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Abstract— **Knowledge management is becoming a fashion in many organizations. This entails the danger that large investments in knowledge externalization are made with little short-term repayment. Moreover, there is a risk that knowledge management administrations operate in parallel and with little connection to the business processes. We argue that the main purpose of business knowledge is improved action, and therefore we must interrelate processes of knowledge creation and usage with the normal business processes both on a conceptual and a system level. The paper presents a model-based approach for solving this integration problem, and describes an implementation architecture which links knowledges processes to a workflow environment. Experiences in an organization where our system was successfully installed indicate that such a "light-weight" integrated solution offers a relatively easy and immediately useful entry point into organizational knowledge management.**

I. Introduction

Work practice, technology, and processes change in the digital economy [1]. In order to stabilize the change process, knowledge management is getting more and more important. Beside new organizational functions like knowledge managers or brokers there are large investments in IS support for knowledge management.

However, this also entails some risks. First, IS support for knowledge is no end in itself. The acquisition of computer manageable knowledge is costly and has to be related to the usefulness of the acquired knowledge [2]. Second, large investments in knowledge management infrastructure can fix current technological support for years, even when now organizational and technological change is measured in months. Finally, how can these many small but rapidly growing knowledge-intensive companies with quick turnover times for people, technology and processes [3] preserve and use their knowledge from the history to act for the future?

In this paper we present the organizational-memory-based workflow environment GRAECULUS[1] and a bootstrapping method carefully designed to demonstrate the main feature of rapid knowledge deployment. This is reached by explicit representation and operationalization of so called **mnemonic processes** (cf. section II) to create, maintain and use knowledge about business processes in a model-based environment. We use the environment to externalize a core of business process models with mnemonic processes while reaching a critical mass for a functional web-based workflow environment very soon.

The rest of the paper is organized as follows. In section II we examine current IS support for activity oriented knowledge and then present the bootstrapping method and our model-based approach in section III. Experiences with using GRAECULUS in a small knowledge-intensive company are discussed in section IV while a summary concludes the paper.

[1] Graeculi were well-educated Greek slaves in ancient Rome feeding their masters with information in interlocutions and negotiations.

TABLE I
MNEMONIC PROCESSES MENTIONED IN LITERATURE

Literature	*Mnemonic processes*
Stein and Zwass [7]	**Acquisition**, **Search**, **Retrieval**, **Retention**, **Maintenance**
Ramesh [11]	**Acquisition**, **Retrieval**, **Retention**, Development, Reuse
Morrison [12]	**Acquisition**, **Search**, **Retrieval**, **Retention**
Wijnhoven [13]	**Acquisition**, **Search**, **Retrieval**, **Retention**, Dissemination
Burstein et al. [9]	**Acquisition**, **Retrieval**, **Retention**, **Maintenance**, Learning

II. Supporting Activity Oriented Knowledge

Each enterprise has something like an *organizational memory* (OM). We do not want to stress the problematic use of anthropomorphic metaphors here, cf. e.g. [4–6] for a detailed discussion. According to the definition given by [7] this OM "*is the means by which knowledge from the past is brought to bear on present activities, thus resulting in higher or lower levels of organizational effectiveness.*" It should be clear by now that enterprises follow some kind of business plans and execute **business processes**. These processes are defined implicitly or explicitly. Following Argyris and Schön we define implicit processes as theories-in-use and explicit processes as espoused theories [8]. An IS-supported organizational memory system (OMS), is a "*means of capturing and giving access to organizational memory*" [9] by so called **mnemonic processes** operating on the OMS. We have reviewed current research literature [10] and extracted a set of mnemonic processes mentioned in almost every paper (marked bold in table I). Our hypothesis is the following. Business processes involving people and technology are that part of the OM promising the best utilization of resources. So capturing and accessing OM should concentrate on these processes. To strengthen the hypothesis we claim that the interrelation of business and mnemonic processes provide an ideal **OM-based workflow environment** for both supporting short-term activities and long-term knowledge management which is motivated in the following.

1. *There should be "no shadow administration" of knowledge engineering.* [14, p. 219].

Since knowledge engineering becomes a fashion a lot of activities in practice and research have been started. Many of them are leading to new functional units, positions, information systems, and so on. While the importance of knowledge engineering is undoubtful, the development, utilization, and maintenance

of knowledge management systems are expensive. The integration of *classical* business information systems and new knowledge engineering processes could be much cheaper.

