1 The Process-Oriented Archive System of the DECOR Solution for Business-Process Oriented Knowledge Management

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Abstract: The recently finished European R&D project DECOR delivered an integrated set of methods and tools for planning, implementing and running solutions for Business-Process Oriented Knowledge Management. Specific technical achievements comprise (i) the provision of a powerful structured knowledge archive which organizes documents and other knowledge objects according to the process tasks they are related with; and (ii) a workflow engine using dynamic task context to pro-actively access this knowledge archive in a running workflow and automatically provide the user with potentially useful information. In this paper we sketch the general DECOR approach and then focus (a) on the Process-Oriented Archive software on one hand, and (b) on its application in one of the three DECOR pilot installations.

Keywords: Business-Process Oriented Knowledge Management

1 Introduction

In this paper we report on a major software result of the DECOR (Delivery of Context-Sensitive Organizational Knowledge) project.[1] The main technological objectives of DECOR were:

a) to provide a structured knowledge archive, organised around the notion of the company´s business processes, which is equipped with

b) active, context-sensitive knowledge delivery to promote a better exploitation of explicit knowledge sources.

[1] DECOR has been funded by the European Commission under grant IST-1999-13002.

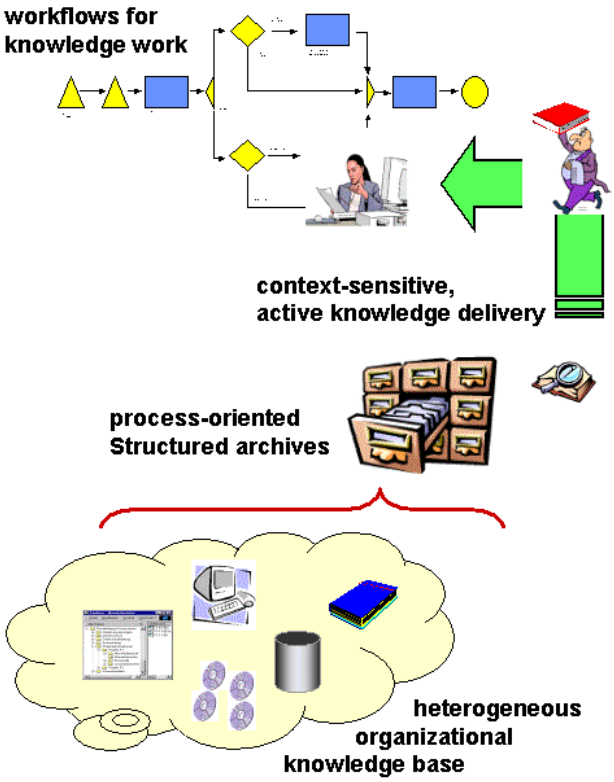

Figure 1: DECOR Overall Scenario

Figure 1 illustrates the scenario we supported in the three DECOR pilot cases: We start with the observation that the organisational knowledge base of explicitly documented knowledge in a company is normally spread over many different sources of documents, forms, media etc. Links and relationships between documents – which are not part of them, but exist *between* them – are usually not represented. ***Ontology-based information systems*** [Fens01,StaStu03] explicitly model the domain knowledge structures and link types which *logically* organise a certain domain of expertise or area of work. The formal representation of the domain knowledge structures generally accepted between the system users, the *ontology*, is the basis for a homogeneous, concept-based content description of knowledge sources. This can be used for knowledge portals to support manual browsing, and for information retrieval algorithms to evaluate queries against an archive system.

In DECOR we examined in particular the role of formally modelled business processes as one such ontology which can be employed to specify the creation and the potential usage context for a given knowledge item (e.g., a document).

Users which are engaged in their daily work usually don't want to spend much time in searching for information, or in storing expertise. What they need is an ***active, context-sensitive knowledge delivery*** service which "knows" what the user is actually doing and employs this information for autonomous information management services at the desktop. In order to achieve this goal, we employ a workflow management system as the host system which is aware of the specific tasks / activities to be performed by a user at a given point in time. *Enriched workflow models* describe information flow between tasks and task-specific information needs. An *information assistant* can observe the running workflow and interpret the modelled information needs for offering active information support from a *process-oriented structured archive*; further it maintains a notion of information retrieval context (which uses additionally modelled information flow variables) allowing for more precise queries to the knowledge archive. Task context can also be used for information storage to describe the creation context of a given knowledge item.

The realization of a system as sketched above is based upon a number of analysis and modelling steps. Business process and workflow models and domain ontologies for knowledge organisation and content description, as well as 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) - or better: Business-Process Oriented KM [AbHi+02] – project. All required steps should be carried out at reasonable costs and with a predictable result. So we need a structured approach for running Business-Process Oriented KM projects which supports all project steps with appropriate methodological guidance and modelling tools. This methodological approach is what we call the *DECOR Business Knowledge Method* which is described in more detail elsewhere [PaMe+02,PaNt+03].

