# Developing a Knowledge Management Technology
## An Encompassing View on KnowMore, Know-Net, and Enrich

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## Abstract

*In this short position paper, we sketch three ongoing projects (KnowMore, ENRICH, and Know-Net) currently running in the Knowledge Management Group of DFKI investigating requirements and approaches to support Knowledge Management (KM) infrastructures for organizations. We also list some promising research issues to be tackled in the near future to come from individually designed KM prototypes towards a rich, modular KM middleware as a solid basis for engineering Intranet-based KM solutions.*

## 1. Introduction

Knowledge has been recognized as an important productivity factor besides labor, capital, and land. Nevertheless, it remains an often neglected asset; it is stored in individual brains or implicitly encoded and hidden in organizational processes, documents, services, and systems. To protect intellectual assets from decay, and to seek opportunities for enhancing decisions, products or services, Knowledge Management (KM) as a discipline of its own right recently gained enormous interest in business and organizational sciences. KM is concerned with the entire process of discovery, acquisition, creation, dissemination, and utilization of knowledge, and is thus an essential issue for enabling the "Learning Organization" [23, 27]. KM has been recognized as one of the key factors for future enterprises [12] which will become more and more important due to ongoing organizational, social, and technological changes.

Computer scientists from different fields of research noticed the upcoming hype in KM and often tend to investigate the usefulness and effects of their specific technology for supporting KM:

1. *Groupware, Workflow, and CSCW* are often considered as core technologies for KM because in knowledge-intensive tasks (like design or strategic planning) collaboration of several individual experts and departments in a company is a natural necessity.
2. *Document management, retrieval, and filtering systems* are often advertised as KM solutions since by far the largest part of available abstract, strategic knowledge is written down in a company (or can be found outside the company) in text-based (in the best case, semi-structured) documents.
3. AI (Artificial Intelligence) people dealing with representing, finding, and processing formal knowledge for decades now, consider the Knowledge Management area as their home and claim *formal ontologies, data mining, case-bases, and expert systems* to be the appropriate techniques.

In our research group, partly driven by our (unfortunately, negative) experiences with trials to push expert system technology into industrial practice, we started about five years ago with a continuous shift from traditional knowledge-based systems towards *Organizational Memory Information Systems (OM)*. In [18] we describe some typical case studies of that period and derive requirements and research topics to be tackled for building an OM based upon both our industrial experiences and the orientation towards the human memory as a guiding principle.

While all of the above three research areas turned out to be highly relevant for building such systems (and some survey articles also put a nice structure on the field showing why these research areas are relevant and how the pieces fit together [6, 10, 24, 25]), we did not see any reason why all the KM hype in information technology should be justified if people just advertise their systems as they had ever been. "document management for knowledge management", or "knowledge management through workflow" are not interesting if the new application doesn't put any new, specific requirements on the technology.

Trying to find out what specific, new requirements could come from the KM area in order to strive for a new quality of information systems, we see the challenge just in the application-driven integration of *all* the areas mentioned above. The key thesis is that:

1. Coordination and collaboration support must be a first-order citizen of KM technology since OM systems must deeply be coupled with the usual way the everyday knowledge work is done; and this way is highly oriented towards communication and collaboration.

2. Since experience improvement and transfer across time and space can only be done by archiving, sharing, finding, and reuse of documents, artifacts, and representations of work, information retrieval and management systems must deeply be interwoven with the collaboration-oriented everyday work.

3. In order to provide the link between these two areas, each storage and retrieval action must be process-oriented and work-context sensitive.

4. As a prerequisite to achieve the above goals, interoperability problems at almost every level of abstraction have to be solved: documents from physically distributed document archives must be retrieved, data from databases with different schemata must be integrated, and kinds of knowledge with different style (heuristic experiences vs. hard legal regulations, individual ideas vs. company-wide rules, single cases vs. general technical documentation, etc.), representation (texts, graphics, formal process descriptions, etc.) and content (product vs. process knowledge, financial data vs. design goals, etc.) must be seen together.

We argue that KM infrastructure is not a strict subarea of any of the fields mentioned above but needs an amalgamation to be successful. In this short position paper, we briefly sketch three ongoing projects (KnowMore, ENRICH, and Know-Net) illustrating several facets of how we explore our way into this direction, and sketch some further work to be tackled in the next years in the upcoming FroDO project.