2. *Change in business processes should be modeled explicitly by means of mnemonic processes in order to stabilize the change process.*

(a) Reference models [15] are generalized "memories" of special business sectors, e.g. for engineering or financial companies. Therefore, costly mnemonic processes performed by consultants operate implicitly on these models for specific needs like tailoring or aligning. But without explicit linkage and recorded traces the experience gained in these operations will be lost.

(b) Business process modeling is embedded in the existing but changing world of human resources and information systems. Every change in any area will lead to changes in other areas. For example, ISO 9000 alignment has caused problems for companies in a turbulent environment [16]. Again, if this change management is handled in an implicit manner, the traceability of changes will be lost [1].

(c) The speed of changes is rapidly increasing. While (re-)engineering tasks in former days could be measured in years the next decade will experience rapid (re-)engineering within weeks based on new organizational models in the digital economy [17]. The efficiency of computer-supported tools to handle this enormous effort will depend on their ability to stabilize the change process.

3. *The processes of modeling and performing tasks are cooperative and evolutionary.*

To support these processes, it is useful to smoothly integrate the existing tacit OM and externalize the processes on demand. It should be possible to start for example with small pilot projects. Enterprise resource planning systems like SAP concentrate on big companies with stable and long living processes. Our approach is directed at small knowledge-intensive companies or groups within a rapidly changing environment.

In the literature we have found little support for both, an explicit notion of short/long-term activities and an explicit interrelation of these concepts. Many systems support short-term communication, cooperation and coordination in networked organizations or distributed project teams. The use of metaphors makes them successful by minimizing training efforts [18]. Systems based on the coordinated exchange of electronic mail have successfully invaded markets because of their simplicity. Microsoft Exchange Server or Lotus Notes are examples for this class of applications.

The level of business process awareness in such systems can be implicit, explicit or mixed. While explicit use of business processes depends on an externalized description of the process, possibly managed by computerized tools, implicit use of business processes depends on theories-in-use.

The idea of combining short-term activity support with long-term knowledge management is obvious (cf. e.g. [19–23]) but simultaneous support for both areas has been limited.

- *Business processes are used implicitly or have been coded into the applications.*

In organizational memory systems like AnswerGarden [24] or Knowledge Pump [25] there is no explicit notion of business processes while there is some kind of explicit mnemonic process support.

- *Mnemonic processes are used implicitly or delegated to manual tasks.*

In many business process modeling tools, workflow management or coordination systems the definition and enactment of business processes is supported well. Microsoft Exchange Server, Lotus Notes, Prominand, ARIS Toolset, and SAP R/3 are prominent for their functionality. But these systems are lacking the explicit support for mnemonic processes.

Recent research systems like Eule 2 [26], KnowMore [27], OntoBroker [28] or WorkBrain [29] which try to integrate workflow management and organizational memory functionalities provide some simultaneous support for both areas. But there is no explicit interrelation of mnemonic processes and business processes on the modeling level nor on the operational level to integrate explicit change process support.

- *Eule 2* stems from a project to restructure office tasks for life assurance management. It had the goal to assign former experts for special business cases to all possible business cases in a customer base. The expertise to manage the business cases is modeled in a strict workflow environment. The user has to follow the rules given by the system. The needed knowledge is integrated by a high-level representation language and a hybrid reasoning component.
- The *KnowMore* project uses the process of building, analysing and executing workflow representations to create organizational knowledge. If some knowledge is created within a workflow, the workflow context is stored so that the knowledge can be retrieved for reuse in other workflows. For information retrieval and active triggering the system uses a logic-based modeling approach on the basis of formal ontologies. An ontology is a specification of shared conceptualization. In business process modeling approaches a meta model has a similar meaning.
- A workflow environment on top of the *OntoBroker* system is presented in [28]. Ontobroker allows HTML, RDF and XML based formulation of knowledge facts. The integration of documents containing knowledge and business processes modeled by means of high-level petri nets will be implemented with a logic-based approach like in the KnowMore project. So, the mnemonic processes are views definig a context.
- *WorkBrain* is an OM-based workflow environment implemented as a HTTP-Server generating HTML pages (eventually with Java applets) dynamically on top of the commercial workflow system FLEXWARE. WorkBrain aims at the improvement of worklow execution by learning in two learning loops based on the case base of executed worklows and the general organizational knowledge base. Learning by doing increases planning and execution quality by modifying workflows at run-time. Learning by supervision modifies workflows at build-time by analysing and reconfiguration. The mnemonic processes in the system, e.g. "Retrieval of suitable workflow cases", support these goals. The mnemonic processes are not explicit themselves but implemented in a case-based reasoning component.