To sum up, DECOR aimed at the following objectives and related results:

- Objective 1: Enable sharing and reuse of context-sensitive, process-related explicit knowledge.
  - DECOR Result 1: ***Process-oriented Knowledge Archive System***
- Objective 2: Ensure extensive exploitation and user-friendly access to Knowledge Archive content.
  - DECOR Result 2: ***Workflow-triggered Knowledge Delivery Toolkit***

- Objective 3: Support knowledge-oriented analysis of organisations and processes.
  - DECOR Result 3: ***Business Process & Knowledge Modelling Toolkit***

Altogether, DECOR, delivered a total solution for business-process oriented knowledge management which (i) equips all software tools with appropriate methodological guidance about how to introduce them into an end-user environment, and (ii) vice versa, provides modelling tools for all steps in the introduction method which require sophisticated domain analysis and knowledge modelling. This set of complementary software and method modules was developed, tested in three pilot user test-beds, and iteratively improved during the project.

In this paper, we foucs on the Process-Oriented Knowledge Archive which is realized employing the commercial KM software CognoVision® offered by one of the DECOR project partners[2]. Further we elaborate a bit on one of the three case studies which was done for PVG (Plasmaverarbeitungsgesellschaft mbH, Springe) – a subsidiary company of the German Red Cross which processes blood donors and blood products. In this highly regulated pharmaceutical area, software validation is a knowledge-intensive task to be supported by DECOR. Details about other elements of the DECOR solution, or about the other case studies, can be found at http://www.dfki.uni-kl.de/decor/ .

The paper is organized as follows: In the next Section 2, we identify requirements for a process-oriented knowledge archive. After a short sketch of the overall software solution developed in DECOR (Section 3), we show in Section 4 how these requirements are met by the DECOR Archive System on top of DHC's CognoVision product. Section 5 elaborates on various details of the PVG case studies. In the last Section 6, we summarize and conclude.

2 Requirements Specification

Analysis of the existing tool landscape and of the three DECOR pilot cases led to the following requirements to be fulfilled by an "ideal" archive system:

1 **Powerful document data and meta data handling:**
The literature, e.g., in the area of lessons learned systems or organizational memories emphasizes the necessities of features such as:

[2] DHC GmbH Saarbrücken, http://www.dhc-gmbh.com

a. Meta data handling: documents must be equipped with an extensible set of attributes to talk about them on the meta level (like trustworthiness, importance, actuality or risks of some knowledge object)

b. Multiple viewpoints: document content characterization (indexing) must be possible wrt. multiple indexing dimensions; also, documents must be indexable with several concepts from the same dimension

c. Ontology-based indexing: models for viewpoint characterization (e.g. indexing ontologies) must be allowed to be more complex structures than just lists or hierarchies of concepts

d. Powerful link management.: it should be possible to define specific relationships at the document level (follow-up document, new version, explanation, contradiction, …), at the ontology level (see under c: to define complex semantic networks), and between the levels (see under b: document refers to concept); also group links (1:n relationships) should be allowed

e. Flexible index handing: it must be easy to change an indexing ontology (new concepts, structural changes) without far-reaching consequences for the whole document archive

2 **Integration functionalities:** In order to build from a passive information system an active organizational memory, we need a powerful API, i.e. all relevant system functionalities normally accessible by the user at the GUI must also be accessible via a programming interface. In order to build a portable solution, the interface should be based upon XML and exchange semantic information using, e.g., the RDF/Schema and ontological information using the DAML/OIL proposals. In order to ease the integration with the end user's everyday work routines, we need easy and intuitive GUI concepts.

3 **Semantics-based document management:** In order to allow more intelligent system behaviour, facilitate high-precision document retrieval, and make easier for the end user and system administrator the burden of document indexing and index (ontology) management, the system should support as far as possible the automatic recognition of document content and content categories.

In order to meet these goals, the DECOR solution combines the functionalities of several commercial tools specifically adapted to the needs of our project. The overall approach is sketched in Figure 2 to be explained in the next Section.

3 Building Blocks of the DECOR Archive Solution

The core element of our software solution is the DHC CognoVision® tool. Its powerful and flexible mechanisms can be mapped easily to the concepts of ontology-based information systems. So, CognoVision provides already most functionalities required above under item 1.

Regarding the ease of use for end user and system administrator, the DECOR philosophy is to provide all modelling and tailoring interfaces as specific MS VISIO® methods which are coupled to CognoVision by a dynamic link exploiting the XML interface to CognoVision.

