Workflow-Embedded Organizational Memory Access: The DECOR Project

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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 organizational knowledge) project which develops, tests, and consolidates methods and tools for BPOKM. DECOR builds upon the KnowMore framework [1,2] 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:

- knowledge archives organized around formal representations of business processes to facilitate navigation and access,
- active information delivery services which—collaborating with a workflow tool for supporting weakly-structured knowledge-intensive work—offer the user in a context-sensitive manner helpful information from the knowledge archive, and
- methods for an organization 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.

Keywords: organizational memory, ontology, workflow

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 im-

provements; both initiatives require a clear organizational take-up and strategic planning at the beginning; KM as well as BPR requires an integrated suite of motivational, organizational 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 organization 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:

1. **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].
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 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 easily accessed. 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.
3. **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) be-

low 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). Then we discuss the (method and tool) modules required to plan, model, install, and run such services (section 3). Finally (section 4) we conclude with some remarks about the status of our work and related projects.

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 organizing 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.

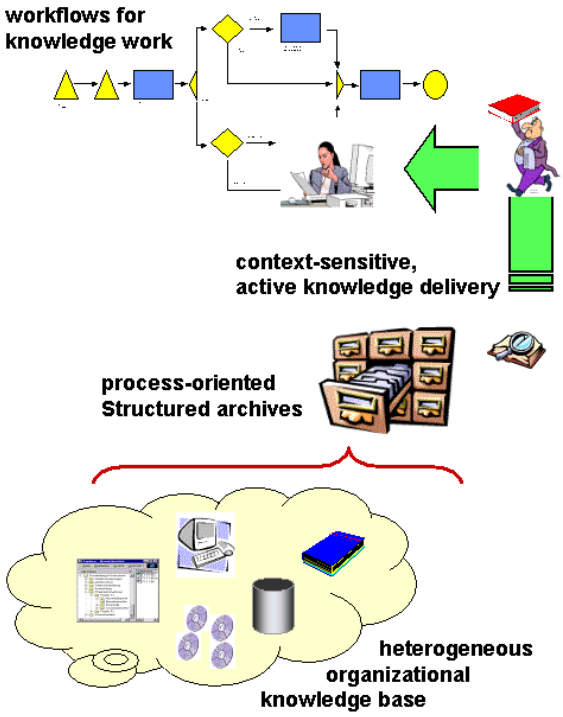

Figure 1: DECOR Overall Scenario—Active Knowledge Delivery at Workflow Runtime

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) organization analysis and modeling steps. (1) Business process maps and other domain ontologies for knowledge organization 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 organization", 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 modeling tools.

3 The DECOR Toolbox for Workflow-Embedded Organizational Memory Access

Figure 2 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. Its main elements include:

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

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. Figure 3 gives a rough idea of the relationships of the different parts of the method. The draft method has already been tested in three industrial case studies. Further details go beyond the scope of this paper.

Module 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, process specific context variables. In contrast to existing ontology modeling 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 modeling formalism (like 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 graphical modeling tool. This ensures a wide usability of the software basis and a good familiarity of non-expert end 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, etc. 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, one of the DECOR project partners [10]. Besides the possibility of directly storing modeling results in CognoVision®, an ASCII based interface for information exchange with third-party tools will be provided, e.g., based upon upcoming ontology representation standardisation approaches such as RDF/Schema or OIL.

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). Business process models are some of many possible ontologies providing archive structuring criteria. The basic archive system can be accessed via XML retrieval messages which combine retrieval constraints formulated over links and metadata. Another access path is manual navigation in hierarchical indices which can be extracted from the index ontologies. Software basis for the DECOR Basic Archive System is the CognoVision® product offered by DHC [20]. CognoVision® allows to represent arbitrary knowledge networks built from attributed objects (structure elements) and attributed links. Information objects are attached to structure elements such that navigation through the network of linked structure elements leads to concrete documents stored in information objects. In detail, information objects encapsulate (i) logical content entitities like the set of all documents with the same content, but in a different language, plus (ii) the respective metadata (author, version, language, etc. Metadata attributes can be freely defined for each type of information object). These powerful mechanisms allow to express arbitrary indexing ontologies and the related document models plus the link to the original (multimedia) document.

