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THE DECOR TOOLBOX FOR WORKFLOW-EMBEDDED ORGANIZATIONAL MEMORY ACCESS

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Abstract: We shortly motivate the idea of business-process oriented knowledge management (BPOKM) and sketch the basic approaches to achieve this goal. Then we describe the DECOR (Delivery of context-sensitive organisational knowledge) project which develops, tests, and consolidates new methods and tools for BPOKM. DECOR builds upon the KnowMore framework (Abecker et al 1998; Abecker et al 2000) for organizational memories (OM), but tries to overcome some limitations of this approach. In the DECOR project, three end-user environments serve as test-beds for validation and iterative improvement of innovative approaches to build:
(1) knowledge archives organised around formal representations of business processes to facilitate navigation and access,
(2) active information delivery services which - in collaboration with a workflow tool to support weakly-structured knowledge-intensive work - offer the user in a context-sensitive manner helpful information from the knowledge archive, and
(3) methods for an organisation analysis from the knowledge perspective, required as supporting methods to design and introduce the former two systems
In this paper, we present the basic modules of the DECOR toolkit and elaborate on their current status of development.

This paper describes the two-years EC-funded RTD project DECOR (Delivery of Context-Sensitive Organisational Knowledge, Grant IST-1999-13002). The DECOR consortium consists of the following partners: German Research Center for Artificial Intelligence DFKI, Kaiserslautern, Germany; Planet ERNST & YOUNG S.A., Athens, Greece; Sema Group Belgium, Brussels, Belgium; DHC Dr. Herterich & Consultants GmbH, Saarbrücken, Germany; IKA Social Security Institute, Athens, Greece; The National Technical University of Athens; Greece.

1. MANAGING KNOWLEDGE AND BUSINESS PROCESSES

Business Process Management (BPM) and Business Process Reengineering (BPR) (Hammer & Champy 1993; Malhotra 1998) have been predominant business trends from the mid eighties til the nineties, and are now evolving from a hype towards "serious tools". In the decade from the mid nineties on, the most "fashionable" trend seems to be Knowledge Management (KM) (Davenport et al 1996; Davenport & Prusak 2000).

Although both topics, BPR and KM, are usually discussed independently, there are important obvious similarities: both aim at similar economic targets, like quality or efficiency improvements; both require a clear organisational take-up and strategic planning at the begin; both need an integrated suite of motivational, organisational and technological tools; technological support for both approaches builds upon comprehensive enterprise models (organizational structure, business processes, information systems structure, …); etc. Both approaches are expensive, difficult and risky. So it makes sense to combine both in order to exploit synergy effects, thus getting "two for one".

Other reasons are, for instance, that BPR is already a well-known term which makes it easier to enter an organization with than with the more "esoteric" KM issue; or the fact that consultants are already familiar with BPR/BPM terminology, methods, and tools which makes it easier to start a KM initiative from this solid ground than totally from scratch. Now the question is what "Business Process Oriented Knowledge Management" (BPOKM) can mean concretely. Basically, promising integration possibilities exist on three levels:

(1) System Design:

Both KM and BPM initiatives start with an elaborated analysis and planning phase. These should be shared between BPM and KM projects. Further, BPM methodology could "drive" (give the rough framework and sequence of activities) for doing the KM specific work.

(2) System Use:

Operationalization of BPM normally means running a workflow tool. Now, if the workflow engine and the KM infrastructure interoperate, this can lead to a higher degree of overall system services. The first three items below show an increasingly closer coupling, and realize increasingly "smarter" information support for the user who solves a knowledge-intensive problem (the context of which is given by the workflow around). The latter two ideas foster filling the knowledge archive and evolving its content during use:

(a) Process-Oriented Knowledge Archive: If business process models are used for organizing knowledge archives, e.g., representing one view in a company or community knowledge portal, they can be used for manual browsing. In particular, it is easy to couple an information system with the actual workflow enactment such that for a given business process activity the respective set of information objects, associated with this activity in the archive index, can be accessed easily. There are several tools in the market realizing this idea (Goesmann & Herrmann 2000; DHC 2001; Fillies et al 2001).

(b) Active Information Delivery: If a workflow engine enacts a business process model, it is possible to attach information need specifications to each activity; then, the workflow system, when starting a specific activity, can automatically pose a query to the knowledge archive according to the attached information need, and proactively offer the results as information support to the user.