Concerning detailed automatic analysis of document content, we designed and implemented an abstract interface between arbitrary document management tools and text analysis / information retrieval packages. At the moment, this interface links together CognoVision with mindAccess®[3], a commercial text mining suite which provides services such as document categorization, search for similar documents etc. This interface can be used for giving indexing suggestions to the user storing documents in the annotation interface. Other forms of interactions (supporting powerful search or supporting ontology construction) are under investigation, but were not implemented within DECOR.

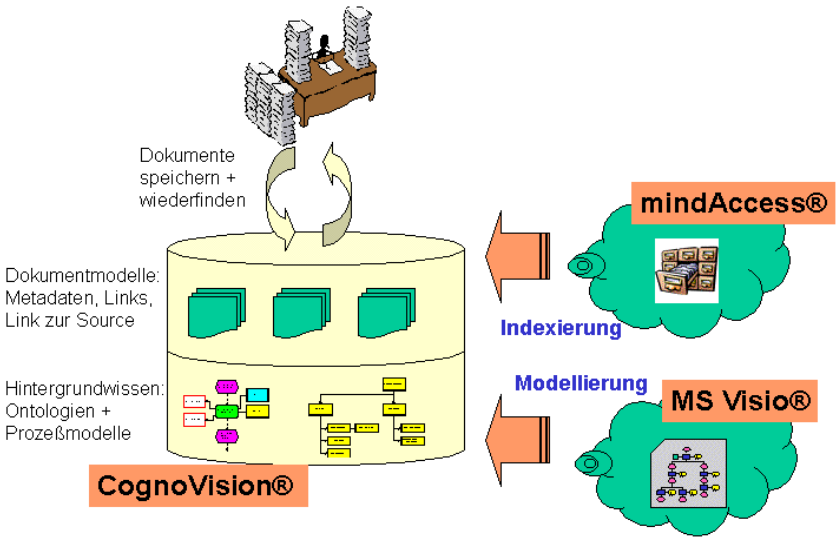

Figure 2: Modules of the DECOR Software Solution

[3] mindAccess is offered by insiders information management GmbH, Kaiserslautern

After this overview of the DECOR approach and technical solution modules, we will focus on the DECOR Basic Archive System, which – in a running system installation – is instantiated to a Process-Oriented Structured Knowledge Archive (according to the BPOKM terminology introduced by [AbHi+02]).

4 The DECOR Archive Component CognoVision

CognoVision allows the representation of global, enterprise specific and individual information independent of system borders. The representation can be personalized, transparent and coming from different fields. The open architecture of the tool allows the simple and fast integration of standard products in the CognoVision workplace. Data exchange with arbitrary systems is realised using XML-based interfaces.

When working with CognoVision the necessary information and functions are provided by the applications already in use, like MS Office products, SAP, document management systems, file servers, or the internet (cp. Figure 3). Cogno-

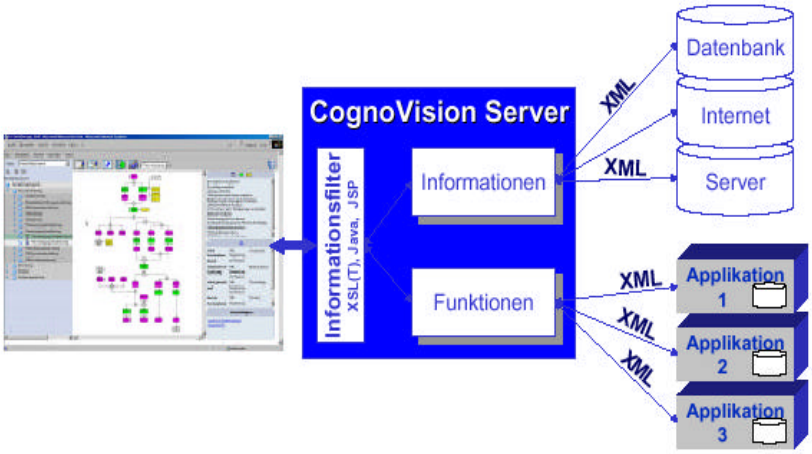

Figure 3: Logical Architecture of CognoVision

Vision is installed on top of these systems as *a logical middleware*, which is correlating the information from the different systems in a context-specific way. Content remains unchanged and can be edited in the original format using the original application. While the document is changed it is locked for other users. After

the change, the document is automatically converted into an Internet format (HTML or PDF) and, optionally, a new version is created. After publication all users have access again to the document.

Hence CognoVision uses already existing functions and systems in order to administrate multi-media information and to create relations between information objects which were created with different applications. CognoVision aims at the realisation of a *structured knowledge network*, which assures the easy reuse of results from varying projects and tasks. This means, the idea of CognoVision is to be able to organize all relevant information corresponding to the individual needs of the user and to correlate them without generating redundant information. CognoVision does not claim to replace legacy applications, but it claims to correlate the results produced with these applications. This allows to integrate information from different systems into one knowledge network.