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]. MindAccess® is an exten-

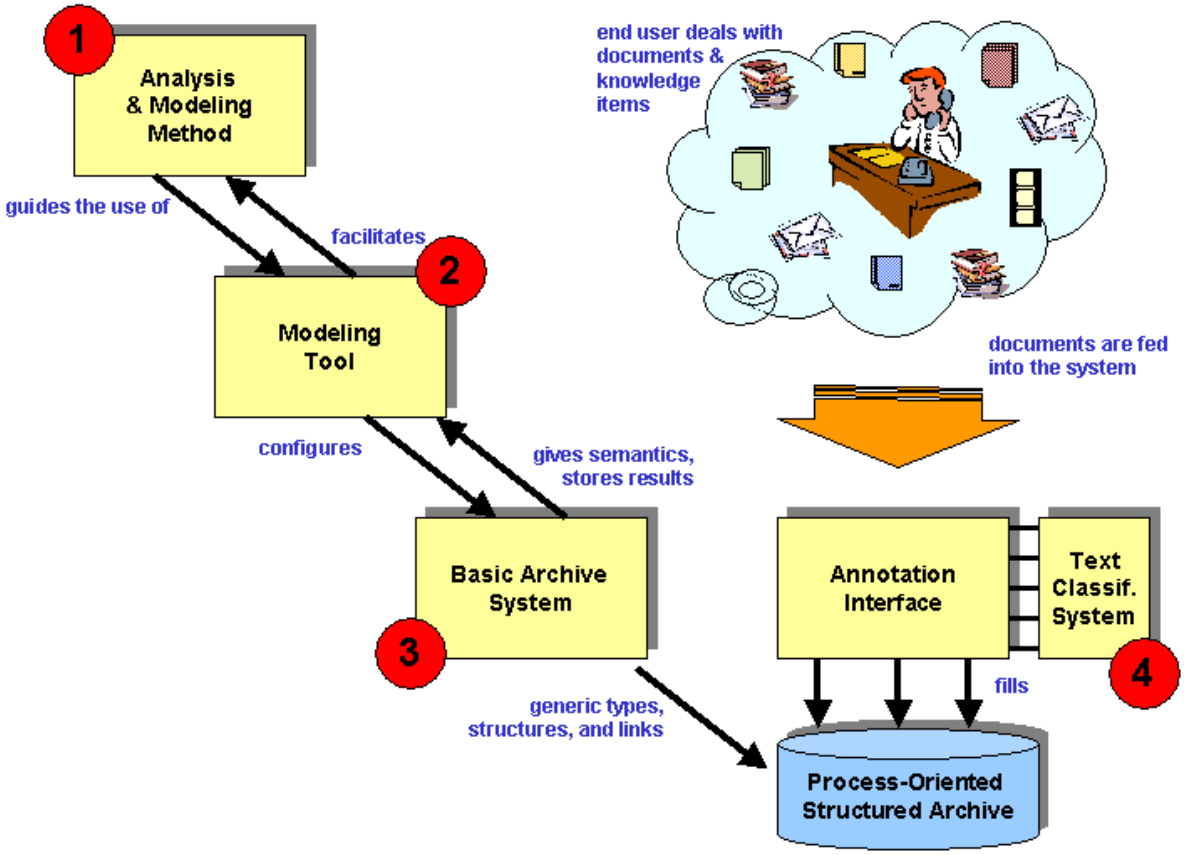

Figure 2: DECOR Modules Used at System Build Time

sible multi-paradigm tool which employs a number of state-of-the-art algorithms.

So far, we characterized the DECOR modules required for designing and installing a process-oriented structured archive and for filling it with annotated knowledge items. Now remember Section 2 which discussed the system behaviour at runtime, dealing with operative business processes (Figure 1). In order to realize the services described there, we need the following DECOR solution modules 5 & 6:

Module 5: Weakly-Structured Workflow Tool

The DECOR Weakly-Structured Workflow (WWF) support shall provide modeling support and enactment machinery for flexible and adaptive workflow. Characterizing knowledge intensive work the following properties can be identified(cp. [8]):

- 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

We analyzed requirements for adequate workflow support for knowledge intensive work and described a prototype with the following properties [28]:

- A process archive contains process templates which later are converted to process models
- Task specifications (arranged in a task ontology) and process logic are defined separately
- Task specifications are hierarchically decomposed into sub-tasks
- Sub-tasks may contain “black boxes”
- Black boxes may be refined at runtime (late modeling)
- MS Visio$^{(R)}$ 2000 is integrated with CognoVision$^{(R)}$ 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 allow for interoperability with knowledge retrieval agents and structured archive. The feasibility of this basic idea has already been