III. Bootstrapping a Workflow Environment

In late 1998 the GRAECULUS system was developed and installed in a small company concerned with operating a demon-

TABLE II
TASK-SPECIFIC PROBLEMS IN A KNOWLEDGE-INTENSIVE COMPANY

Problem	Example	Reason	Possible Measure
(P1) Tacit task-related information not available	"How can I cancel an entry?"	Employees not available or occupied	Internalize explicit task-related information
(P2) Location of explicit paper/computer-based documents not known	"Where is the template for name plates?"	No central repository	Combine distributed documents and tasks
(P3) Business processes not documented	"Why is there no checklist?"	Work load hinders documentation	Externalize business processes and combine with tasks
(P4) Information flow breaks	"Is the flyer ready?"	Part-time workers not always available	Externalize and annotate finished task
(P5) Short-term contracts for employees	"Where is the guy who made the flyer last time?"	Employment of (PhD) students	Externalize tasks and related information
(P6) Employees can not work with all software	"How can I load that IGES file in Konsys?"	Many software packages, personell turnover, daily work pressure	Combine and internalize task-specific software documentation

strational production plant and performing 20 workshops per annum in modern production technology (e.g. CAD/CAM), quality management, and related issues. This company shows typical characteristics of a knowledge-intensive firm. Central factor of production is technological knowledge and its transfer from university/industry to industry which results in a high throughput of information. Additionally, the daily work load and the personnel turnover are very high, mainly due to R & D activities and therefore additional employment of (PhD) students. The effect of the two phenomena is a permanent loss of organizational memory. Some of the company's real problems have been identified in the bootstrapping process and are shown in table II. This justifies the need of an OM based workflow environment in this company even though the average company's total staff is only about 10 people.

For the realization of an OM-based workflow environment it is important to have a certain amount (critical mass) of information already in the system. Thus, we need a bootstrapping process [30] for the creation of the system. In order to define a way how to start the rapid knowledge deployment process in a real organization we employ the dynamic knowledge conversion approach by Nonaka and Takeuchi [31]. The describe the creation and usage of organizational knowledge through the dynamic interplay between tacit and explicit knowledge. Tacit knowledge is personal knowledge hard to formalize or to communicate to others. Explicit knowledge is formal knowledge easy to transmit between individuals, groups or information systems. The dynamic process creates a continuous spiral of organizational knowledge creation with the four modes of knowledge conversion: **socialization** (converting tacit knowledge to tacit knowledge), **externalization** (converting tacit to explicit) , **combination** (converting explicit to explicit), and **internalization** (converting explicit to tacit). The process itself is structured as follows:

1. *Identify the core business processes in the enterprise.*
This can be done in brainstorming sessions or unstructured interviews. A primary core business process for the company is the organization and performance of workshops. The workshop schedule is planned in advance for an one year period. Workshops much asked for can be repeated short dated. The organization process itself is stable and repeatable. Mainly, it consists of many time-comsuming but simple tasks, e.g. billing or preparing workshop material, which can be delegated to student workers. So, externalization starts with that process.
2. *Identify people (agents) working within the core processes.*
We have selected five people involved in organizing workshops. Three of them have been quite a long time in the company. The two others have been project engineers in their first year. Both have been supported by a few student workers.
3. *Let agents describe their processes and tools. Use a business process model to represent these concepts.*
Do structured interviews or perform group meetings [32] with the different agents. In the knowledge elicitation process we have been faced with the problems mentioned in table II. Interestingly, both experienced and inexperienced employees did not complain about the lack of explicit engineering or R & D expertise but the lack of tedium knowledge of how to perform simple tasks. While the complaints of inexperienced worker are quite obvious, the experienced workers complained about the disturbance of their work by being asked for task information frequently. So, primary goal of the elicitation process has been the identification of the processes performed by the agents and the supporting tools and documents. In GRAECULUS the usage of arbitray business process models is possible as long as the concepts of the models can be related to the meta model.
4. *Create to bootstrap repository.*
Use the mnemonic process *knowledge creation* to externalize process, agent and tool representations in the underlying repository. Externalize the links between knowledge agents, processes, tools, and documents. All objects and relations have been created with the GRAECULUS system by transcribing the elicitation results. Also, the system's representation and its usage has been externalized (cf. section III-A).
5. *Empower people in short training sessions.*
Employees learnt to use the system very fast because of it simplicity. Training effort was also reduced since people were already involved in the bootstrapping process. Especially search facilities have been adopted very well. Knowledge creation was a problem at first. People disliked to externalize knowledge fearing it could be wrong or not interesting. Later on, knowledge externalization processes were used more frequently, especially in delegated tasks performed with the workflow component.
6. *Let the system run to build up knowledge.*
Some of the experiences users made with the systems are discussed in section IV.