Such a knowledge network is built from Information Objects, Structure Elements, and Links, and Attributes. ***Information Objects*** consist of:

- an original content object (remaining in its original application, and represented by a link or URL, or copied into the CognoVision database) or a set of content objects (e.g. the same content in different languages or versions, or an aggregated, "virtual" information object composed from several parts), plus
- metadata, i.e. a freely definable set of attributes for the given type of content object, links to other information objects, and classification links describing to which structure elements an information object belongs

Structure Elements and Attributed Links are the basis for the user to define views with the corresponding structures where documents can be linked to. *Views* describe application-, project-, or user-related aspects of information. As abstract, conceptual structures, views are for the user the most appropriate entry point to his personal, electronically available information sphere. He or she may create arbitrarily many views with subject-related correlations for different subjects. Fields of knowledge which are correlated by their content, are reasonably condensed into one view. Views might be generated automatically when one imports data from an other application. For example if one imports data from the ARIS business modelling toolset, ARIS groups, models, and model objects are imported as views into CognoVision.

Views, structures and information objects can be correlated by ***Links*** which can be classified into link types and which carry type-specific attributes. In contrast to hyperlinks which simply carry a linking target, CognoVision links can have arbitrarily many, freely definable attributes. The types of links and their attributes can be designed by the customer when customizing the tool.

Attributes which can be maintained for information objects, views, structures and links, can be classified into types. All attributes can be configured depending on

the needs of enterprise using the DECOR tool. The following types of attributes are available:

- Name and type of the object
- System attributes: are provided automatically by CognoVision. Examples for system attributes are: state, original language, date of last change, time of last change, …
- Definable attributes: When CognoVision is customized, one defines which attributes can be assigned to which type of object.
- Additionally one can assign keywords to each object.

Attributes and keywords are the criteria for the **search** in the DECOR archive tool. With the search results, a preview and all metadata (document properties) are displayed.

Figure 4 illustrates our approach: existing information sources are represented by placeholders in the CV Knowledge Base which is organized according to and accessible / browsable / searchable via arbitrarily definable CV Knowledge Views (here, several types of folder trees, but in principle arbitrary network structures).

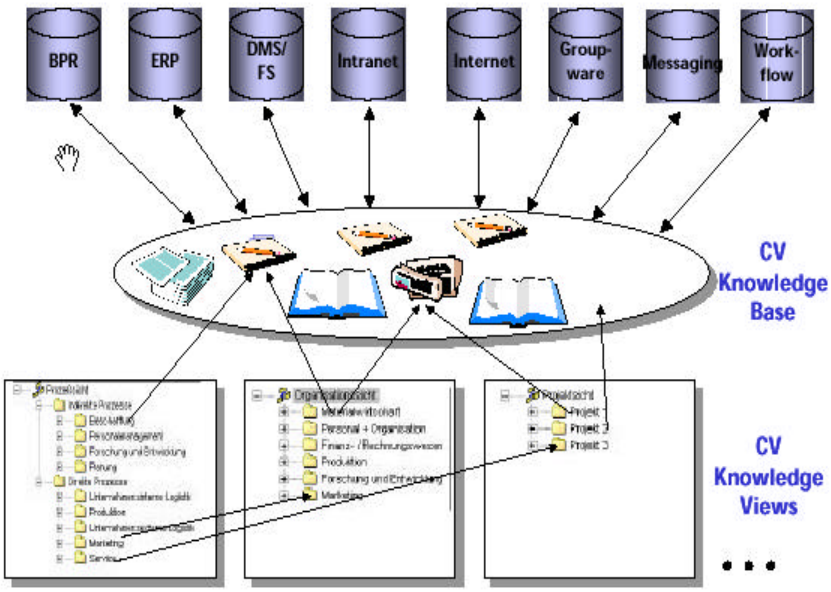

Figure 4: Knowledge Networks in the Archive System

The core of this system is the application server which manages the intelligent administration and representation of links from and to data which can be stored on different servers or heterogeneous IT-systems. The database server administrates the links between information objects.

Versioning and multilinguality. We can administrate links depending on their actuality. All objects which are administrated directly by CognoVision can be versioned. The link then points always to the actual version of the information. For objects which have been changed after publication, the system distinguishes depending on the access rights. Persons who are only allowed to read the object see the published version of the object, and persons who are allowed to change the object see the changes which have been made after publication. All objects (views, structures, information objects) can administrated in different languages and versions. The change history of an object can always be reproduced. All objects can – if necessary – be set back to an earlier state. Versions are numbered following the ISO standard. The version and language of the object which is displayed to the user, depends on his or her access rights relative to the object. CognoVision allows to maintain objects in different languages in parallel. Information is always displayed in the language selected during the login if available. An intelligent selection mechanism is implemented to display always the most actual content. If the information is not available in the desired language then it is displayed in English or in the original language.