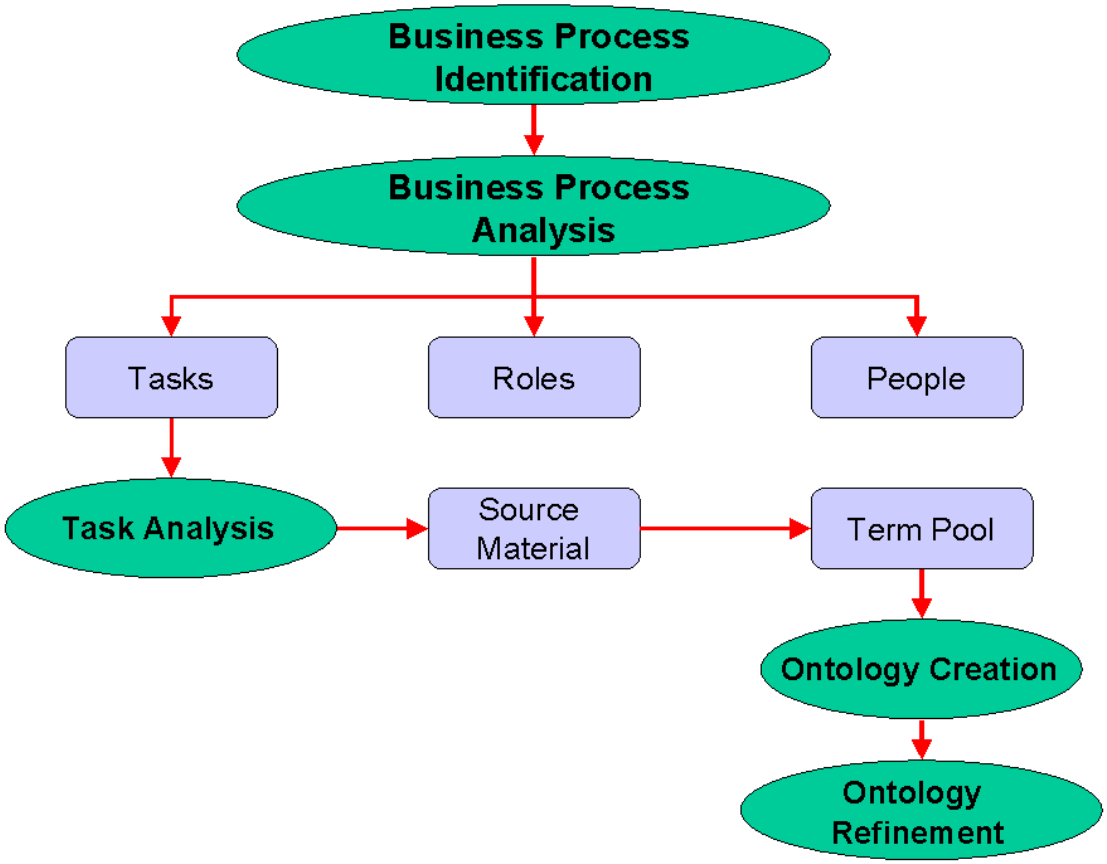

Figure 3: Overview of Ontology Development Method

shown in other projects [2,3]. 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 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].

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 [29] 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-focused scenario by appropriate analysis methods, modeling support, and introduction and maintenance advice. This description of the overall system design and the play-together of different toolkit elements was the main concern with this paper.

Another focus of DECOR is the *technological consolidation* of academic research results using (de facto) standards (like FIPA, RDF/S, Topic Maps, CommonKADS, IDEF), commercial software (CognoVision$^{(R)}$) and widespread tools (Visio$^{(R)}$, JADE) wherever possible in the scenario.

Regarding the several modules of the overall framework, the status of our work (product, demonstrator, design phase) differs considerably (see above). Similarly, the related work for several modules is quite heterogeneous.

The idea of *knowledge-oriented organization analysis* is not fundamentally new, so our method is grounded in existing work. However most existing approaches (cp., e.g. [14,24]) do not lead to such far-reaching IT innovations as our project. The idea of BPOKM is also a main topic of the EU project PROMOTE [19] which has similar analysis goals and methods, but relies on a conventional strongly-structured workflow paradigm. Other ongoing work in our direction can be found in [35,36]. Concerning ontology editors and ontology-

based document annotation interfaces, there are also several ongoing efforts [37,38], but few commercially mature results up to now. Further, we consider the deep integration of method and tool and the grounding on widespread technology as crucial for practical solutions.

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 [7], try to detect the task a user is actually performing, and use this knowledge to retrieve context-oriented information. In contrast to our process-embedded scenario, only the local work context can be obtained in this way (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 [26] comes very close in many points to our scenario. However, they focus more on matters of individual user profiles. [11,20] 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, [22] comes to similar results as DECOR. Interestingly, [21] identify very similar characteristics as typical for many business processes in the new area of "electronic government".

Concerning the *basic archive system*, the CognoVision$^{(R)}$ tool is at least as powerful as technologically similar competitors, however the integration of a method-supported modeling tool and a powerful automatic classification facility seems unique to our knowledge.

Currently, the described method and software modules are under development as described. Further, the DECOR work is organized 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 will support 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 under 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 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 the storage of documents enriched with their creation context, and the evolution of process knowledge as a knowledge management process intertwined with workflow execution.

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