A. The Modeling Approach

To interrelate the mnemonic with the business processes on a conceptual level, we construct a meta model which emphasizes

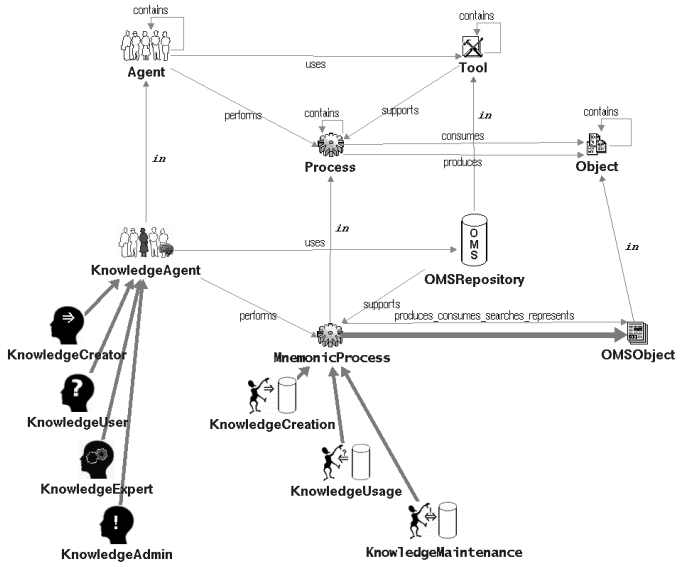

Fig. 1. Organizational Memory Meta Model (CONCEPTBASE Window Dump)

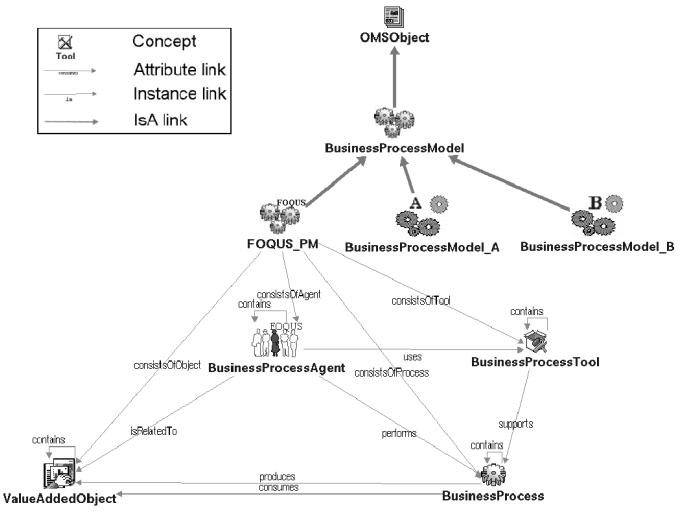

Fig. 2. Business Processes are Objects of the OM (CONCEPTBASE Window Dump)

the coherence between both kind of processes. The meta model is based on an extended entity-relationship approach, the Telos language [33]. The mnemonic process part of the meta model is given in figure 1 using a graphical presentation. Each icon represents a concept of the meta model. Attribute links between concepts are shown as arrows labeled by an attribute name. Instance links are arrows marked by the label *in* while isA-links are presented as bold arrows. In the following concepts are typed *italic*. The modeling process has been performed with the CONCEPTBASE system [34] to check integrity and consistence of the models. The meta model then has been transferred to the relational database management system on which the GRAECULUS system has been built. The most important ideas underlying the meta model can be summarized as follows:

1. *Business processes models are the primary objects of the system.*

Organizational activities contain important knowledge. *Business processes* will be represented by models expressed in a language chosen by the agents. Since we used a meta model approach, the use of different modeling languages is possible. These models can be interrelated by means of *mnemonic processes* and meta modeling techniques. For GRAECULUS we use the language described in [35] which has been developed and validated in the FOQUS improvement management context [36, 37]. For the sake of brevity we here describe the concepts only in short.

Process. This concept describes *business processes performed* by *agents*. *Business processes* can be refined by *contains*.