Access rights and user management. CognoVision is a multi-user system. Therefore it includes functionalities for user management. The administrator can add and delete users. He can store user data. He can assign roles and individual functional rights to particulars users.A granular system of access rights controls the access to the knowledge network. Rights are assigned by the author of an object.

Customizing. The customizing functionalities of CognoVision allow users to define types of attributes, types of links, types of information objects and types of structure units. It is possible to assign to a given type of links, information objects and structure units a particular set of attributes. In this way CognoVision allows the user to set up the ontology to define the knowledge network. The DECOR archive integrates MS VISIO as a **modelling tool.** VISIO is connected during modelling to the CognoVision database. With this kind of integration, it is possible to define modelling methods in VISIO as one knows from other modelling tools, like, e.g., the ARIS toolset. A *method* means that only a restricted set of shapes is allowed, and only a defined set of links is allowed for connecting a given pair of shape types. Shapes and edges in the Visio model are - during the process of modelling - mapped to objects and links in the CognoVision database. CognoVision checks that the link types are consistent with the selected modelling method. Complete Visio models are represented in CognoVision as HTML-files where the shapes are anchors for CognoVision links. These means models can be used for the navigation through a knowledge network.

With CognoVision it is possible to create links from other objects in the CognoVision database to shapes of the model. Thereby graphical models can be connected to the knowledge network in CognoVision. For example, CognoVision offers the possibility to connect business process models to the business process documentation. Models can be published in the enterprise Intranet, for example, and used as the base for navigation through the business process documentation (cp. Figure 5).

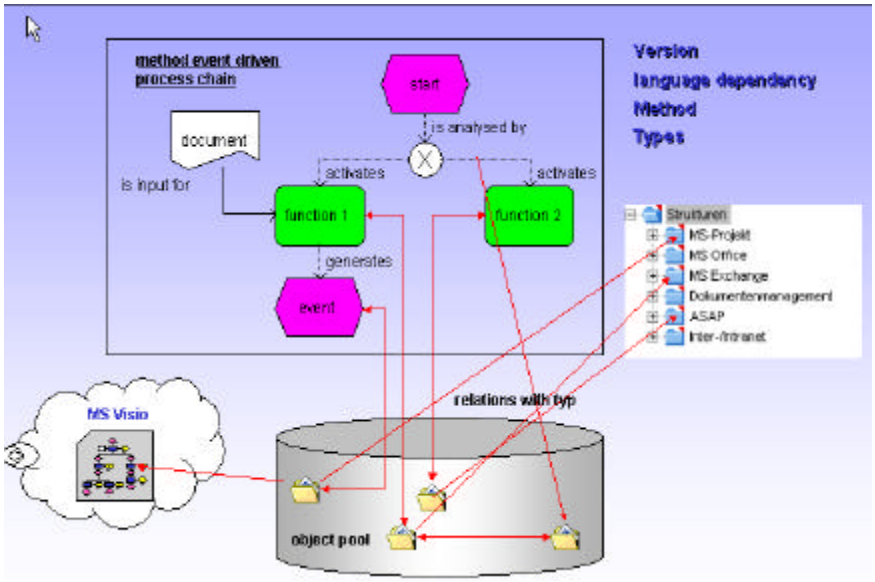

Figure 5: Creating VISIO Business Process Models for Knowledge Organization in the DECOR Process-Oriented Knowledge Archive

5 The PVG Case Study: Validation Workflows

The business process considered in the PVG case was the process of validating changes in PVG's SAP R/3 system. This process has the following remarkable characteristics:

1. It is critical to ensure the continuously validated state of PVG's production which is a key criterion for quality in the pharmazeutical area *(mission-critical process)*
2. It involves many tasks, is highly document-oriented, and involves several people in different organizational roles *(typical "workflow candidate")*
3. Changes must be documented according to national and international rules *(documentation need)*

4. The change process must follow provably the national and international rules *(typical "workflow candidate")*
5. Correct and effective execution requires for some tasks manifold kinds of background knowledge which today is often neglected (like standard operating procedures, templates, legal information, SAP background knowledge, etc.) *(knowlede-intensive process)*
6. The knowledge level of different people in the process, as well as between different people enacting the same task in different process instances, may differ considerably *(knowledge sharing need)*
7. The continuous improvement of validation quality and validation efficiency by knowledge reuse and knowledge sharing between people and over time is an ongoing task *(knowledge management need)*

In this list, while the first argument justifies the importance of the process chosen, the items 2 to 4 ask for workflow support, while items 5 to 7 demand a KM solution as laid out by the DECOR approach.