## 2. KnowMore: Knowledge Management for Learning Organizations

KnowMore was a basic research project funded by the German government investigating design principles for OMs. In [2], we describe the three-layered system approach of KnowMore shown in Figure 1.

The central idea of the KnowMore project is giving access to *multiple heterogeneous knowledge sources* enabled through a comprehensive knowledge description based on a formal information ontology which in turn imports notions from the organization and the application domain ontologies of the company.

KnowMore realizes *active information delivery* integrated into the respective business processes through the running workflow engine. This allows an explicit representation of context for a query which can be instantiated at runtime. Heuristic retrieval from several repositories accessible via the knowledge description level can be achieved by navigation within the domain ontology.

Thus the KnowMore notion of knowledge can be described as *knowledge = information linked into the application context.* [3] gives an impression of the functionality of our running system prototype.

In order to ameliorate the problem of manually annotating knowledge sources by knowledge descriptions we implemented an ontology editor with an integrated thesaurus generator (TREX) and a knowledge description editor linked with the learning text classification workbench (TCW) developed in our research department [17].

In our above listing of four technical challenges for KM technology, KnowMore mainly contributes to the retrieval (and, on the fly, to the interoperability) problem on the basis of a weak formalization and linked to a strong notion of workflow to get the link into the application.

## 3. ENRICH: Enriching Representations of Work to Support Organizational Learning

ENRICH [31] is a project funded by the European Commission in the research program on “IT in learning and training in the industry” performed by four research / software partners and three industrial end user companies. Using three specific industrial case studies knowledge creation by structured group discussion and the evolution of a common ontology in a shared workspace are studied. Thus, ENRICH is mainly focused on the groupware aspect of KM.

It is based on the idea that *knowledge = information linked to some formal model.* The three case studies are mainly based on two existing tools:

1. The Digital Document Discourse Environment (D3E) supports the publication of web-based documents with integrated discourse facilities and interactive components. D3E is based on extensive research into how hypertext systems can support critical reflection and the analysis of arguments in writing and software design [28, 30]. D3E consists of tools for generating and managing a site, and tools supporting the document interface.

2. The WebOnto tool (Domingue 1998) supports the collaborative construction of conceptual domain models over the web [11]. These models—providing the formal context for informal sources to be accompanied

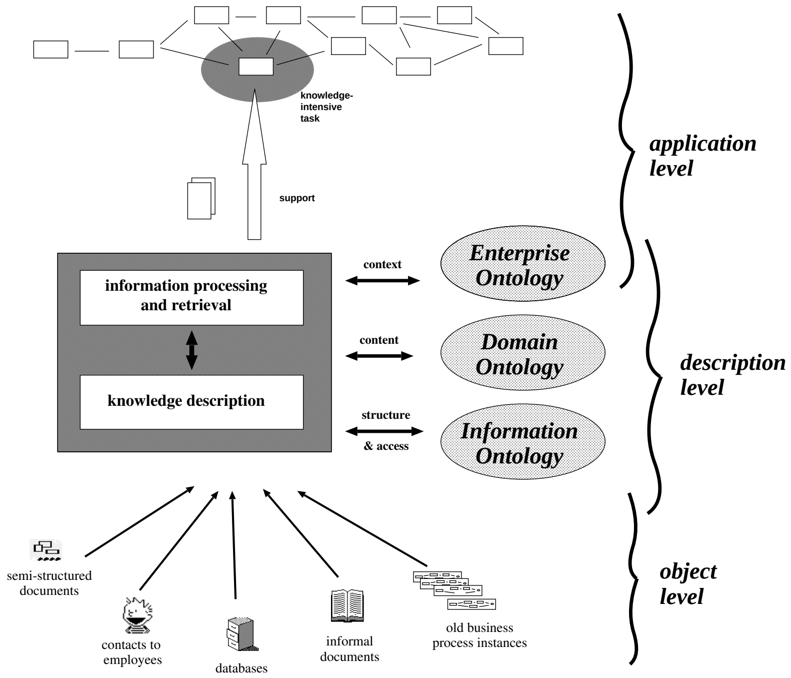


**Figure 1. OM Levels in The KnowMore Project (running prototype)**

by—are represented in the OCML (Operational Conceptual Modeling Language) [21] knowledge modeling language developed at the Knowledge Media Institute of the Open University, Milton Keynes, UK.

