4.2 Man-Machine-Cooperation

Semi-automated systems that run autonomously most of the time but require occasional user interaction (if there is not enough information available to make a decision) could be defined as “hybrid” systems.

The article: “Effective management of knowledge requires hybrid solutions of people and technology.” [Davenport, 1996] defined hybrid systems in knowledge management.

The proposed hybrid system consists of:

- a knowledge management system, that forms the core of automated part and uses a semantic network (see 2.2.1);
- information professionals implementing and managing an ontology that allows the representation of knowledge structures;
- automated processes to discover employees’ topics of expertise;
- knowledge brokers;
- experts in certain topics;
- employee profiles;
- a portal offering search functionality, a personalised view of information stored in the KMS (see 4.3), easy management of users’ information, and a communication system;
- special search algorithms (such as calculating additional hints (see 4.5)).

4.2.1 KMS and Knowledge Structure

The knowledge structure proposed is a core based on a network structure (a definitional network is recommended, see 2.2.2). This corpus should contain all the concepts relevant to the organisation, (also called core concepts). Nodes of this knowledge network could refer to documents, to articles, or other resources (e.g., to IT systems that the company uses). Information professionals are responsible to maintain the core concepts within the system.

Furthermore every employee is represented by a node within the knowledge network. Mapping the organisational units and hierarchical company structures is highly

recommended. Nodes that represent people should contain contact information or provide a link to resources providing relevant personal information such as human resource management systems or user directories (see 2.3.1). Figure 4.2-1 illustrates such a structure where employees are linked to a user directory identified by an UID (unique ID) (contact information stored in the user directory). This allows user information (such as an email address) to be retrieved during user searches.

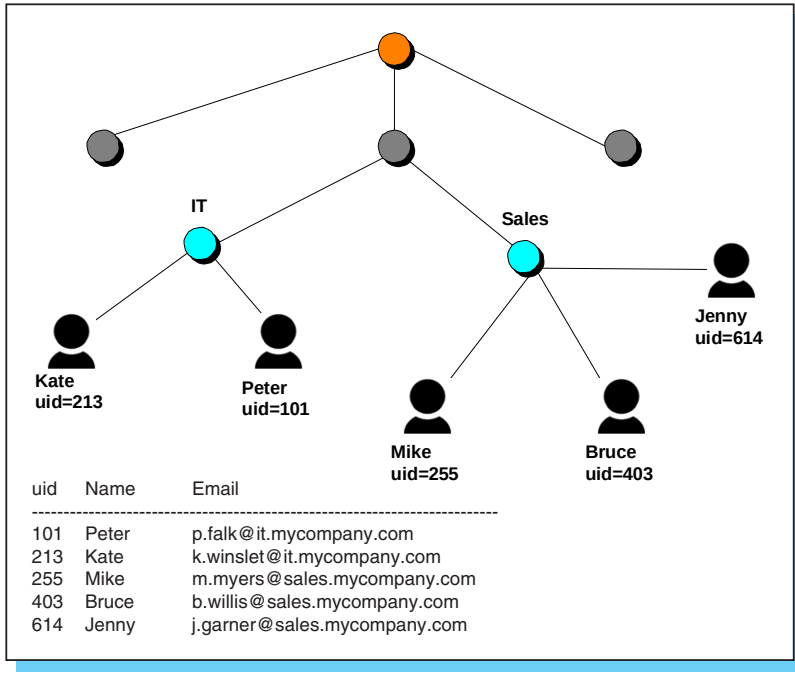

Figure 4.2-1 Example Knowledge Network with Employee Structure

4.2.2 Employee Profiles

KBs need to ensure that the information stored within the user profiles is accurate. This can be insured by involving users' personal KBs in the maintenance process. An employee should have the opportunity to maintain his own profile by drawing on set vocabulary to describe personal skills, expertise and knowledge. Most companies store

employees' personal information in a directory or human resource management system. There are some advantages from linking employees' information and area of expertise to the knowledge network:

- The knowledge network provides the vocabulary for the choice of experiences. If a topic is not present in the knowledge network and there is an expert available the topic needs to be added.
- It might be easier to draw out a conclusion. Figure 4.2.2 shows that a salesman (Bruce) might ask a developer (Kate) to change a product (the system provides an overview of developers who have the necessary skills to complete the task).
- Every user able to access the knowledge network is able to view their colleagues' areas of expertise.

It is the KB's job to motivate and assist employees in maintaining their profiles on a regular basis. However, maintaining the profiles manually leads to profiles that are out of date. An automated solution (see 4.2.3) might be introduced to fix the problem.