Since all software components operational in PVG must be in a validated state achieved by long-term systematic testing, the following strategy was pursued to install and test the DECOR solution and come as far as possible towards an operational system:

- To define the baseline metrics for improving the quality of PVG change management, DHC performed an audit assessing the percentage of correctly performed and documented changes.
- The process-oriented structured archive as presented above was installed in PVG in Spring 2002. Since then, all changes in the PVG system were documented using this system.

Baseline metrics. During the initial quality audit by DHC for assessing the quality of the current change management process, the documentation discipline and the resulting documentation quality were evaluated. We cannot present detailed figures here. However, it can be said that a significant improvement potential was identified. For instance, in only 10% of the considered cases a test documentation was delivered. Further it turned out that the quality of the technical realization of a software change was not homogeneous. For instance, the test behaviour of different users differed considerably, also the documentation behaviour, and the implementation efficiency.

Expectations. With the above sketched status in mind, PVG's head of Quality Assurance expressed the following general expectations for the introduction of the DECOR system:

- Quicker and easier workflow
- Changes will be done completely in compliance with defined procedures

- Changes will be documented completely
- Improved planning and dating of work

5.1 The PVG Process-Oriented Knowledge Archive

The knowledge archive installed at PVG contains 780 documents of 15 different types of information objects. They are organized according to the structure of the change process, the structure of the SAP system considered, and thePVG organizational units, with a total of 44 structure elements in the respective ontologies. This shows that – although a considerable number of documents was found to be useful as validation background knowledge – the organizing structures are relatively lean, in order to give to the end user some easy to use entry point, and not to overburden him with over-complex structures. The currently running test installation is managed by PVG's Quality Manager and is used by 20 active users, with a quite different individual usage profile. Some are regular users, others are very seldom confronted with the system, or with SAP changes in general. Since the installation of the archive system, about 3300 document accesses could be counted. Figure 6 gives an idea of the kinds of documents and structures in the PVG test installation.

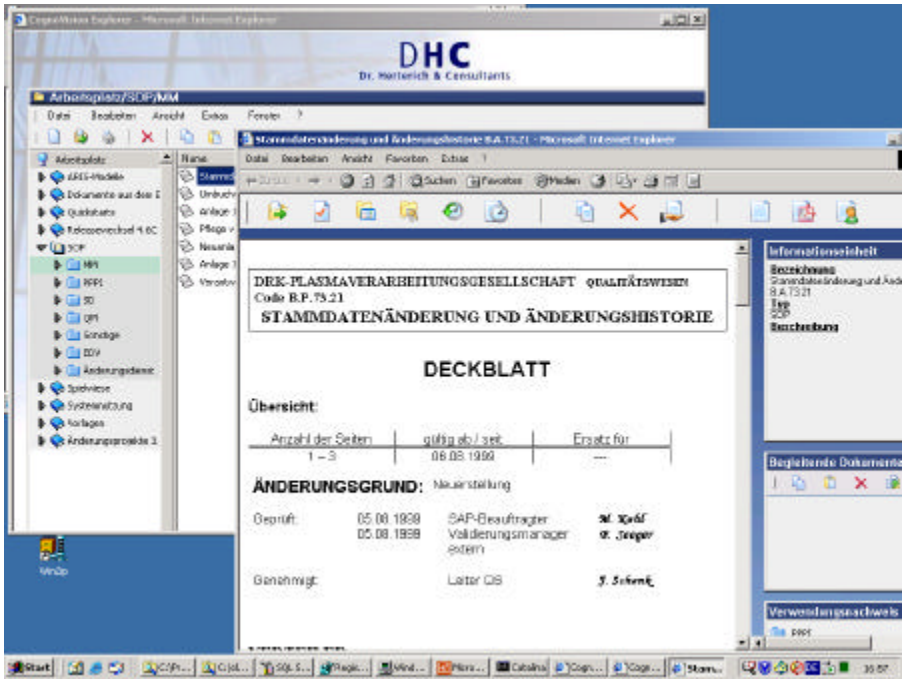

Figure 6: A PVG Sample Document (foreground) and the Underlying Knowledge Network (background)

5.2 PVG workflow enactment

The PVG change management workflow contains about 55 tasks performed by 10-15 different people (or, organizational roles). Its major purpose is to ensure the compliance with all official regulations regarding document flow, logics of approval, and documentation. The major KM tasks (cp. [PaMe+02]), which extend the conventional workflow tasks, concern:

- Access to SOP's and document templates for a given task (static task context)
- Access to specific background information or earlier, similar changes for the given change process instance (dynamic task context: department which requests a change, SAP module affected, risk class, change class, change type)
- Automatic creation of a project folder per process instantiations which gathers all documents created during the process enactment, and automatic establishment of the required links between documents

Figure 7: Task Browser of the DECOR Workflow Engine

Figure 7 shows the task broser for one of the early tasks in the workflow, namely the classification of a requested change; the end user has to decide about the relevant data characterizing the given change request: department affected, SAP module, change class, change type. These variable values can be set in the left part of the window. As supporting material, the user may access the Standard Operating

Procedure (SOP) for change management in the PVG R/3 system, which is offered as a hyperlink in the right part of the window.