The concrete application scenarios of ENRICH are:

1. The Team Workbook: Fostering best practices through the intertwined teaching and use of planning methodologies such as Total Quality Management (end user: British Aerospace, developer: Knowledge Media Institute, UK)
2. The Experience Archive: Assisting the sales force and engineers to share expertise through enriched product documentation archives (end user: Siemens AG, developer: TecInno, Germany)
3. The ProGroup Electronic Manual: Supporting wide-area organizational learning using a proactive electronic group manual to integrate multiple group memories for technical machine maintenance logs (end user: SAARBERG AG, developer: DFKI)

## 4. Know-Net: Knowledge Management With Intranet Technologies

The Know-Net project [20, 8] is funded by the European Commission within the "IT for learning and training in industry" program, and is currently being performed by an interdisciplinary consortium which consists of three end user companies, three developer partners, and two management consultancies.

At the technical side Know-Net aims at developing a software tool which integrates groupware functionalities with AI methods enabling the handling of knowledge objects. The tool shall include:

1. an intranet-based knowledge platform at the enterprise-level that will serve as the basic mechanism for an organizational memory and will include mechanisms for: the codification, mapping, sharing and re-use of explicit knowledge in multimedia content; the structuring, indexing and organization of corporate knowledge taxonomies, and the facilitation of knowledge use by appropriate interface, navigation and intelligent searching and filtering tools. The tool will be based on the KnowledgerTM suite of products (from KNOWLEDGE ASSOCIATES) and the work on intelligent agents of DFKI.

2. collaborative tools supporting communities of practice at the team-level, in order to facilitate the creation of shared memories and interpretive context that are essential to effective communication and team performance. Such tools will include: real-time group discussions/meetings and discussion lists; project-based

bulletin boards and forums; on-line topical conferences with threading features and interactive expertise databases.

In contrast to the research oriented KnowMore project and the ENRICH focus on highly innovative KM application scenarios, Know-Net is mainly interested in finding out the requirements of "typical", "standard" users in a typical KM introduction situation in knowledge-intensive, service-oriented companies, and in the question how far support by integration of stable, existing technology can go. So, we heavily build on the commercial KNOWLEDGER suite of Lotus Notes based KM tools provided by the KNOWLEDGE ASSOCIATES developer partner. So, Lotus Notes equips us with most of the required collaboration and coordination technology, and the KNOWLEDGER process models guarantee that knowledge workers work in a way such that the respective Notes knowledge bases will be filled. What is weak in the existing solutions, are source and platform independent content-oriented search facilities which will be realized via methods and tools used and developed in KnowMore and other projects not described here. However, also all innovative techniques shall be incorporated via standard Intranet techniques such that a realistic application chance is given. Figure 2 shows a sketch of the retrieval part of the tool under development.

## 5. Future Work: FroDO—A Scalable OM Framework for Evolutionary Growth

In this short position paper, we could just try to give a rough sketch of what is currently going on in some central ones of our KM projects at DFKI Kaiserslautern. In the workshop presentation we will point out similarities and differences, we will try to find common themes for working towards reusable modules for building intranet based KM systems, and will discuss our future work into this direction which will mainly be done in the upcoming publicly funded FroDO research project [1].

While the KnowMore approach to Organizational Memory addressed the problem of distributed and heterogeneous knowledge sources by a knowledge-intensive centralized inference upon a global set of ontologies FroDO will abandon the premise of central ontologies. In large companies, legacy databases and independently introduced (partial) OMs in different departments are based on the specific, partial ontologies as they are needed in these departments. In order to conjointly use knowledge from several such independent knowledge sources, the ontologies must be made compatible by defining the required mappings.

The integration of external knowledge sources exhibits another facet of the same problem: existing external services come with their own ontologies (e.g., WWW access via the AltaVista classification scheme or a computer science library organized according to the ACM Computing Reviews classification) and access methods.

Roughly speaking, for integrating several parts of an enterprise's organizational knowledge base as well as for integrating external sources, one has to find pragmatic solutions to the ontology mapping problem as it is currently a hot topic in the intelligent information integration community ($I^3$) dealing mainly with distributed relational databases [32, 5].

