A VIRTUAL ADVISOR FOR RECYCLING PROCESSES IN CONCRETE CONSTRUCTION

EIN VIRTUELLER BERATER FÜR KREISLAUFPROZESSE IM MASSIVBAU

UN CONSEILLER VIRTUEL POUR LES PROCESSUS DE RECYCLAGE DU BÉTON DE CONSTRUCTION

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SUMMARY

Knowledge based online systems are useful tools to increase the efficiency of the utilisation of research results in practical applications. BiM-Online is an interactive system that covers the field of recycling processes in civil engineering.

ZUSAMMENFASSUNG

Wissensbasierte Online-Systeme sind zweckdienliche Hilfsmittel zur Verbesserung der Nutzung aktueller Forschungsergebnisse in der Baupraxis. BiM-Online ist ein interaktives System, das den Bereich der Kreislaufprozesse im Massivbau abdeckt.

RESUME

Les systèmes interactifs basés sur la connaissance sont des ressources propices à améliorer l'utilisation des résultats de la recherche appliquée. BiM-Online est un système interactif qui couvre le domaine du recyclage dans le génie civil.

1. INTRODUCTION

The research program "Building material cycle in concrete construction (BiM)“, that was promoted by the Federal Ministry for education and research (BMBF) and the German committee for reinforced concrete (DAfStb) since 1996, took aim at the reuse of gravel obtained from demolished concrete constructions. Processing methods for rubble consisting of mineral components of crushed concrete were investigated in order to gain possibilities of using such material as aggregates for new concrete. This recycling process should be made possible without the need of special permissions. Therefore the new recycled materials have to be in accordance with DIN 1045-1.

The entire program consisted of a large number of single research projects with involvement of 22 research institutions distributed all over Germany. The broad scope of the BiM-program covers almost all aspects of concrete recycling. The compiled knowledge represents a high economical value and it should therefore be made available to interested scientists and engineers. Because of the complex relationships between the different topics this task can hardly be fulfilled by the use of simple print media. It also was desirable to offer quick and comfortable tools for the investigation of the collected knowledge base. An important solution for these problems is called „computerised knowledge management“, which is already used in some fields of industrial engineering. Modern information technology and especially the client-server concept within wide area networking architectures make it possible to offer large online-databases and fulltext retrieval mechanisms. Thus the availability of the information can be significantly improved.

The development of appropriate information and communication concepts within the research program was the task of two special subprojects. The creation of a „central database“ and an „expert system“ were the initial topics of these two projects. The work was carried out at the building materials institute (IWB) at the University of Stuttgart. In close co-operation with the other research institutions a structured database was build.

This could be used by the involved researchers to get information about interim results and the current process status of other subprojects and was a valuable resource that made co-operation more efficient. This first step of the knowledge base was realised as a combination of relational database-tables and a document collection. The users had access to the content of this hierarchically organised database structures via a webbased hypertext surface which can be used in an intuitive way.

In order to prevent rash publication of preliminary results, the access to the half-yearly interim reports and to the results from material testing were subject to a password protection during the course of the project. Additional information of more general interest was made available to Internet users without direct participation in BiM. The public part of the online system covered a topical overview, a listing of the project participants and information about existing publications that was organised in a special database. Since June 1999 the entire database presenting the final results of the research program was made accessible to public. By the end of October 1999 the information system, that can be approached via the address http://www.b-i-m.de and is called BiM-Online, is used by approximately 30 users per day. Email contacts and the analysis of the server logfiles show, that most of the system users are located in universities and other research facilities.

2. BIM-ONLINE DIALOGUE

Users concerned with civil engineering practice demand capabilities on information systems that differ from the needs of scientists and researchers. During planing, design and execution of building projects usually little time is left for the involved engineers to study research results and to draw appropriate conclusions.

Beyond the supply of the scientific result of the BiM-program it was therefore necessary to anticipate possible problems and questions arising during demolition, processing and reuse of building material and to offer helpful statements. These statements concerning practical questions were summarised in so-called „lessons“. Each lesson is a coherent sequence of usually several information pages regarding a certain question.

The length of a single lesson is depending on the range of the available knowledge and on the other hand on the complexity of the problem, which is to be processed in the lesson. In order to offer specific information to the user it is in most cases necessary to do further inquiries according to additional relevant input data.