Agent. This concept characterizes humans (groups of human) of software *performing* a business process.

Tool. The *tool* concept describes technologies *supporting* the *agents performing* their *processes*. There is a clear distinction between tools and additional resources which belong to the object concept.

Object. In a business process environment the *object* concept describes artifacts *consumed*, *manipulated* or *produced* in business processes.

An OM-based workflow environment which supplies a knowledge-based support to the company's activities seems to be appropriate to enhance the primary objective - the competitive performance - of a company. Hence, the *mnemonic processes* have to deal with the activities of the company. As a consequence, the *business processes* get the role of objects, which will be *produced*, *consumed*, *searched*, and *represented* by the *mnemonic processes* (cf. figure 2).

2. *Knowledge agents are involved in any kind of processes.*

Due to both previous explications, it is obvious that knowledge agents are not only involved in *mnemonic processes* but also in b*usiness processes*. In reference with *mnemonic processes* we have to refine the concept of *agent*. Therefore, we distinguish the following refined concepts (cf. figure 1).

Knowledge Creator. New knowledge is obtained through conversion of explicit and implicit knowledge. In knowledge-intensive enterprises most of the employees frequently *create* new knowledge. To make this knowledge useful for the company's goals, the *knowledge creator* must be able to externalize and share this knowledge. Within the OM model the *knowledge creator performs* the *acquisition* of new knowledge, so this concept refers to *knowledge creation*.

Knowledge User. People who are looking for some knowledge - e.g. people, searching for an answer to an emerging question - are called *knowledge users*. *Knowledge users perform* knowledge *search and retrieval processes* within the OM model and eventually become experts through their intensive use of processes, objects, and tools.

Expert. Experts are people who hold a certain part of knowledge relevant for the company. These people *maintain* an important part of the OM because they hold implicit knowledge, difficult to externalize and in so far can hardly be supported directly by computer supported tools for knowledge management.

Knowledge Administrator. The *knowledge administrator supervises* the OMS. For knowledge can get conflicting or invalid over time, it is necessary to do so. He can explicitly select *processes*, *objects*, *tools* and *agents* for *maintenance processes* like aging and archiving. *Monitoring processes* can also be *performed* by

TABLE III
KNOWLEDGE CONVERSION & CONNECTING STRATEGIES (ADAPTED FROM [38])

Knowledge flow	*. . . People*	*. . . Knowledge*
People to . . .	**Socialization** Asking an Expert	**Externalization** Query Filtering Guided Exploration
Knowledge to . . .	**Internalization** Subscription Task-specific Pushing	**Combination** Navigation

the OMS itself, e.g. for assigning expert roles to agents (*knowledge maintenance*).
Agents use the *OMS repository* as an essential *tool*. Through the linkage of relevant information to the business processes, knowledge concerning the processes is stored permanently in this knowledge repository. Furthermore, the modeling approach guarantees a documentation of processes for further use, e.g. in personnel training.
3. *Mnemonic processes are business processes themselves.*
The *mnemonic processes* establish an important determination for successful knowledge management because someone is unable to make use of stored knowledge without them. Therefore, these processes are a central part in GRAECULUS. As described in [19] the resulting workflow environment is not only a repository but has to be embedded in the processes and tasks of the organization. Even though *mnemonic processes* have more long-term characteristics than short-term *business processes*, it is important to emphasize that *mnemonic processes* are activities of the company as well. So, these activities have to be supported by GRAECULUS just as *business processes*. Therefore, it is insightful to model mnemonic processes in the same manner as *business processes*. For the sake of brevity we describe only **mnemonic usage processes** here. The use of existing knowledge is significant for an effective company's performance in changing environments. The quality of decisions and problem solutions is influenced by its abilities to search and retrieve [39]. Hence it is important to provide effective means to access knowledge directly through suitable storage structures. Morrison [12] describes techniques like "asking an expert", querying, filtering, guided exploration, subscriptions, and navigation as effective strategies in different usage contexts. Workflow-based systems introduced the process of task-specific pushing of information [19, 35]. O'Leary [38] adds the idea of connecting people and knowledge to the idea of knowledge conversion modes introduced by Nonaka and Takeuchi [31]. In table III we assign the *mnemonic processes* related to *search & retrieval* to the knowledge flows described by O'Leary.

B. GRAECULUS *Architecture*

The GRAECULUS architecture is based on a client-server concept. Both, data storage and implementation are realized on a central server. The resulting advantage is a single, non redundant data storage with no need for replication. To realize persistent storage and efficient access, a relational database management system is deployed. We used a public domain multi-user, multi-threaded SQL server.

