Business-Process Oriented Delivery of Knowledge through Domain Ontologies

Andreas Abecker[1], Gregoris Mentzas[2], Maria Legal[3], Spyridon Ntioudis[2],Giorgos Papavassiliou[2]

[1] *German Research Center for Artificial Intelligence (DFKI), P.O. Box 2080, D-67608, Kaiserslautern, Germany, Tel: +49631-2053470; Fax: +49631-2053210*
E-mail: aabecker@dfki.de

[2] *Department of Electrical and Computer Engineering,National Technical University of Athens, 9, Iroon Politexniou Str., 15780 Zografou, Greece, Tel: +301-7723895; Fax: +301-7723550*
E-mail: dioudis@softlab.ece.ntua.gr

[3] *PLANET ERNST & YOUNG, Apollon Tower, 64 Louise Riencourt Str., 11523 Athens, Greece*
E-mail: mlegal@planetey.com

Abstract

We shortly motivate the idea of possible IT support business-process oriented knowledge management (BPOKM) and sketch some basic approaches to achieve this goal. Then we describe the DECOR (Delivery of context-sensitive organisational knowledge) project, which develops, tests, and consolidates methods and tools for BPOKM. In the DECOR project, three end-user environments serve as test-beds for validation and iterative improvement of innovative approaches to build: (i) knowledge archives organised around formal representations of business processes to facilitate navigation and access, (ii) active information delivery services which offer the user in a context-sensitive manner helpful information from the knowledge archive, and (iii) methods for an organisation analysis from the knowledge perspective, required as supporting methods to design and introduce the former two systems
Finally we present the basic modules of the DECOR toolkit .

1. Motivation: Business-Process Oriented Knowledge Management

Business Process Management (BPM) and Business Process Reengineering (BPR) [15,23] have been predominant business trends from the mid eighties until the nineties, and are now becoming "serious tools" instead of a hype; in the decade from the mid nineties on, the most "fashionable" trend seems to be Knowledge Management (KM) [8,9].

Although both topics are usually discussed independently, there are important obvious similarities: both KM and BPR aim at similar economic targets like quality or efficiency improvements; both initiatives require a clear organisational take-up and strategic planning at the begin; KM as well as BPR requires 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 the two approaches 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 organisation than the "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) shall mean concretely. Basically, one can find promising integration possibilities on three levels:

- **System Design:**
Both KM and BPM initiatives require an elaborated Analysis, Planning, and Introduction 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. Contributions to this idea are made, e.g. by [19,24,27].

- **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 quality 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:

  - **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 new tools in the market realizing this idea [10,12,14]

  - **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 this attached information need, and proactively offer the results as information support to the user.

  - **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 approach has recently been investigated in several research projects [3,29]. It is the basis of the DECOR approach.

- **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.

- **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 [30], 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.

- **System Evolution:**
In the sense 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 (cp. [31]).
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 [6,8] shows that knowledge-intensive processes tend to be characterized by dynamic changes of goals, information environment, and constraints, also 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 most benefits of 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 [31]: (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.

In this paper, we present the whole scope of the DECOR services envisioned (section 2) and discuss the (method and tool) modules required to plan, model, install, and run such services (section 3).

2. Short Overview of the DECOR Approach

Our starting point is the observation that in a company the explicit knowledge (documents, databases, intranet) is normally spread over many different sources of documents, forms, media etc. Furthermore, links and relationships between documents are often not represented. *Ontology-based information systems* [5,25] 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. Having such an archive organized around ontological structures, the ontologies can be used to design knowledge portals for manual browsing, or the can be used by information retrieval algorithms evaluating queries [32,33]. 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 exploits this information for autonomous information management services at the desktop. To achieve this goal, DECOR employs a workflow management system as the host, which is aware of the specific tasks to be performed by the 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. 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 or Business Process

Management 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.
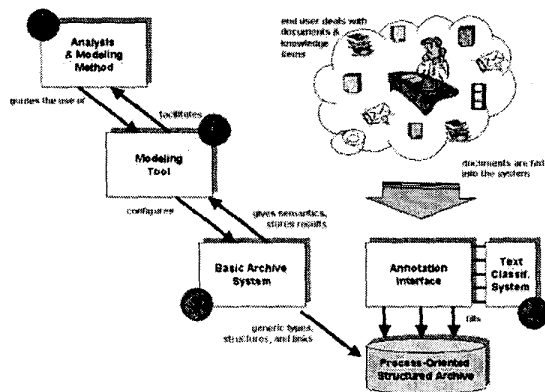

Figure 1: DECOR Modules Used at System Build Time

3. The DECOR Toolbox

Figure 1 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.

