resources, as an example of modular design of knowledge which has excited many in both corporate and academic sectors. The past development of creating new or de-composing existing digital resources as granular and interoperable digital objects, which are intended to be optimal for reusing in numerous application domains, encountered a range of challenges. The author addresses the rhetoric in the dispute on defining learning objects, the various models of granulating content, the cost of adopting the complex LOM standard, and the immature stage of SCORM specifications which single-mindedly follow instructional packaging of content for teaching a single learner via a machine. Among all the dismay and distress of the modular design approach to knowledge, basically, it is the lack of an applicable model and practice to deal with the context information side which has made the researchers scratching their heads. Some researchers have, correctly, concluded that organizational context, i.e. the specifics of workplace settings in military, educational, or corporate environments, greatly influence design and use of learning objects. This seems to be obvious, but does not bring much for operational use. Moreover, the question of how and what value the LO approach has for the individual learner is left unanswered. Thus, some of the completely unresolved demands on LOs have been abandoned in this thesis. Especially, this affects planning granularity beforehand, centered on content creation, to anticipate reuse without taking into account unforeseeable and ever evolving contextual changes for their future application. Instead, the concept of "knowledge nuggets" (K-nuggets) is employed in the constructive parts of this thesis. K-nuggets bear a rich environment for their contextualization to take into account the normality of the many context signatures reflecting the respective application environment they are (re-) used in.

E-learning development at the workplace demands a model which integrates individual employee/learner's learning processes with working context. Current approaches of modular design of knowledge do not fulfill this need. Motivated by this challenge, the author has developed the "Contextual Model for Workplace Learning on-demand" (CM-WLOD) in chapter 4. The CM-WLOD approach is towards an ontology-based data model to classify, organize, manage and communicate contexts for workplace applications in a collaborative manner. Within this model, the main focus is on context, the complexity of which is one of the greatest challenges at the workplace. The on-demand factor is assumed via the availability and readiness of business information and communication systems that apply CM-WLOD. The content management side of knowledge in this model is taken as a given fact. Following the arguments in the introductory chapter 1, learning at the workplace is not a phased-out process from working. Under the scope of this thesis, learning makes no differentiation between sharing and collaborating activities concerning knowledge creation at the workplace and other areas of knowledge management in the organization. The focal point of modeling context is based on seven contextual parameters which reflect a pragmatic approach to organizational data modeling. For optimizing sharing, an approach of context signatures for reusing and repurposing content is derived, by assigning different sets of context information to content material collections. Moreover, CM-WLOD embodies the individual learners/employee's personalization process along with organizational usage in sharing contextualized knowledge at the workplace. For this, an approach of guidelines for handling loosely-coupled and strongly-connected content is derived.

Chapter 5 presents the prototypical implementation of CM-WLOD on a state of the art KM-system layer stack. Central parts are a layer providing document management, communication and collaboration services (IBM Lotus Notes), and as a layer dedicated to knowledge management (K-pool system, developed at the University of Paderborn). The goal is to prove the applicability of the model and to present showcase applications. For this, it is shown how the CM-WLOD data model and structure are adopted to the customization options presented by K-pool and Lotus Notes. In the adoption, and for isomorphic modeling CM-WLOD on top of K-pool, the author had to suggest two functional extensions for K-pool. One is to allow more than one context signature for a given set of content materials. The other is to allow for a deliberate set of values of contextual parameters to define a selection profile for content, assembled according to the profiled context. The last part of chapter 5 elucidates several aspects of the practice of workplace learning on-demand via CM-WLOD implemented on the KM system, especially from an individual learner's perspective. For this, based on a "persona" approach the functions of a workplace learning "dashboard" are presented. This dashboard provides a collection of portlets to contextualize work tasks vs. knowledge management tasks in an integrated fashion. Many typical usages are delineated, such as differentiating content which is strongly-connected or loosely-coupled to work tasks, or mechanisms to re-contextualize content.

The last major part of this thesis, chapter 6 captures the success of achieving contextual granularity by implementing and practicing CM-WLOD, especially in a collaborative environment. For this, reusing, repurposing or referencing of both organizational and personal context information is demonstrated via use of various contextual tools. The motivation for the various showcase demonstrations is that the collaboration activities revealed in this thesis were all pulled and pushed by context information identified in the CM-WLOD approach for usage at the individual workplaces of all involved team members. In a section devoted to interoperability issues it is shown how the context signatures of CM-WLOD can be easily exchanged with the metadata parts of other content repositories. Functions for exchange with Dubline Core Metadata Element Set and IEEE LOM are implemented as prototypes in CM-WLOD.

7.3 Recommendation for Future Research

The combined outcome of this study indicates that the current state of information and communication technology does empower workers in contextual sharing and collaboration at the workplace in an effective and efficient way.

To look critically, the author has to point out two aspects in her assumptions for CM-WLOD application. One is, to not closely enough explicate the specific requirements on the general personal attitude of the ideal employee, i.e. knowledge worker, according to CM-WLOD, including his/her skill set of using IT at the workplace. The other assumption pertains to the organizational infrastructure in need with respect to management, guidance, compliance, technology, etc. for collectively achieving contextual knowledge sharing and on-demand learning at the workplace in a collaborative manner. In the scenario of this thesis, the IT competency of the knowledge worker was pre-supposed as a default element. This is because design and implementation of the CM-WLOD approach do not require too many IT-specific technical skills.

However, the author did recognize during her work on the CM-WLOD project that the usage of a knowledge management system as the day-to-day contextual communication and collaboration platform has not been a natural practice yet, as compared to e-mailing, online chat, or text processing. But, the author realizes that the next generations of knowledge workers, before starting their work life, have already acquired technology skills from daily use of Internet and PC tools, not least from playing computer games. Nevertheless, contextual collaboration technologies do require mentality changes from a consumer, self-centered and owning behavior, to the more systematic- and compliance-driven sharing approach in an organization or formally organized community.