GRAECULUS was implemented on the server using servlets [40]. Servlets respond to HTTP-queries of web browsers and generate web pages dynamically. No additional installation on the clients is necessary. Using web browsers facilitates hardware independence and user fitness. Scalability of a central-server based servlet engine is ensured by frequently used services on the internet, e.g. Java Developer Connection. The implementation and the deployment of GRAECULUS was proven easy and cheap - the whole implementation of GRAECULUS contains no more than 15.000 lines of code.

The mnemonic processes use the knowledge repository in different ways. Newly externalized knowledge is propagated into the knowledge repository by knowledge acquisition, so the knowledge repository gets enhanced and actualized. In knowledge creation processes affected objects will be locked by GRAECULUS to avoid inconsistencies. The retrieval of knowledge can be obtained by search functionalities. Convenient search strategies are necessary to attain flexibility and fast search runs:
Guided search allows to look for particular instances from chosen concepts of the business processes. Therefore, the agent can select a desired concept and receive a list of all stored instances, from which he can choose the sought item.
Full-text search allows to look for a particular pattern in the whole knowledge repository. All relevant items will be listed.
Index search provides an ordered list of all stored items of which the agent can choose the desired item.

The process "asking an expert" is used to obtain further implicit knowledge. For retrieval, the searched items will be displayed and interrelated items will be referred. To organize the retrieval of files effectively these files can be opened through MIME functionalities of web browsers directly.

To preserve the consistency and actuality of the knowledge repository different maintenance processes are implemented. Mainly, the successful integration of new knowledge can be checked by monitoring the use of knowledge. Further examples are the prevention of data loss through backup functionalities. For a proper assistance of the agents an explicit user management is put into action.

A background archive is used to swap out aged knowledge

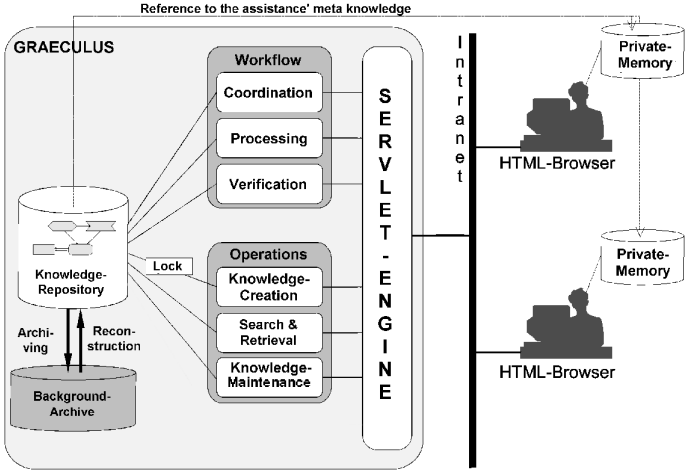

Fig. 3. GRAECULUS Architecture

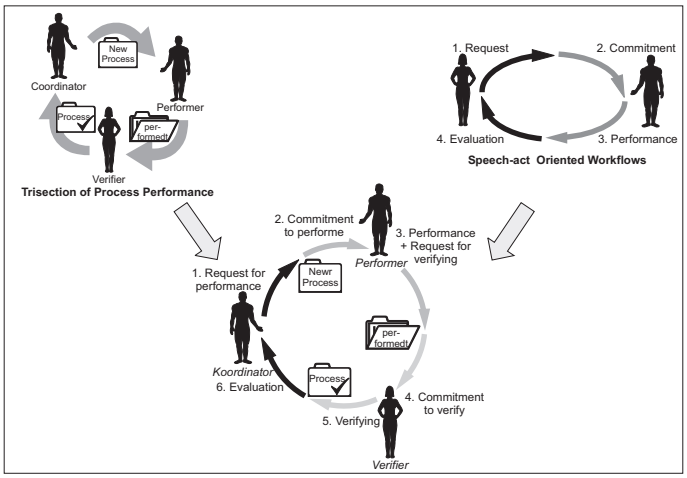

Fig. 4. GRAECULUS Workflow Approach

that would lead to inconsistencies with the current knowledge. Aged knowledge will not be deleted because even former knowledge about process performance may provide useful information about history and development of the organization. To retrieve aged knowledge, it can be reconstructed from the archive.