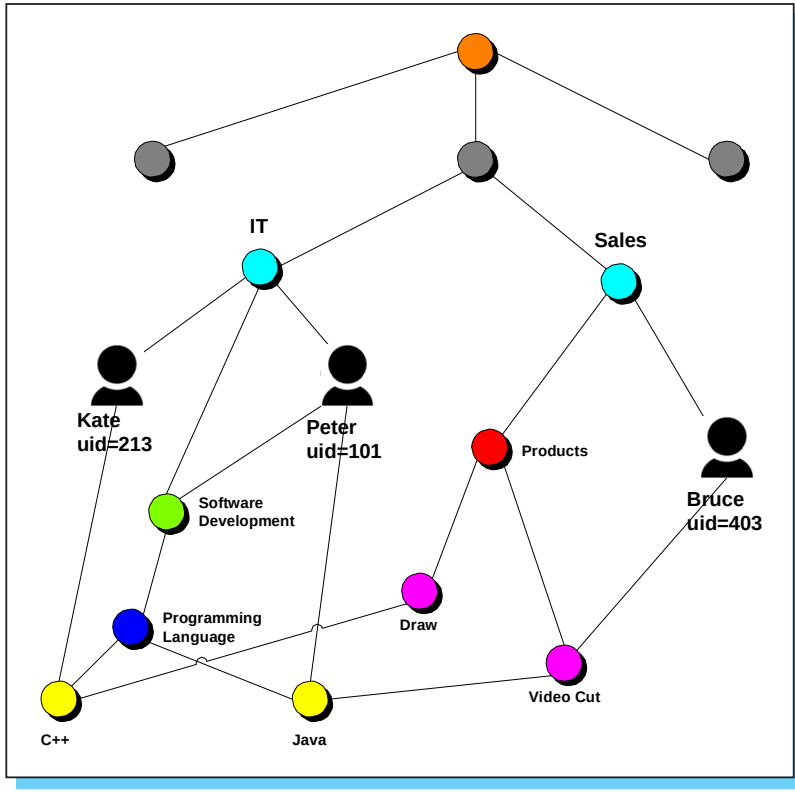

Figure 4.2-2 Example Knowledge Network with Employee Experiences

4.2.3 Automated Update Processes for the Maintenance of the Knowledge Network

Knowledge management is a time-consuming task as shown in Chapter 3.5. This is because most employees produce information in different formats: reports, project documentation, product documentation, marketing material, price sheets, orderings etc. These documents are usually stored on a file server or within a document management system.

Technologies exist within knowledge management that are able to interpret document semantics and draw conclusions in order to enhance the quality of a semantic network. There are several information retrieval based methods to achieve this described in the literature:

- automatic knowledge acquisition by semantic analysis and assimilation of textual information [Glöckner et al., 2006];
- probabilistic latent semantic indexing [Hofmann, 1999];
- unsupervised learning from dyadic data [Jordan et al., 1998].

Besides academic approaches some KM products offer semantic analysis of text based information (see 2.3.2), e.g., USU [www.usu.de] Knowledge Miner and empolis [www.empolis.com] e:kms.

Figure 4.2-3 illustrates how documents might be integrated into the knowledge network automatically. Document 1 is linked with persons A and B because of their authorship. Document 2 is linked to its author (B) and the topic “database” because of the result of semantic analysis that found the relationship to databases, just as the link between document 3 and the author C and the topic “design”.

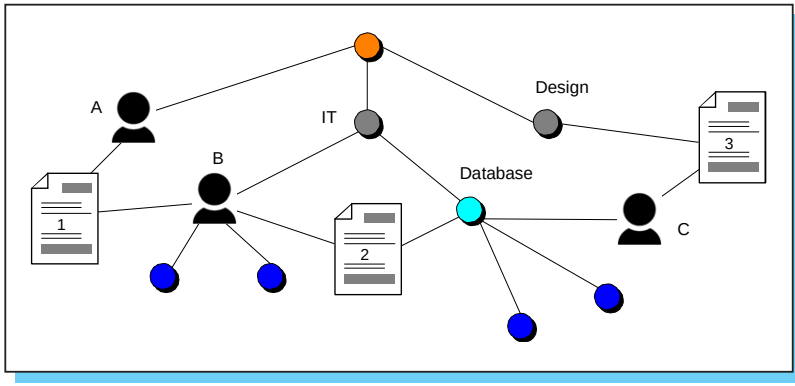

Figure 4.2-3 Automated integrated Documents within a Knowledge Network

Additional conclusions are possible after the automated integration of the documents into the semantic network as shown in Figure 4.2-3:

- there is a relationship between the employees A and B;
- employee B may learned something in the topic “database”;
- there is a relationship between the employees B and C in the topic “database”;
- employee C may learned something in the topic “design”.