Module 1: DECOR Business Knowledge Method
The DECOR Business Knowledge Method provides a methodological approach for systematically running projects for business-process oriented knowledge management. It comprises of the following five steps:

- **Step 1: Business Process Identification.**
  This activity involves the identification of the most appropriate business process/-es to be used as the central point for the development of the ontology. The selection of the most appropriate business process or processes can be based on the following two criteria: (i) *Knowledge intensity* (Scale: strong-weak), (ii) *Process complexity* (Scale: high-low). The *knowledge intensity* can be determined based on attributes such as contingency, decision scope, agent innovation, agent impact, learning time and knowledge half-time. Regarding *process complexity* the relevant

attributes include process steps, involved agents, interdependency between agents and process steps, and process dynamics. Agents are persons and/or software programs which process knowledge. The business processes with high process complexity and stronger knowledge intensity are those that should be considered to be of higher importance.

- **Step 2: Business Process Description.**
  This activity involves a general description of the selected business process/-es in terms of (a) tasks consisting the business process; (b) roles involved; and (c) key people and source material. This step is necessary in order to establish a comprehensive description of the specific business process. This analysis contributes to a better understanding of the process, identifying the tasks, the roles and the people involved in it.

- **Step 3: Task Analysis.**
  This activity involves a more detailed description of the individual tasks including their input and output objects, the source material handled within or delivered by the task, the roles performing the task and so on.

- **Step 4: Ontology Creation.**
  This activity involves the development of a preliminary ontology taking into account the analysis made during the preceding steps. Each piece of collected data must be traceable back to its source. Therefore we suggest the use of four important support documents to facilitate source data traceability: 1) Source Material Index, 2) Source Material Description Form, 3) Term Pool, and 4) Term Description Form. Finally, the source material is analysed to construct an initial ("first pass") characterization of the ontology.

- **Step 5: Ontology Refinement.**
  This activity involves the refinement and validation of the ontology, in order for the development process to be completed. During this step, the ontology structures are "instantiated" (tested) with actual data, and the result of the instantiation is compared with the ontology structure. If the comparison produces any mismatch, every such mismatch must be adequately resolved. Refinements (if any) to the initial ontology are incorporated to obtain a validated ontology.
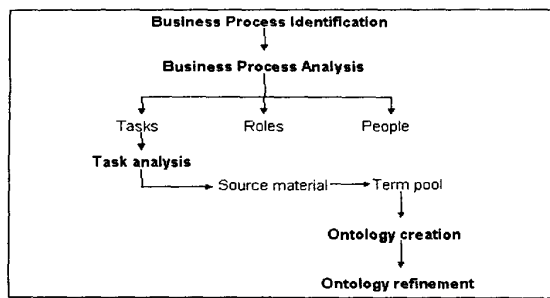
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Figure 2: Overview of Ontology Development Method

Figure 2 depicts the five steps of the Decor Ontology Development Method. The currently available first draft comprises process analysis and domain ontology construction. It amalgamates elements from the CommonKADS [4,27] and the IDEF5 [16] methods. The draft method has already been tested in three industrial case studies.

Module 2: Business Knowledge Modelling Tool

The DECOR Modelling Tool will support in an integrated manner all modelling activities related to the method described above: (weakly-structured) processes, task-specific information needs, domain knowledge structures, process specific context variables. In contrast to existing ontology modelling tools, it shall primarily address users without a specific AI (Artificial Intelligence) background. It shall be oriented towards existing BPM tools (like ARIS™ or ADONIS™) and built upon a widespread ontology modelling formalism (like the IDEF graphical modelling primitives). The DECOR Modelling Tool is currently under development.

Module 3: Basic Archive System

The Basic Archive System stores knowledge items plus metadata and links between knowledge items. Knowledge items are documents (or links to documents), or links to tacit knowledge (concretely, e.g., a homepage for each employee in a yellow page system as a summary of his skills and experience). Metadata are represented in terms of underlying ontologies designed with modules (1) and (2). Software basis for the DECOR Basic Archive System is the CognoVision® product offered by DHC [20].

Module 4: Annotation Interface

In order to fill our archive system, we need a software tool for easily attaching semantic categories (in terms of modelled ontologies) to knowledge items in order to feed them into the process-oriented structured

archives, index them, and establish the required links. 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 will design 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 [18], and the MindAccess® SDK provided by insiders information management GmbH [34].

Module 5: Weakly-structured workflow tool

The DECOR Weakly-Structured Workflow (WWF) support shall provide modelling support and enactment machinery for flexible and adaptive workflow. In [28] we analysed requirements for such a workflow support and described a prototype. 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 allow for interoperability with knowledge retrieval agents and structured archive. The feasibility of this basic idea has already been shown in other projects [2,3]. Strong requirements from our three DECOR case studies are the seamless embedding of a conventional strong-structure workflow approach as a proper subset and a comfortable system interface usable by a "normal end user".

Module 6: Context-aware knowledge agents

The purpose of the DECOR Context-aware Knowledge Agents is to co-operate with workflow engine and modelled 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 [13] compliant software agent platform like JADE [17].

References

Due to space limitations references are not included in the paper but can be made available by e-mail request to Spyridon Ntioudis (dioudis@softlab.ece.ntua.gr)