C. Integration with Daily Work

GRAECULUS is embedded in the daily work activities. Thus, the actuality of stored knowledge is ensured and the assets of GRAECULUS are used in performing tasks directly. Still, the system should accompany the agents in performing their tasks without restricting their functioning. GRAECULUS does not prevent the agents' creativity and ability of learning which would prevent process performance improvement.

We found a trisection of a typical process performance which involves three agent roles. As shown in figure 4, an agent initiates a new task, whereby he adopts the role of a coordinator. He delegates the execution and the subsequent verification of the task to other agents and concludes it after these steps.

To support this approach, a speech-act oriented workflow model [41] has been expanded to map the business and mnemonic processes on workflows which can be supported by GRAECULUS. This model is based on the language/action perspective [42] and describes the communicative relationships between a customer who asks for an action, and a supplier who fulfills this work.

The processing of tasks will be referred through the necessary communicative procedure. Concerned agents will be supported in performing their tasks through a workflow component which accompanies them through task performance according to his role and offers them additional information with regard to the performed tasks. The component is implemented by means of deterministic automata and uses structured email to establish communication with agents. More assets are gained through the ability to monitor the process performance by means of the system's logging facilities. The status of a process and the responsible agent can be indicated at any time.

Furthermore, the agents can directly improve the knowledge repository through their new knowledge, gained through the execution of the task, and interrelate this knowledge with the appropriate task. It has to be emphasized that through the creation of new knowledge GRAECULUS can derive knowledge about expertise, i.e. implicit knowledge. An agent can profit from knowledge profiles of other agents and further knowledge about executed processes which is implicitly generated by GRAECULUS (cf. section III-D).

The interrelation between the knowledge base and the daily work through the workflow component of GRAECULUS preserves the validity of the stored knowledge. Invalid or inconsistent information is detected and corrected immediately by agents performing processes.

D. An Application of the Environment: Knowledge Maps

It is really important for organizations to know who has which knowledge because transparency of knowledge is increased by recognizing deficits in certain areas or assign competences to certain tasks. Even if an employee has left an organization, it is important to realize how much knowledge has left also. An visualization of these facts is possible through use of so called knowledge maps. Existing approaches include knowledge topographies, geographic information systems, knowledge matrices, and knowledge source maps.

However, creation and management of such knowledge maps are costly. GRAECULUS creates and manages such maps (references to user meta knowledge, cf. figure 3) automatically by storing and analyzing traces of its use. Every time people are using the functionalities of the system, the models in the database are instantiated. By querying the tables a knowledge profile of an employee will be generated online as a new HTML page. In extreme, such profiles include all the business processes and mnemonic processes employees have performed but the queries can be parameterized to cut down result sizes of the queries. It is possible to query if an employee have accessed objects more than 10 times which could be determined as a criterion to be an expert for those objects.

The following query formulated in SQL leads to the dynamically generated HTML page in figure 5 (all readable information in German), where type discriminates the users role in objects, e.g. expert for "WORD letter template".

```
SELECT AgentFulfilOMSObjectRole.Type,
       OMSObject.Name,
       OMSObject.Description,
       OMSObject.Type
  FROM AgentFulfilOMSObjectRole,
       OMSObject
  WHERE AgentID = "Sylvia"
  && AgentFulfilOMSObjectRole.OMSObjectID
       = OMSObject.ID
```

IV. DISCUSSION

To show the abilities of GRAECULUS, we present an example from the company in which the system is currently operational. As shown in section III this is a real world example. An employee receives the order to create a new standard text letter to send invitations for a workshop. This will be done by a coordinator with the workflow component of GRAECULUS.

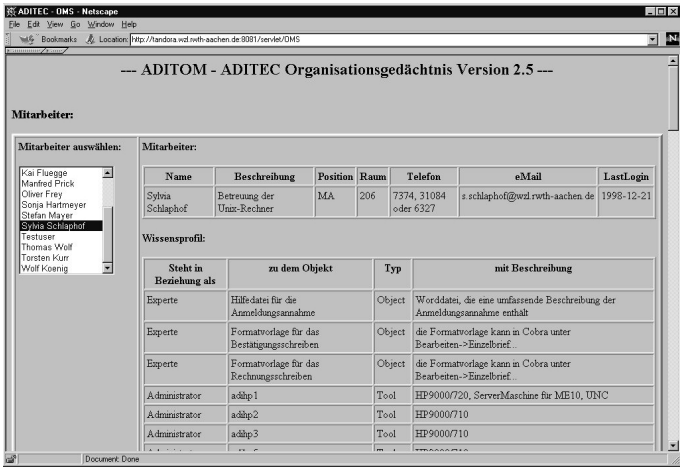

Fig. 5. Dynamically Created Knowledge Map (Window Dump)