Another more critical issue is that knowledge management activities at the workplace cannot be achieved solely by sophisticated models or technologies. In an organization, sharing and collaboration goes as a flow with top-down systematic encouragement on the leadership side and bottom-up input from the workplaces on the knowledge workers side. These aspects will be the core ideas of the recommendation for future studies.

Contextual sharing and collaboration in an organizational workplace is not only the endeavor of individual workers, but also the responsibility of the organization. Management researchers in the arenas of organizational learning and human resources may look for the appropriate types of reward systems for encouraging contextual sharing. Rewarding does not necessarily (or least) mean monetary awards. A recognition system among peers or a referee/ranking system which distinguishes the most valuable knowledge philanthropies in the organization may be searched for. Knowledge philanthropies refer to people who are putting effort and time in contributing content and context information in a team. This has not to be understood as being all too esoteric. But, a dull attachment file without thoughtful contextual tagging and content re-organization should not count as a valuable knowledge contribution. Because, first of all, the organization network is not a dumping place for information up-loading. Secondly, putting unpolished and not contextualized content in the team's content pool is an irresponsible activity which only adds more organizational work for the peers, and where the thrown-in content is difficult, if not impossible, to retrieve.

From a tactical standpoint, top-down leadership is also required in enforcing organizational contextual sharing and creation of knowledge at the workplace. One of the successful deployments of the CM-WLOD approach, the author has managed and participated in, was in the SIM-Center of Tsinghua University, Beijing. The implemented contextual model comes alive because of the strong and consistent support of the center's manager, Prof. Yushun Fan.

He has given orders (a straight way) to his team members in organizing all their knowledge works (e.g. presentations, project documentations, theses, etc.) in the SIM CM-WLOD system. In this way, all knowledge will be contextualized, shared, well-maintained, and searchable within the organizational KM-system regardless of personnel changes. It might sound very Chinese with respect to the style of leadership, but sometimes a well-reasoned push or enforcement is indeed in need while moving things forward. Therefore, the tactical issues of leadership can be another fruitful study in pulling and pushing contextual knowledge management processes at the workplace.

As with technical design, the field of using the computer workplace for efficiently handling e-activities is an area to develop and integrate individual as well as organizational working processes contextually. In plain language, the knowledge worker's daily activities involve an array of tasks, i.e. reading e-mails, editing electronic files, browsing on the web (lost track what has been interesting or useful), chatting online with a colleague, scheduling an appointment on a e-calendar for next week, using tools for specific lines of business, etc. These activities, so far, all happen in different IT environments, some determined by the individual, some organizational, and some external. There is a vacuum for design and development of a tool set that brings these e-activities into respective contexts in an integrated fashion (far more than has been presented as suggestion for a "Personal Workplace Learning Dashboard" in this thesis). Furthermore, it can be a powerful personal e-workplace managing tool enabling connection of different activities from different technology platforms, together with related knowledge nuggets, all in a working context. A result of such an "activity management" tool set would be eliminating technical headache and freeing resources for knowledge workers who may solely put efforts on achieving business goals.

At last, the author realizes that CM-WLOD prototyping has just touched the tip of the iceberg regarding the complex issue of context. Thus, the core value of this thesis is to give future researchers practical experiences in their approach to contextually sharing knowledge on-demand and collaborating at the workplace.

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Abbrevations

ADL & ADLNet	Advanced Distributed Learning & Advanced Distributed Learning Network, sponsored by DoD, US Government
AICC	Aviation Industry Computer-based Training (CBT) Committee
ALI	Apple Learning Interchange, multimedia educational resource repository form Apple Inc.
CBT	Computer-based training
CDHK	Chinese German Graduate College in Shanghai, China (German: Chinesisch-Deutsches Hochschulkolleg)
CM-WLOD	Contextual model for workplace learning on-demand, the author's model in this thesis
DCMES	Dublin Core Metadata Element Set
DCMI	Dublin Core Metadata Initiative
DoD	Department of Defence, US Government
ECM	Enterprise Content Management
GCC	Groupware Competence Center, at the University of Paderborn, Germany
IEEE	Institute of Electrical and Electronics Engineers
IEEE LOM	Learning object metadata standard, from IEEE
IMS	Instructional Management Systems, Global Learning Consortium supported by industry
K-nugget	Knowledge nugget, general content element in the author’s content granularization approach
LMS	Learning Managament System
LO	Learning object
LOM	Learning object metadata
LTSC	Learning Technology Standards Committee from IEEE
MERLOT	Multimedia Educational Resource for Learning and Online Teaching, a Learning Resource Repository currently supported by 23 systems and institutional partners of higher education in the United States
MIT OCW	Open Courseware, of the Massachussetts Institute of Technology
RIO & RLO	Reusable information object (RIOs) & reusable learning object (RLO), from Cisco Systems Inc.
SCORM	Sharable Content Object Reference Model, from DoD
WLOD	Workplace learning on-demand
WORC	Wisconsin Online Resource Center

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Ehrenwörtliche Erklärung

Hiermit erkläre ich, dass ich die vorliegende Dissertation selbständig verfasst und nur die angegebenen Quellen und Hilfsmittel benutzt habe. Wörtlich oder inhaltlich übernommene Stellen sind als solche gekennzeichnet.

Die Dissertation ist keine Gemeinschaftsleistung.

Hiermit erkläre ich, dass ich noch an keiner deutschen oder ausländischen Hochschule den Antrag auf ein Promotionsverfahren gestellt habe.

Paderborn, im Juli 2007

Pei Wang-Nastansky