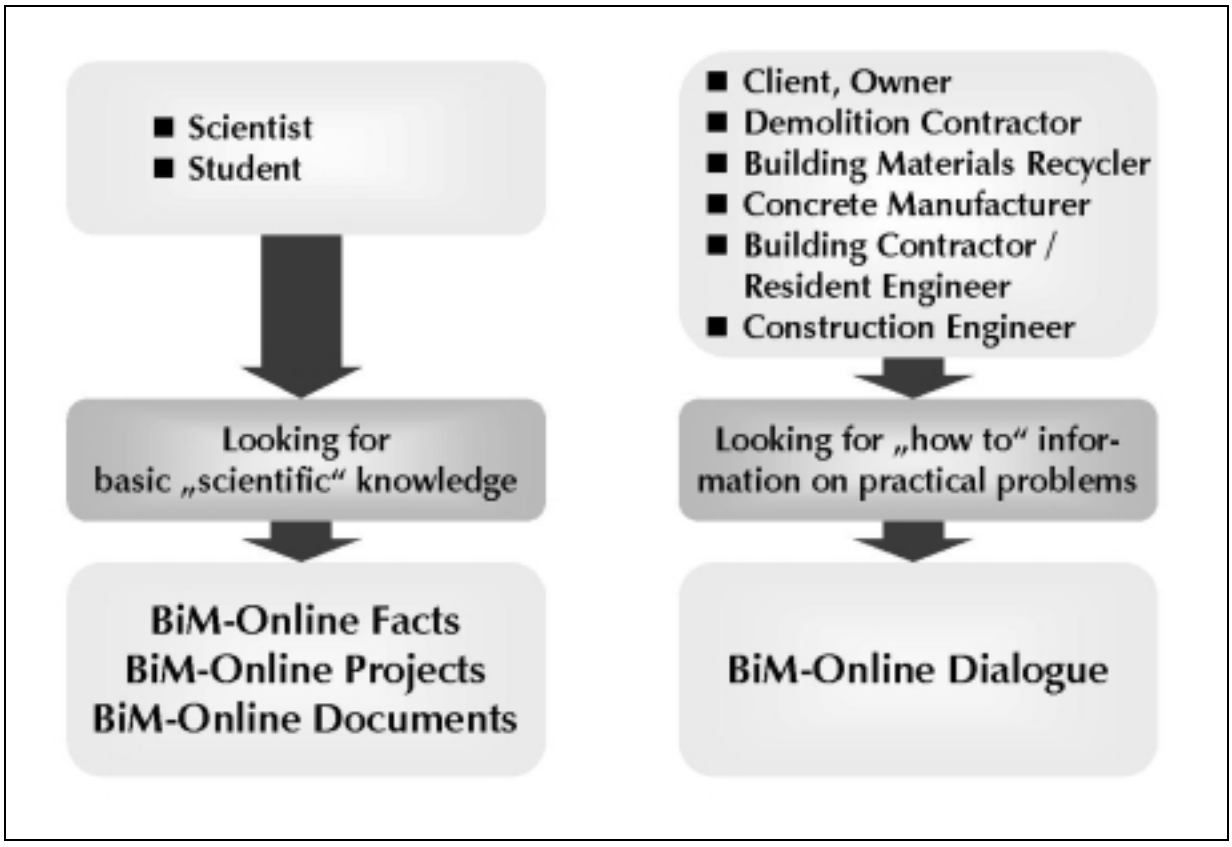

Fig. 1. *For practical use the research results have to be structured in a problem oriented form.*

Thus the system reacts almost like a human expert for building material cycle processes would react in a consulting discussion. It offers direct access to the information of practical relevance even to users who are not experienced in handling and searching complex data bases. Besides the hypermedia concept of the World Wide Web (WWW) facilitates the integration of further sources of information substantially. Especially cross references between individual lessons can be implemented quite easily by the use of hyperlinks.

The user is able to gain information directly concerned with the BiM-research-program as well as secondary information provided by other online-sources without loosing the advantages of the clearly structured user interface of BiM-Online. The screenshot in the middle of Fig. 2a shows the screen content after clicking the „Literatur“-button: In an additional window those literature sources which cover the basic knowledge of the current lesson page are listed. The dialogue-system hereby makes use of the literature database which is also available as an independent module of BiM-Online. If the cited document is available within the BiM document collection the user is able to request its on-screen-reproduction by mouseclick. Adequate presentation of the information network which is very complex and extensive in width as well as in depth makes great demands on the user interface. Fulfilling these needs is very important in order to prevent the user from the feeling of „being lost in hyperspace“.