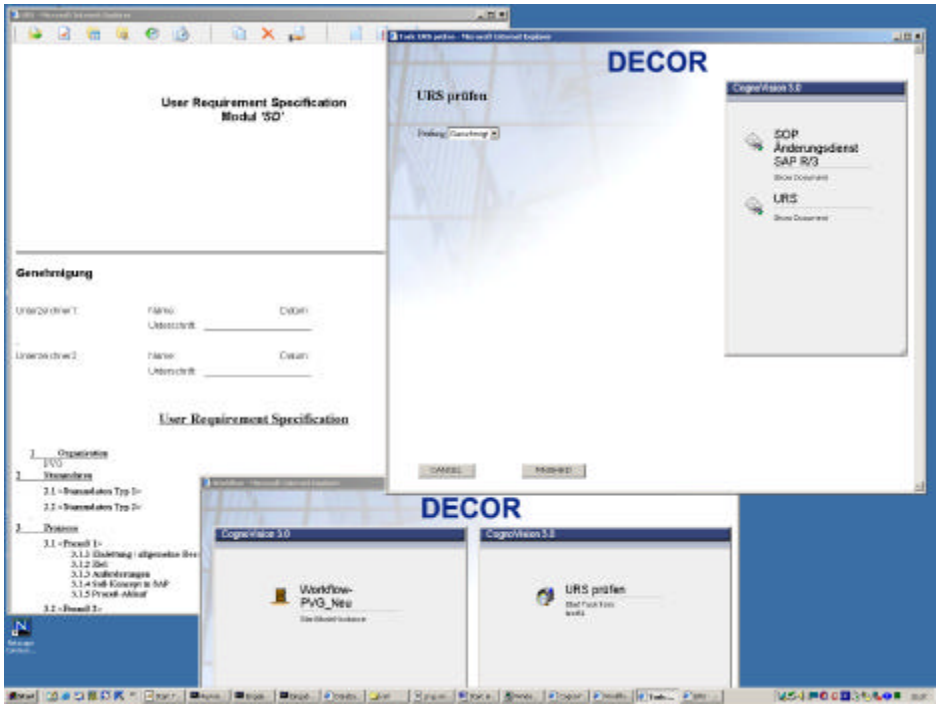

Figure 8: The Workflow Task „Check User Requirement Specification“

Figure 8 shows the task “Check URS” which is about approval of a user requirement specification (URS). Of course, besides the access to the respective URS document as an operational workflow document, we have also access to the change management SOP as background knowledge in the document browser at the right part of the window.

5.3 User Experiences and Reactions

For a serious quantitative evaluation, the PVG system is not yet long enough in use. Nevertheless, the first impressions of the PVG QA Department can be summarized: In general, two major user classes can be identified, where for each of them specific argumentations speak for the DECOR solution:

- For experienced users who work often with change processes (in particular, the SAP programmers) the biggest problem for QM (see the baseline metrics above) seems to be that they do not respect the regulations. Here

the workflow enactment shall be a gentle means to *force* people to work in compliance with the rules.

- Please note that in this case the best context-sensitive search is required to achieve user acceptance, because only a really excellent functionality can convince an expert user to do things where he thinks they hinder him doing the daily operative business.
- As a corrolary we can derive the importance of continuously measured system performance (not only during a research project, but also in daily business) to demonstrate the usefulness.

- On the other hand, casual users in the change process normally have problems to overview its complexity, to know the regulations, and to follow the rules. Here, the system shall *help* them by giving appropriate guidance and background knowledge.
  - Here, *active* knowledge retrieval is crucial, since the casual user does not know what to search. Further it should turn out to be useful having a well-organized archive of networked information sources which allow a content-oriented browsing through the material.