But there is a risk to misinterpret information: if document 3 deals with “database design” the link between document 3 and the topic “design” is not correct. Using the probabilistic model might be an example (see 2.2.3 and Figure 2.2-30) a word’s frequency within a document is used for semantic analysis. The term “design” may be used several times in document 3 but in another meaning.

Automated updates of the semantic network need to be monitored, but in practice this would be a time-consuming process. A notification process might be a possible solution: illustrated in Figure 4.2-3 the user C is asked whether his document should be linked to the topic “design” or not.

4.2.4 Search Functionality

The portal offer several retrieval options to the users. The standard search of the KBN is a general purpose simple search (a direct text-based search see 2.2.3).

Searching for Documents

The search for documents is a fuzzy search. The first step of this semantic search is a simple search which provides direct hits. The search results retrieved are limited to documents. A filter prevents personal details being displayed as results. All relations with distance k=1 starting from the direct hits are included as indirect hits.

Searching for People / Experts

Searching for experts is very similar to searching for documents. Only the filter settings are different. Contact details are displayed instead of documents. Contact to an expert via the KBN-portal can be arranged then.

Searching for other Knowledge Brokers

Utilising this search a user or a knowledge broker is able to find other knowledge brokers. It is a focused search (not fuzzy like the semantic searches). Therefore users have to enter the area of expertise.

Searching for Expert Communities

Searching for communities of experts is also a focused search. By entering the name of the desired community or the subject of the community all persons within this community are listed. A community is defined in KBN as a voluntary association of experts specialising in a certain topic (for details see 4.4).

Searching for Departments

Searching for departments is similar to the community search. Personnel of a department found are displayed within the result set.

Forwarding of unsuccessful Searches to a Knowledge Broker

Usability of the system might be enhanced by transferring a task at directly to a KB. This also shows the potential of the hybrid solution. A user is able to switch between the automated part and the involvement of people at any time during the process. Therefore the user interactions are tracked within the portal. In an advanced mode the user should be allowed to select or deselect actions that will be transferred to the KB.

4.2.5 Search Results Restrictions and Ranking of Experts

Standard internet search engines display as many results as they can find for a single request, these are usually split into several parts with a certain number of results per page.

When searching for an expert the system has to decide **how many experts** should be retrieved. General topics have a bigger number of experts than specific topics. Depending on the topic the system should retrieve a reasonable number of experts and not a fixed number. [Demartini, 2007]

How to find the **adequate expert** if there is a large number of experts available? One might imagine that in a software development company a lot of experts exist for a certain programming language. A problem is that trainees might be included in the same list as experts. Whom to ask?

One possible solution can be based on a **hierarchical company structure**. If the user does not explicitly request experts from higher hierarchical layers, then only experts within his hierarchical level or lower will be displayed. A hierarchical meta-structure of a company may be developed to tackle the problem. These hierarchical dependencies are not contained in Figure 4.2-1. Figure 4.2-4 illustrates a possible meta structure for company hierarchies integrated in a structure as shown in Figure 4.2-1.