Moreover, offering a comprehensive solution to information logistics for knowledge-work processes means not only to handle a variety of sources and ontologies, but also a variety of communicating and cooperating services: from conceptually simple, but technically highly complex networked selection, extraction, and fusion of factual knowledge (e.g., when continuously monitoring competitors and sales amounts in a given market segment) to technically simple (namely accessing only one document base), but conceptually complicated knowledge retrieval (e.g., faced with a difficult decision problem, searching a free-text best-practices database for a similar situation). There are arbitrary scenarios possible between these two extrema.

For some of these scenarios, complex retrieval architectures have been proposed, often based on some notion of *agents*. Some specialist functionalities which can be found in a comprehensive OM building and utilization environment are, for instance:

- *digital reference and acquisition librarians [7]* which know their respective knowledge source and organization principles, and how to effectively access, search, and maintain it;

- *wrappers and mediators [32], ontologists [13], and knowledge brokers [4]* which add intelligent interfaces to legacy databases, maintain and transform conceptualizations of different sources, and make sources accessible to higher-level inferences breaking down complex information needs into simpler information subgoals;

- *document analysis [9, 22] and information extraction specialists [29]* which map informal knowledge representations to formal structures;

- *task / process agents [16] and knowledge push / pull mechanisms [19]* which manage and monitor workflow enactment and realize context-sensitive information supply.

It is not the goal of the FroDO project to build an omnipotent OM system with implementations for all these services. Instead, we will analyze the basic concepts shared by different scenarios and provide a coherent framework which