(c) Dynamic Process Context: If the approach above is extended in such a way that not only fixed, predefined information needs are attached to business tasks, but information needs are parameterised by variables to be filled by the running workflow instance, an even better, context-specific information retrieval can be performed, which takes into account instance-specific information. This idea has recently been investigated in several research projects (Abecker et al 2000b; Staab & Schnurr 2000). It is the basis of the DECOR approach.

***(d) Contextualized Information Storage*:** If the concrete workflow context of a document being created is known to the KM system at storage time, this creation context (in terms of details of the actual business process instance) can be archived together with the document. This information can be used for a better retrieval in other, similar business situations, or can be used for assessing the quality of the knowledge contained (Who created it? Was the embedding project successful? Is there other important background information related with this process instance? Etc.). This aspect of coupling workflow and KM systems is often neglected, up to now.

(e) Context-Embedded Discussions: If a context-dependent information delivery service actively provides background information for a running business process instance, this can also stimulate discussions about content and quality of the information objects retrieved. According to the reflection-in-action paradigm (Sumner et al 1999), the user should have easy possibilities to make comments, attach discussions, send e-mails to authors or knowledge

managers, etc. if a running activity gives rise to critique some information object.

(3) System Evolution:

In the spirit of continuous process improvement, it should be tried to continuously feed back experience and change requests coming from new insights / requirements or changed environment factors to the process design unit in the organization, thus steadily keeping up-to-date the formalized process models with the best practice about how to enact them. This continuous improvement process is a KM process itself.

For all three integration levels discussed above, it was already sufficient to have a conventional, fixed business process model. However, a deeper analysis of knowledge work (Buckingham Shum 1998) shows that knowledge-intensive processes tend to be characterized by dynamic changes of goals, information environment, and constraints, or by highly individual and ad-hoc communication and collaboration patterns; this makes it difficult to plan in detail the work on a knowledge-intensive task in advance. The easy way to deal with this observation (which preserves all benefits achievable with the KM-workflow integration in the section above) is to model the related business process just quite roughly and embed the knowledge-intensive subtasks in black boxes without further details.

We propose a more fine-grained description in order to achieve more of the usual workflow benefits like process documentation, automated document routing, planning support, etc. To this end, a promising way was shown by (Wargitsch et al 1998): (i) below the level of granularity which can be fixed in advance, compose case specific workflows from archived skeletons or process fragments, (ii) enact and adapt the so-configured workflow at runtime, and (iii) evolve the skeleton repository by reflection-in-action, discussing the pros and cons of certain fragments when using them.

In the DECOR project, we concentrate on the first three items of the list above (regarding the system use phase): process-oriented archive structuring, active knowledge delivery, and dynamic process context. In order to systematically build such solutions in business practice, it is further required to investigate the system design phase.

2. AN OVERVIEW OF DECOR

Starting point is the observation that in a company the organisational knowledge base of explicitly documented knowledge is normally spread out over many different sources of documents, forms, media

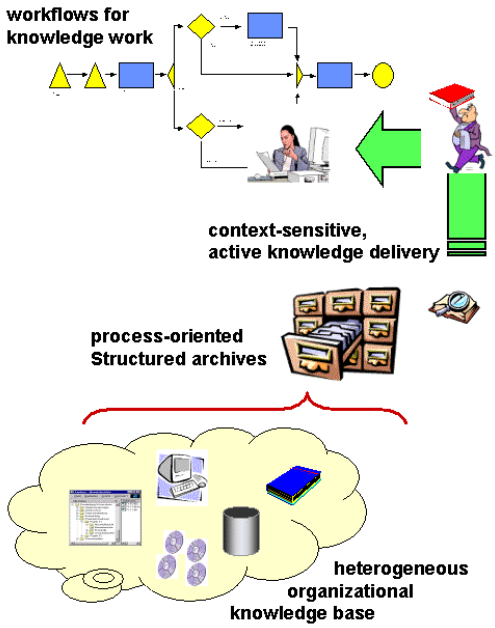

Figure 1: Overall Scenario for Active Knowledge Delivery

etc. Furthermore, links and relationships between documents are usually not represented. ***Ontology-based information systems*** (Benjamins et al 1998; O'Leary 1998) acquire from the community of system users the commonly agreed upon domain structures (concepts and definitions, relationships, constraints, axioms) *logically* organising a certain domain of expertise or area of work. Then, a formal representation of these generally accepted domain knowledge structures, the ontology, is the basis for a homogeneous, concept-based (instead of keyword-based) content description of knowledge sources which can be used for knowledge portals to support manual browsing and for information retrieval algorithms evaluating queries against an archive system. In DECOR we employ formally modelled *business processes* as one such ontology which can be used to specify the *creation*, or the potential *usage context*, or both, for a given knowledge item. This leads to the idea of a ***process-oriented structured archive***, a meta information system providing conceptual structures to access the underlying legacy systems.