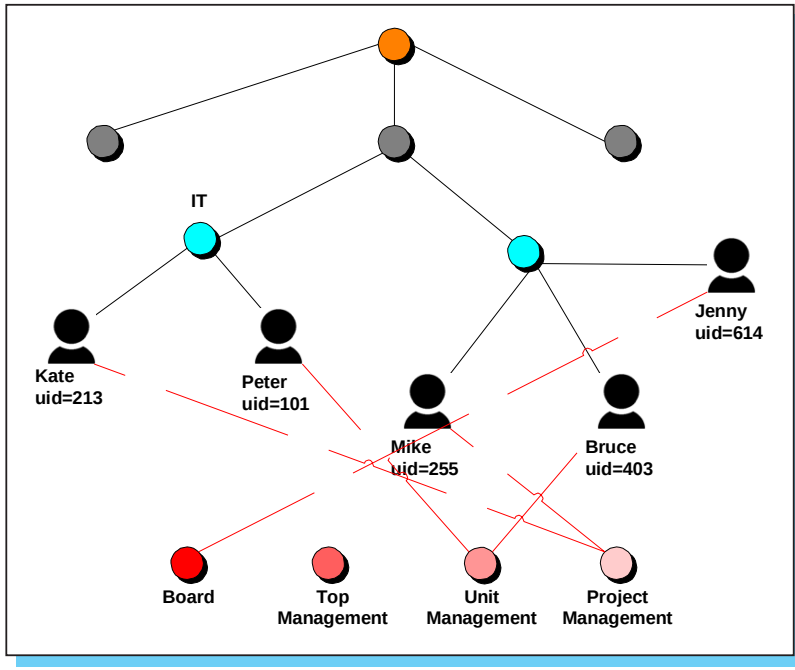

Figure 4.2-4 Meta Structure for Company Hierarchies

Another criterion is the **availability of experts**. Therefore the character of requests can be divided into two categories:

a) requests that can be answered quickly, and
b) request that need cooperation over a longer period of time.

Requests of type a) might require a fast response. The system should offer information to the user regarding expert status such as:

- online or offline,
- busy / do not disturb,
- away / not available, and
- call / ask me.

The user has to decide whom to contact subject to availability of the expert.

The decision between online and offline status may be implemented using a single-sign-on solution [Leggett, 2005] provided by the company or using the login / logoff function of the KBN portal. The status away / not available can be based on an electronic calendar functionality that the company might offers (or similar functions to be developed for the KBN portal).

An expert who offers his expertise through the KBN portal has to announce his status to potential users. The option to select between the “busy” and “call me” status must be provided by the KBN portal. This status must also be imported from the companies IT infrastructure (communication technologies used within a company play an important role). Skype Web for example allows Skype users to display their status on a Web page or other applications [www.skype.com]. Some (voice over IP) telephone systems offer similar functionality. For example the use of “wengo visio”, a web-based video chat system, that might be provided by the KBN portal (see Figure 4.9-11) as described in Section 4.9 offers only two modes: online or offline. Users need to switch wengo visio off if they do not want to be disturbed.

It depends on company culture whether “busy” or “call me” status is the default setting after login into the KBN portal. This default status can also be stored to the experts’ profile.

Additionally ranking experts found in search results is based on **existing relationships** between users seeking and experts. Previous user rankings are also taken into account. Relationship management and rating of experts are part of the personalisation concept (described in Section 4.3).

Sometimes the experts base **location** is of importance, for instance when a user is looking for a project team.

4.2.6 Supporting Complex Requests / Querying Multiple Experts

Complex requests (such as type b shown in 4.2.5) should be supported by a personal KB. The KB searches for experts, asks them whether they are able to cooperate with the user asking the question. The chosen expert then establishes a direct communication with the user seeking for help.

There should be a parallel function to send requests to many experts in case a user wants to ask potential experts by himself without any assistance of a KB. This may be implemented like a **market place for requests**. Experts who are willing to help accept a request and contact the enquirer, the request will then be marked as in progress. The user can choose between two different models of market places:

- a public market place where employees' have access to all requests, and
- a restricted market place where a request can only be viewed by experts chosen by the user who made the request.

These two kinds of market places are also available for KBs to distribute client requests to a public group of experts.

4.2.7 When to Contact a Personal Knowledge Broker

The first idea found was to track user interactions with the portal and analyse navigiation paths within the knowledge network. After the system has analysed the user's navigation path by the tracking algorithm it can be concluded that a user:

- navigates directionless,
- navigates in loops over the same node(s),

- navigates inside an area that can be identified as topical area including existing experts, or
- exceeds a certain number of interactions.

Then the users are asked whether he / she would like to contact a KB or expert.

Discussions with potential users identified that the number of interactions accepted before contacting the KB depends on several conditions:

- Hierarchical level within the company; the higher level the lower the number of interactions accepted.
- Time pressure regarding users; the higher his time pressure the lower the number of interactions accepted.
- Type of search:
  - Searching for special facts or details within the users own topics areas results in a higher number of interactions accepted, e.g., searching a function of a library used by a programming language.
  - Getting an overview of a topic that is unknown for the user leads to a medium number of accepted interactions.

This leads to the conclusion that users must decide when they want to contact a KB. Therefore the KBN portal offers this option at any state and at any time, unless not allowed for some employees depending on their company's policy.

Nevertheless, a special search assistance algorithm is introduced in Section 4.5. This algorithm provides hints like expert names familiar with the user's requested topic or identifys navigation loops and displays important nodes in the neighbourhood of the user's navigation path.