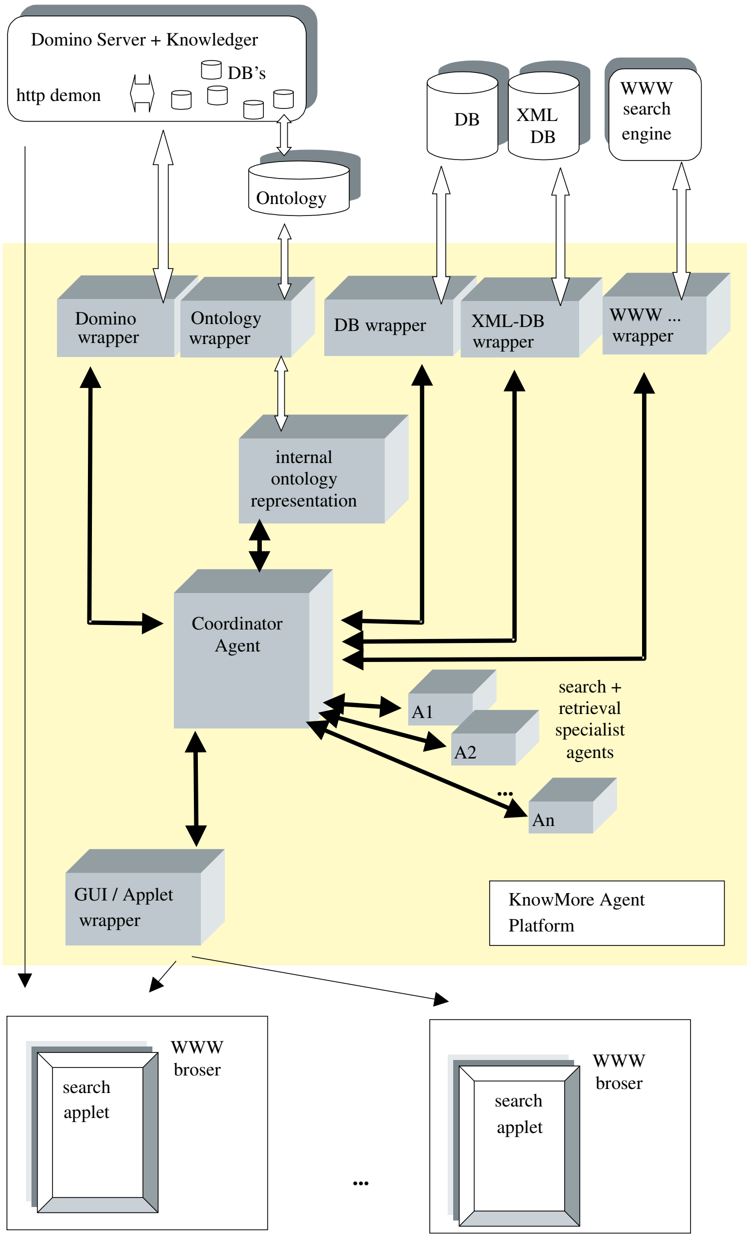


**Figure 2. Software Architecture in Know-Net (under work)**

aims at an easy plug-in of many possible services. This framework must be based on an appropriate notion of agency, it must provide powerful, tailored communication services in order to allow for synergies between different kinds of OM services and knowledge sources, and it must provide central, frequently used basic services, e.g., querying the information ontology. To put it simply, we aim at designing sort of an *OM middleware*.

Besides these issues central to the OM retrieval service, the OM framework must provide at least two other types of services:

1. User input and incoming documents and news are typically informally represented, whereas the knowledge organization is based on formal notions. Hence a smooth transition between informal and formal representations must be supported. Here we will investigate information extraction, text and document analysis techniques.

2. Knowledge in an enterprise is used and created in the context of knowledge work. We will investigate a methodology for business-process oriented knowledge management which includes generalizing our notion of workflow from structured to weakly structured processes.

Figure 3 shows a sample instantiation of our OM framework primarily consisting of activities in a business process, two OMs based on two different ontologies, a legacy database, inference and update components working on these OMs and the legacy database, and some document analysis and information extraction specialists with a central control unit.

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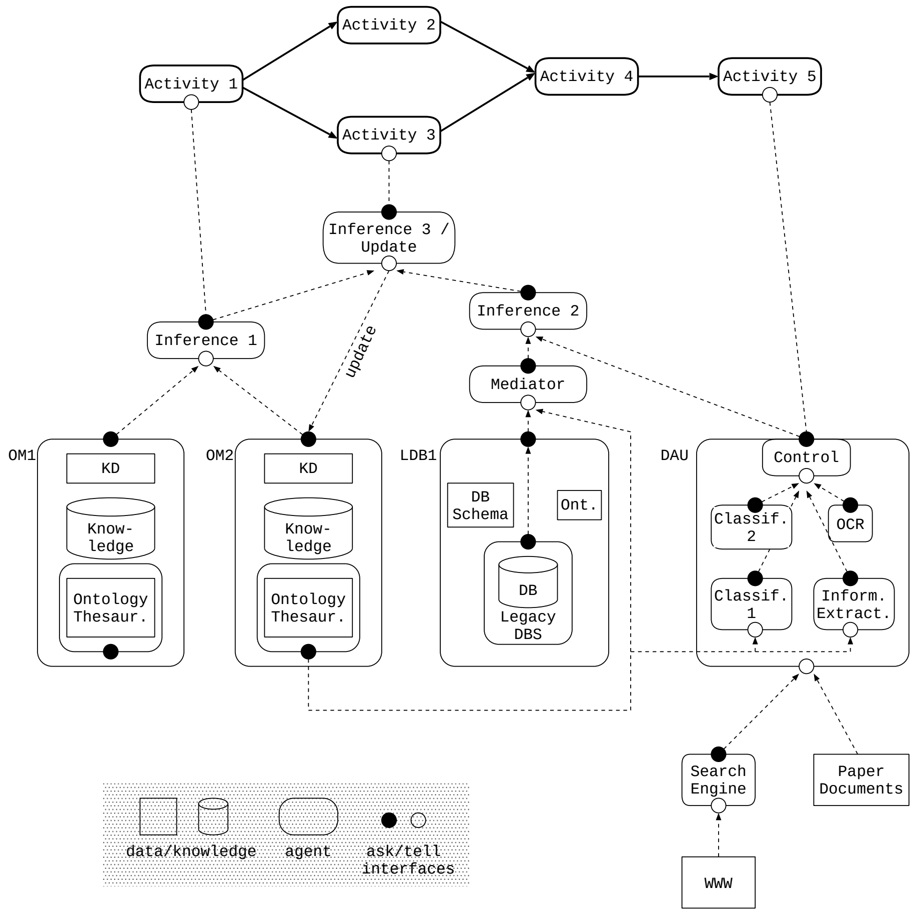


**Figure 3. Sample FroDO Framework Instantiation (planned)**


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