On the other hand, users are engaged in their daily work routines; they don't want to spend much time in searching for information or storing expertise. What they would need is an ***active, context-sensitive knowledge delivery*** service which "knows" what the user is actually doing and uses this information for autonomous information management services at the

desktop. To achieve this goal, DECOR employs a workflow management system as the host system which is aware of the specific tasks to be performed by each user at a given point in time. We consider *weakly-structured workflow models for representing knowledge-intensive work routines* which are usually not so strict and predetermined as, e.g., administrative workflows. *Enriched workflow models* describe information flow between and information needs for specific tasks. An ***information assistant*** observes the running workflow and interprets modelled information needs to offer active support from the process-oriented structured archive; further it maintains a notion of information *retrieval context* using the additionally modelled information flow variables which allows for more precise queries to the archive. Task context can also be used for information storage to describe the creation context of a given knowledge item.

Altogether, existing knowledge sources are used and extended in a more efficient and more consistent way throughout the company. Figure 1 illustrates the several system parts playing together at system usage time.

However, the above scenario is based upon a number of non-trivial (and not so cheap) organisation analysis and modelling steps. (1) Business process maps and other domain ontologies for knowledge organisation and content description, (2) weakly-structured workflows for knowledge-intensive business processes, and (3) information flow and information needs for workflow enrichment, must be acquired and maintained over time. The overall approach must be introduced in a company in the larger context of a comprehensive Knowledge Management (KM) or Business Process Management (BPM) initiative. All required steps should be carried out by "normal consultants" in a "normal organisation" at reasonable costs and with a predictable result. Recapitulating, we need a structured approach for running Business-Process Oriented KM projects which supports all necessary project steps with appropriate methodological guidance and modelling tools.

3. THE DECOR TOOLBOX

Figure 2 below shows the modules of the DECOR toolbox which support design and implementation of a system which can then be used as described in the previous section.

We discuss the several complementing modules in some more detail:

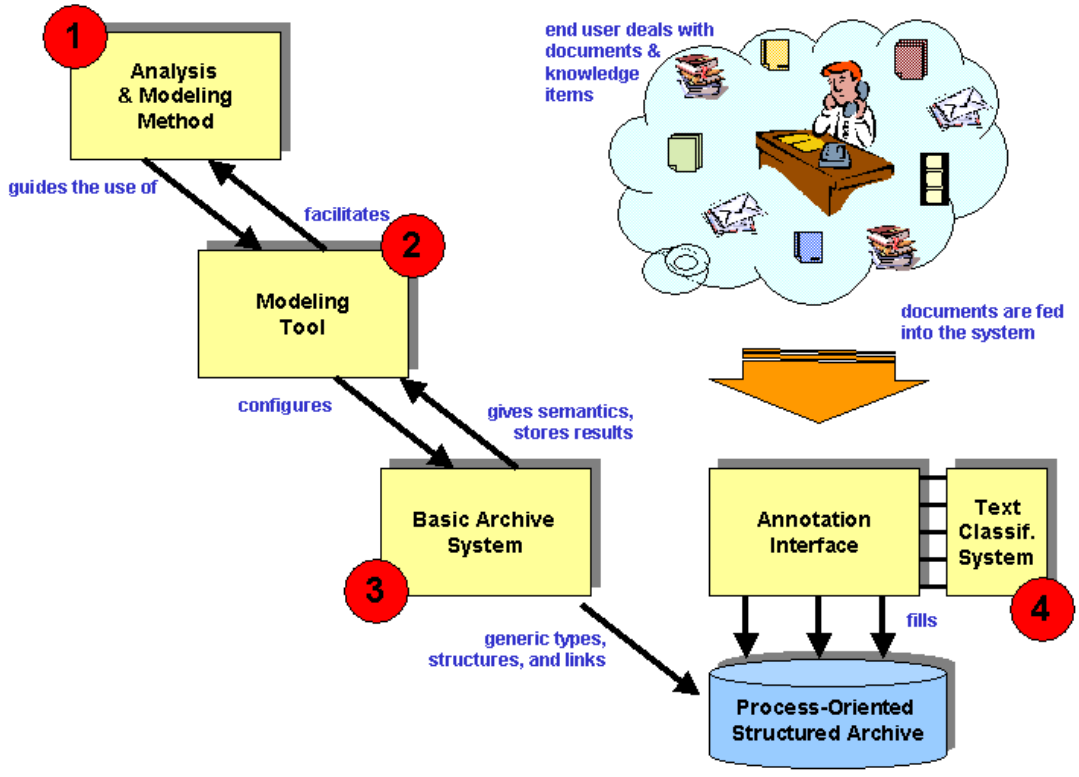

Figure 2: DECOR Modules for System Building

(1) DECOR Business Knowledge Method

DECOR's Business Knowledge Method provides a methodological approach for running BPOKM projects. Its main elements include:

- Identification of knowledge-intensive processes
- Process analysis
- Domain ontology construction
- Analysis of task-specific knowledge needs
- Dealing with weak workflow structures

The current draft comprises process analysis and domain ontology construction. It amalgamates elements taken from CommonKADS (Akkermans et al 1999; Schreiber et al 1999) and IDEF5[1]. Figure 3 sketches the relationships of the first three analysis steps. The draft method has already been tested in our three case studies and is subject to further improvements.

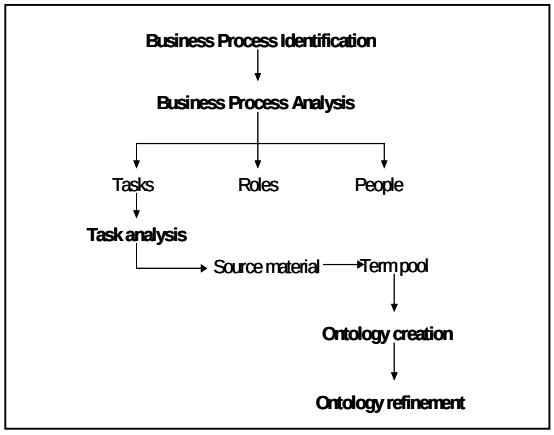

Figure 3: Business Knowledge Method: From Process Analysis to Ontology Design

(2) Business Knowledge Modeling Tool

The DECOR Modeling Tool will support in an integrated manner all modeling activities related to the method described above: (weakly-structured) processes, task-specific information needs, domain knowledge structures/ontologies, process specific context variables etc. In contrast to many existing ontology modeling tools, it shall primarily address users without a specific AI (Artificial Intelligence) background. It will be oriented towards existing BPM tools (like ARIS™ or ADONIS™) and build upon widespread ontology modeling formalisms (like topic maps or the IDEF graphical modeling primitives). The DECOR Modeling Tool is currently under development. It is being realized as a set of related modeling methods for the commercial Microsoft VISIO® 2000 visualization tool. This ensures a wide usability of the software basis and a good familiarity of non-expert users with the overall look-and-feel. The VISIO® interface actions will be coupled by a dynamic link to the DECOR Basic Archive System (see below). So, modeling activities at the user interface directly lead to the respective effects in the configuration of the underlying knowledge networks: new concepts or links are inserted in the ontologies, business process models are extended, or indexing concepts added to document models. This dynamic link to the Basic Archive System allows to equip the graphical modeling interface with a semantic foundation: e.g., only reasonable links are possible, links which do not respect the value restrictions of the represented relationship can directly be rejected. A first demonstrator of this dynamic link between VISIO® and the DHC CognoVision® tool (the software basis for the DECOR Basic Archive System) has already been implemented by DHC. Besides the possibility of directly storing modeling results in CognoVision®, an ASCII based interface for information exchange with third-party tools will be provided based upon upcoming ontology representation standardisation approaches like OIL.