The current range of the total knowledge base of the BiM-dialogue-system spans over 83 lessons with altogether 379 dialogue-steps. Additional lessons covering the field of environmentalfair demolition methods are still under development and hence not counted so far. Due to the desired efficiency of the information search it is not useful to offer all the contained lessons to every single user. It is rather necessary to delimit the user interests at the very beginning of the online session in order to select an appropriate subset of the lessons. Information systems and databases usually offer two different strategies to cope with these needs:

A) keyword search within the information base
B) selection of contents via menu lists

Using strategy A, the userspecific content can be precisely reduced if a useful keyword is taken into account. The power of keyword search strategies can be further increased by the use of boolean expressions. The words OR, AND, and NOT are used to create relationships among the keywords in search queries. Such advanced queries are a flexible tool for sophisticated database retrieval. However users that are not too familiar with the topic will encounter some difficulties in finding appropriate keywords.

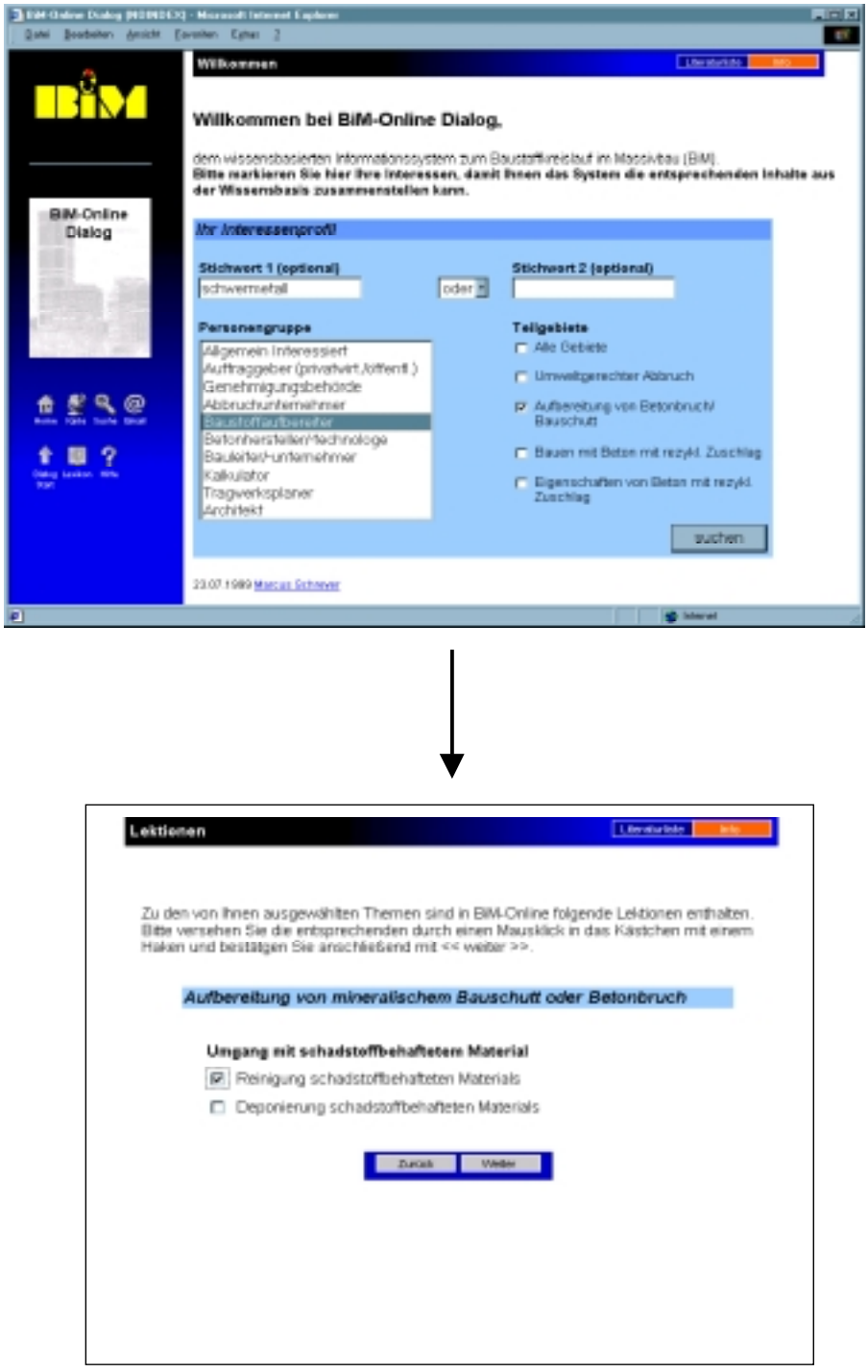

Fig.*2a Example for a BiM-Online Dialogue: A recycler wants to know wich cleaning methods are suitable for rubble, polluted with heavy metal. He acesses the knowledge base via the interest profile keyword=“Heavy metal“, interest group=“Recycler“ and subtopic=“recycling rubble“. Two hits in the topic „Handling polluted material“ were listed. The second lesson called „Cleaning polluted material“ is chosen and confirmed.*