Starting with these initial observations, one can come to speculations about promising usage scenarios in the future:

- Already immediately, the system can be used as a training system for newcomers (see also the ADVISOR project [StPo01]) to teach them with example data (old changes) plus background knowledge, having the whole process overview, seeing all affected parties.
- The more the system content grows with time, the more interesting it could become as a knowledge sharing medium between different experienced users (also, for knowledge transfer over time). To this end, the system should be able to automatically retrieve material from earlier, similar situations. This leads to ideas for future work:
  - While this is currently easy for retrieving information from fully or partially identically specified situations, we encounter the limitations of the currently implemented CognoVision search mechanisms for a real similarity-based search. This could be subject to future development work.
  - For a further commercial contact with PVG, some “easy” workarounds have already be thought of, like combining attribute-based metadata search with manual relaxation of search constraints and / or with fulltext search in documents.

The impressions of PVG Quality Manager's from the first usage months can be summarized as follows:

- The quality of change process instances will immediately improve since people are "forced" to behave according to the regulations. It is obvious that most of the missing documentation and process steps cannot be omitted anymore. So, already the use of the workflow automation considerably improves the status quo.
- Since the only way to deviate from the correct way is to stop the workflow and to go on with work without the system, the workflow administrator tool helps to monitor and control things better.
- The integration of workflow and archive seems intuitive and useful. A reason for the usefulness seems to be that many people tend to think process-oriented step by step, and seldom in a systemic manner having in mind the whole picture with complex interrelationships. This problem can be ameliorated by working along the prescribed process, by having access to the relevant documentation, and by having the relevant links and relationships represented in the archive.
- PVG estimated that the system reduces the time for a change by 10-15%. Of course, the gain will be smaller in complex changes where the major part of the elapsed time is consumed by the programming work for implementing the change.
- In this last case (complex changes, which do not profit much form pure automation of document and information flow) a much more important gain of change efficiency could be achieved by the already mentioned similarity-based search for older change documentations from similar situations. However, this is subject to future work.

After all, the combination of workflow and process-oriented archive proved to be worthful. Besides the benefits already identified, we can summarize: a system as described in this paper helps that existing knowledge sources are used and extended in a more efficient and more consistent way throughout the whole organization. Of course, it allows also to faster distribute changes of procedures, and of background regulations and advice for enacting these procedures.

6 Summary and Conclusions

The DECOR solution is – maybe, except for the PROMOTE solution [KaTe00] – the only complete solution for BPOKM covering analysis methods, analysis tools, and BPOKM enactment on the basis of intelligent archives and workflow enactment. In this paper our focus was laid on the DECOR Process-Oriented Archive

software which is built around the CognoVision tool, complemented by mindAccess for automatic document classification and advanced retrieval, by MS VISIO for graphical modelling, and by a "homemade", simple workflow engine. Though the combination of these components is very powerful, there are certainly other commercial KM suites comprising comparable functionalities. However, the strong point of our approach is the modular, extensible architecture which allows to exchange the classification component, the workflow engine, or the modelling tool very easily. Another advantage of the current configuration is that those components together are relatively cheap compared with widespread "full" KM suites like Autonomy. Independent from these (almost) standard functionalities and their unique combination to realize proactive information support with dynamic task context [AbBe+01], we emphasized in this paper particularly the specific strengths of the CognoVision core of our archive system. Its particularly expressive mechanisms for structuring and annotating information objects is definitely not achieved by other state-of-the-art KM or Document Management tools.

We are still at the begin of exploring the full potential of such powerful document and knowledge organization tools. First promising application areas are, e.g., the efficient creation of Intranet-based corporate handbooks, e.g. in companies which produce complex products or follow complex, highly distributed and heterogeneous, or often changing processes.

Areas of future work comprise:

- A logical next step after the introduction of BPOKM systems is the sound **evaluation** of their short- and long-term effects on business performance (within DECOR, only a very limited time period could be spent for evaluation). This is a non-trivial and interesting scientific task since there is no clear understanding up to now about appropriate metrics to assess direct and indirect effects of KM initiatives (cp. [MeAp+02]). But it is also a very practical and necessary task for promoting the practical success of such approaches.
- The DECOR case studies showed that it is difficult and time-consuming to design a PVG-like application from scratch. However, if built once, many parts should be reusable for other customers in the same business area and with similar business problems. E.g., the DHC "Validation Handbook" – a well-structured knowledge-pack containing the validation-specific background knowledge and material can already be sold as a stand-alone product. This shows the way to **reference KM processes** and **reference knowledge packs** as an interesting business area exploiting the power of software tools like CognoVision which is difficult to use and understand by a "normal" customer at first sight.
- **Application-specific links** and **aggregated information objects** are seldom considered in practice. Here, state-of-the-art technology provides functionalities the application-potential of which is not yet fully recognized. At DFKI, first experiences in this direction were made with the Electronic Fault Recor-

ding system [Ber99] and the KONARC study [SiTs+00]. In the European INKASS project[4] we are currently further investigating these aspects in the area of *Knowledge Trading*.

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