(3) Basic Archive System

The Basic Archive System stores knowledge items (documents and links to documents or tacit knowledge) plus metadata and links between knowledge items. Metadata are represented in terms of underlying ontologies designed with DECOR modules (1) and (2). Business process models are one of many possible structuring criteria. Manual navigation in hierarchical indices extracted from index ontologies is allowed, as well as querying the archive by XML retrieval messages which combine retrieval constraints formulated over links and metadata. Software basis for the DECOR Basic Archive System is the CognoVision® product offered by DHC GmbH (Müller & Herterich 2001). CognoVision® allows to represent arbitrary knowledge networks built from attributed objects (structure elements) and attributed links, and to link information objects to structuring elements. Information objects encapsulate (i) logical content entitities like the set of all documents with the same content, but in a different language, and (ii) the related metadata. These powerful mechanisms allow to express arbitrary indexing ontologies and the related document models plus the link to the original (multimedia) documents.

[1] See http://www.idef.com/

(4) Annotation Interface

In order to fill the archive system, we need a software for easily attaching semantic categories (in terms of modeled ontologies) to knowledge items, or, in terms of CognoVision®, link information objects to structuring elements. In this way, documents are fed into the process-oriented structured archives and indexed, and the required links are established. This DECOR module is still to be designed. Since indexing is a well-known bottleneck for ontology-based KM systems (indeed, for all document management systems), we are building a generic interface of the annotation tool to an automatic text classification software. Currently we test two such classification systems, the learning text classification workbench (TCW) developed at DFKI (Junker 2000), and the MindAccess® API provided by insiders information management GmbH. MindAccess® is an extensible multiple-paradigm tool which employs a number of state-of-the-art algorithms.

So far, we characterised the DECOR modules required for designing and installing a process-oriented structured archive and for filling it with annotated knowledge items. Returning to Section 2 (which discussed the system behaviour at runtime dealing with operative business processes, Figure 1), we can add the following DECOR solution modules:

(5) Weakly-structured workflow tool

The DECOR Weakly-Structured Workflow (WWF) Support provides modeling support and enactment machinery for flexible and adaptive workflow. In (Schwarz et al 2001) we analyzed requirements for such a workflow support coming from the characteristics of knowledge intensive work (see Figure 4, cp. (Davenport et al 1996)). We described a prototype with the following properties:

- A process archive contains process templates which later are converted to process models
- Task specifications and process logic are defined separately
- Task specifications are hierarchically decomposed into sub-tasks
- Sub-tasks may contain "black boxes"
- Black boxes may be defined at runtime (late modeling)
- MS Visio® 2000 integrated with CognoVision® as the basis for process modeling

Although there exist already prototypical implementations of specific parts, the DECOR WWF support is still in its design phase. Important features are the interfaces to retrieval agents and structured archive. The feasibility of the basic idea has been shown in the KnowMore project (Abecker et al 2000; Abecker et al 2000b). Strong requirements from our three DECOR case studies are the seemless embedding of a conventional strong-structure workflow approach as a proper subset and a comfortable system interface usable by "normal end users".

(6) Context-aware knowledge agents

The purpose of the DECOR Context-aware Knowledge Agents is to co-operate with workflow engine and modeled information needs, thus proactively offering information from the process-oriented structured archive to the user in charge of a certain task. The feasibility of the principal idea has also been shown in KnowMore. Implementation details in DECOR have to be clarified, the implementation will presumably be based upon a FIPA[2] compliant software agent platform like JADE[3].

- Unique and of low volume
- Variability in performance across individuals and time
- No strong sequential order
- Frequent exceptions and changes
- Uncertainty in inputs and outputs
- Unstructured work rules and routines
- Involves personal judgement and experience

Figure 4: Knowledge-intensive Work

4. RELATED WORK AND PROJECT STATUS

The main distinctive feature of the DECOR project is the idea of a ***total solution*** to context-aware, workflow-embedded information retrieval for knowledge-intensive tasks. So, the main advantage above research prototypes like KnowMore or work at AIFB (Staab & Schnurr 2000) which were mainly concentrated on intelligent techniques in the centre of information retrieval, ontology-based document representation, or context representation, is the completion of this technology-focussed scenario by appropriate analysis methods, modeling support, and

[2] http://www.fipa.org

[3] http://sharon.cselt.it/projects/jade

introduction and maintenance advice. The description of the overall system design and the play-together of different toolkit elements was the main concern of this paper.

Another project focus is the ***technological consolidation*** of research ideas using (de facto) standards (FIPA, RDF/S, Topic Maps, CommonKADS, IDEF), commercial software (CognoVision®) and widespread tools (Visio®, JADE) wherever possible in the scenario.