The instructed employee learns by navigating the business process "create a standard text letter" that he requires a certain letter template. Unfortunately, he does not know, where the template file is stored, whereupon he performs "asking an expert". GRAECULUS is now searching for an agent who is explicitly denoted as an expert in templates, or someone who is using templates frequently. If both search runs fail, the result of the request will be the knowledge creator of the template and therefore, the agent who created this template. Here, GRAECULUS creates a link between fully independent processes. Now, a prepared email tool is invoked automatically to establish a contact to the knowledge creator. Simultaneously, the employee can initiate an acquisition process and assign the knowledge creator to complete the lacking information in GRAECULUS.

The example demonstrates how an input on the operational level is able to cause effects on the modeling level. This clarifies, how the OM-based workflow environment can be deployed directly through interrelating business and mnemonic processes.

We evaluated early use in a period covering roughly 3 months by means of the I/S success model developed by DeLone and McLean [43]. After the bootstrapping process of about 2 months which turned out about 200 objects, search and retrieval processes of GRAECULUS are made available to half of the company's staff. The workflow and the knowledge acquisition component were added later. Thus, the users could get familiar with GRAECULUS by starting with the part which adduced most advantages.

The usage evaluation process was twofold. For evaluating the amount of GRAECULUS use we utilized its logging mechanism. For evaluation of user satisfaction with GRAECULUS, we have integrated a survey form into GRAECULUS and performed structured interviews with the users.

In the evaluation phase of GRAECULUS the users performed 80 logins which generated 1518 web pages. The mnemonic processes have been adopted by the users very soon. Especially search functionalities - guided search more than full-text or index search - have been used frequently.

The acquisition component has been added in the mid of the period. It has been used with a little delay because users feared to acquire false or useless knowledge. But these fears vanished when they realized to be an essential part of the system. The use of acquisition results in a knowledge growth by 50 objects (25 %) in the remaining 5 weeks.

The primary effects observed through the deployment of GRAECULUS are the following:

1. GRAECULUS has been used by new employees to work in the company's core processes.

Since the work load of staff is very high new employees will not be acquainted with the company's activities by other employees but have to do this independently. With GRAECULUS they learn about the company's processes more efficiently and also profit from added experiences.

2. GRAECULUS facilitates all employees in performing unfamiliar tasks.

For most company's tasks are not assigned to certain employees but will be performed by everyone, GRAECULUS is also used to clarify uncertainties about task performance.

In structured interviews we evaluated the rapid knowledge deployment approach to knowledge management.

1. *The system was brought to the knowledge not vice versa.*

By installing the system there was no additional effort for new personnel. All knowledge agent roles have been filled by the staff. There was no need for a knowledge engineer. The knowledge administrator's role has been filled by the system administrator.

2. *The users liked the rapidity of knowledge deployment.*

The bootstrapping period has been followed by a bi-monthly implementation period in which most of the system's components have been realized by one programmer. After that period, all of the externalized knowledge was at their disposal. They have got an almost immediate feedback for taking part in the bootstrapping process.

3. *The users got a feeling about the usefulness of knowledge management.*

After a short initial period filled with fear and uncertainty the system's processes have been accepted and the users feel empowered in their roles. They understand that they are not only performing business processes but also enhancing the corporate knowledge of the company.

V. SUMMARY AND OUTLOOK

We have presented a OM-based workflow environment with the explicit integration and interrelation of mnemonic processes which are used to create, access, and maintain an explicit representation of an organizational memory together with a bootstrapping method for a rapid knowledge deployment. The system has been implemented and evaluated in a small knowledge-intensive company under controlled conditions.

We choose an experimental approach by introducing technology into an organization and then observing the use. By combining qualitative and quantitative data gained from these observation processes we then develop the next generation of IS support. Although, this approach is limited through the time-consuming intensity of long-time experiments. The results presented here are limited through the short evaluation period. Efforts are under way to study the use of our approach in more organizations. Besides the operational functional characteristics of GRAECULUS the approach has also

analytical capabilites as shown in [44]. We use the approach for comparative studies between engineering and cultural science projects. A community web site to study patterns of knowledge organisation and communication in cultural science is operational under http://www-i5.informatik.rwth-aachen.de/lehrstuhl/research/projects/FKMedien/.

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