Fig.2b *Three dialogue steps in the lesson „Cleaning of polluted material“: In the first step, you chose that you want to assign a certain pollution to an adequate cleaning method. The next screen shows a table with the desired information. If you want to, you also can get further literature sources and additional information about the methods as shown here.*

In such cases strategy B offers a framework of hierarchically structured menu items. On the other hand menu systems possess the disadvantage that they become strongly nested and confusing when the databases grow larger. Unlike the keyword search the menu based information retrieval is not able to offer possibilities to take different subsection into consideration at the same time. The user dialogue is completely determined by the menu structure created by the system developer.

In order to achieve the advantages of both discussed search strategies BiM-Online-Dialogue incorporates an input box that combines both methods to a userspecific interest profile. Such a profile consists of keyword queries supplemented by specific menu lists, in which the user can assign to one of several given groups of interests and distinguish the lessons that are of special relevance to him. All single lessons in the database had to be classified with regard to this profiling mechanism. In this way the dialogue system has been provided with the ability to recognise interconnections between lesson content and the profile of user interest. The user can search the knowledge base starting with a coarse assignment to a field of activity and obtain a first overview of those aspects in which the recycling processes could have significant influence on his work. Users who are more familiar with the system can increase the efficiency of the search by the additional use of the above mentioned boolean expressions.

After the selection of appropriate lessons the screen shows a current lesson in the upper part with a list of the recommended choices below it. The user has the possibility of starting and processing his lessons in any desired order.

Technically the implementation of the access to the lesson is carried out by the use of the programming concept „active server pages“ (ASP) which forms the so-called „middleware“ between the relational database that includes the knowledge and the HTML user interface that is accessible via internet connection. ASP is a technology that offers serversided scripting.

The scripts themselves can be programmed in the easy to learn programming language Visual-Basic-Script (VBS) that is closely related to the widely known Visual Basic. The VBS-program code can be directly implemented into the HTML source-code of the respective webpages. This versatile and powerful programming technology is used to control the database queries via SQL-commands. The close interaction between WWW-technology for the implementation of accessible user interfaces and client-server-concepts for the programming of the database access is the basis for such large knowledge based systems in the internet. Thus the administrative requirements that arise during the growth and the development of the content can be reduced to an affordable level.

The structure of the individual lessons is partly linear, i.e. the information is presented in a certain sequential order. In most cases however the flow of a lesson depends on the interaction with the user. The dialogue between the user and BiM online makes it possible to deal with non-standard situations concerning a given problem and to request detailed information from the user in cases in which a very general statement would not be useful (Fig. 2).

Examples:

Lessons of linear structure (sequential order of the information units is fixed):

- Processing of concrete and masonry rubble to RC-aggregates
- Pollutant contamination and limit values

Dialogue-based lessons (user interaction influences the process):

- Selection of an optimal method for crushing waste concrete
- Elastic modulus of concrete with RC-aggregates

3. SUMMARY

Modern information and communication technology makes it possible to increase the availability of knowledge in a new and amazing manner. At the building material institute at the University of Stuttgart current methods are investigated in order to organise scientific results in complex research data bases that are accessible via internet. Additionally the here presented system component BiM-Dialogue has the aim to accelerate the transfer of research results into practical application.

The still fast growing internet is particularly suitable for such tasks, because it enables the access to such information systems to almost everyone in a comfortable way, since it is independent of the computer operation system. It utilises an user interface which is easy to use and which offers modern multimedia abilities. The distribution of knowledge via internet is very economical and the hypertext concept is an ideal basis for the representation of even very complex topics.

BiM-Online uses those modern technologies to increase the efficiency of the utilisation of current research results concerning recycling processes in civil engineering. The totality of the results produced in a large research program is collected and has been made available to public using problem orientated interfaces that take userspecific needs into account.

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