Regarding the several individual elements of the overall framework, the statements about the status of our work (product, demonstrator, design phase) differ considerably and are also discussed above in the respective parts. The related work for several modules is quite different, too.

The idea of ***knowledge-oriented organization analysis*** is not fundamentally new, so our method is deeply grounded in existing work. However most existing approaches (cp., e.g. (Goesmann & Herrmann 2000; Mertins et al 2000)) do not lead to such far-reaching technical innovations as our project. The idea of BPOKM is also a main topic of the EU project PROMOTE (Karagiannis & Telesko 2000) which has similar analysis goals and methods, but relies on a conventional strongly-structured workflow paradigm.

The idea of ***context-aware information retrieval*** is sometimes interpreted in a not workflow-related way: Often, highly knowledge-intensive processes are not formally modeled because they are too complex or because they are too much ad-hoc. *Attentive systems*, e.g. personal information agents like WATSON (Budzik & Hammond 2000), try to detect the task a user is actually performing, and use this knowledge to retrieve context-oriented information. In this way, in contrast to our process-embedded scenario, only the *local work context* can be obtained (e.g., the application a user utilizes). Thus, relevant knowledge from preceding tasks is hardly available to better specify the information need. In the long-term, a combination of both interpretations of work context could be promising. The EU project CoMMA (Perez et al 2000) comes very close to our scenario in many points. However, they focus more on matters of individual user profiles. (Klemke 2000; Elst & Abecker 2001) show the way to a comprehensive context modeling as a unifying view for all these approaches.

The requirements for ***weakly-structured workflow*** systems to support knowledge-intensive work, are seldom discussed in the literature. However, (Macintosh 1999) comes to similar results as DECOR. Interestingly, (Lenk & Traunmüller 2000) recently identified very similar characteristics as typical for many business processes in the new area of “electronic government”.

Concerning the ***basic archive system***, the CognoVision® tool is at least as powerful as technologically similar competitors. However, the integration of a method-supported modeling tool and an automatic classification facility seems unique.

Currently, the described method and software modules are under development as described. The DECOR work is organised around the development of three pilot systems in the medical and social security sector:

One pilot is being installed at IKA, the Greek Social Security Institute. The system supports the process of granting full old age pension to insured people which - as part of a normal administrative workflow - contains few central, knowledge and document intensive steps for finding a decision. These steps must be legally checkable, they are often done with uncertainty, are influenced by many legal regulations, and they are central for the correct result of the process. The DECOR pilot will improve a consistent, high quality of service for these decision steps.

One pilot is placed at the interface between a most important Brussels hospital and CPAS, the body of each city that has to deal with people who are in social, financial, … trouble. In the workflow of accomplishing the patient file and sending administrative and accounting data to CPAS, there are often delays and wrong decisions made due to missing information, knowledge and experience (which is available in other steps of the process) which leads to heavy financial losses.

One pilot is being built for a subsidiary of the German Red Cross, which deals with the acquisition, transport, storage, and processing of blood and blood plasma donors. In this highly sensitive application area, all software systems employed, and in particular the company's SAP R/3 installation must be validated according to national and international laws and regulations. The process of making changes to this SAP R/3 system while keeping the validation status is document and knowledge-intensive and will be supported by our pilot system.

Altogether, the DECOR project develops (and continuously tests in the three pilot sites) a practice-driven, total solution for business-process oriented knowledge management. Long-term goals for extending the scenario concern context-enriched *storage* of documents, and evolution of process knowledge as a knowledge management process intertwined with workflow execution.

REFERENCES

Abecker, A., et al, 1998, 'Towards a Technology for Organizational Memories', IEEE Intelligent Systems, 13(3), May/June.

Abecker, A., et al, 2000, 'Context-Aware, Proactive Delivery of Task-Specific Knowledge: The KnowMore Project', *Int. Journal on Information System Frontiers, Kluwer, 2(3/4).*

Abecker, A., et al, 2000b, 'Information Supply for Business Processes – Coupling Workflow With Document Analysis and Information Retrieval', *Knowledge-Based Systems, Elsevier, 13(5): 271-284*.

Akkermans, H., et al, 1999, 'Hot Issues and Cool Solutions in Knowledge Management: An Industrial Case Study', *KAW'99, Banff, Canada*.

Benjamins, V.R.,et al, 1998, 'Knowledge Management Through Ontologies', *PAKM-98, Basel, Switzerland*.

Buckingham Shum, S., 1998, 'Negotiating the Construction of Organisational Memories, In Borghoff, U.M. and R. Pareschi, R., eds., *Information Technology for Knowledge Management*. Berlin, Heidelberg, New York: Springer-Verlag, pp. 55-78.

Budzik, J. and Hammond, K.J., 2000, 'User Interactions with Everyday Applications as Context for Just-in-time Information Access', *Proc. Intelligent User Interfaces 2000. ACM.*

Davenport, Th., et al, 1996, 'Improving Knowledge Work Processes', *Sloan Management Review, Reprint Series, 37(4), Summer*.

Davenport, T.H. and Prusak, L., 2000, *Working Knowledge*, Harvard Business School Press.

Elst, L. v. and Abecker, A., 2001, *Integrating Task, Role, and User Profiles for Context-Specific Information Delivery in Organizational Memories*. Draft under evaluation.

Fillies, C. et al, 2001, 'Prozessmodellierungswerkzeuge und das Semantic Web', *In (Müller et al 2001).* In German.

Goesmann, T., and Herrmann, Th., 2000, 'Wissensmanagement und Geschäftsprozeßunterstützung am Beispiel des Workflow Memory Information System WoMIS'. *In Herrmann, Th., et al, eds, Verbesserung von Geschäftsprozessen mit flexiblen Workflow-Management-Systemen, Band 4*, Heidelberg: Physica-Verlag. In German.

Hammer, M., and Champy, J.,. 1993, *Reengineering the Corporation: A Manifesto for Business Revolution*, New York: HarperBusiness.

Junker, M., 2000, Heuristisches Lernen von Regeln für die Textkategorisierung, Dissertation, Fachbereich Informatik. Universität Kaiserslautern. In German.

Karagiannis, D., and Telesko, R., 2000, 'The EU-Project PROMOTE: A Process-Oriented Approach for Knowledge Management', *In Reimer, U., ed, PAKM 2000, Third Int. Conf. on Practical Aspects of Knowledge Management*

Klemke, R., 2000, 'Context Framework - an Open Approach to Enhance Organisational Memory Systems with Context Modelling Techniques', *In Reimer, U., ed, PAKM 2000, Third Int. Conf. on Practical Aspects of Knowledge Management*

Lenk, K., and Traunmüller, R., 2000, 'Perspectives on Electronic Government', IFIP WG 8.5 *Conference on „Advances in Electronic Government", Zaragoza*.

Macintosh, A., 1999, *Adaptive Workflow to Support Knowledge Intensive Tasks*, Working Paper, Artificial Intelligence Applications Institute (AIAI), Edinburgh, Scotland.

Malhotra, Y., 1998, 'Business Process Redesign: An Overview', *IEEE Engineering Management Review, 26(3).*

Müller, H.-J., et al, eds, 2001, *WM`2001-Workshop „Geschäftsprozeßorientiertes Wissensmanagement", Baden-Baden*.

Müller, St. and Herterich, R., 2001, 'Prozessorientiertes Wissensmanagement mit CognoVision', *In (Müller et al 2001).* In German.

Mertins, K., et al, 2000, *Knowledge Management: Best Practices in Europe*, Berlin, Heidelberg: Springer-Verlag.

O`Leary, D., 1998, 'Using AI in Knowledge Management: Knowledge Bases and Ontologies', *IEEE Intelligent Systems, May/June, pages 34 - 39.*

Perez, Ph., et al, 2000, 'Corporate Memory Management through Agents', *The eBusiness and eWork Conference, Madrid.*

Schreiber, G., et al, 1999, *Knowledge Engineering and Management: The CommonKADS Methodology.*, MIT Press.

Schwarz, S., et al, 2001, 'Anforderungen an die Workflow-Unterstützung für wissensintensive Geschäftsprozesse', *In (Müller et al 2001).* In German.

Staab, S., and Schnurr, H.-P., 2000, 'Smart Task Support Through Proactive Access to Organizational Memory', *Knowledge-Based Systems, Elsevier, 13(5), pp. 251-260*.

Sumner, T., et al, 1999, 'Moving from On-the-Job Training towards Organisational Learning', *12th Banff Knowledge Acquisition Workshop.*

Wargitsch, C., et al, 1998, 'An Organizational-Memory-Based Approach for an Evolutionary Workflow Management System – Concepts and Implementation', *HICCS`31, Vol. 1, pp. 174-183.*