A WEB-BASED COMPUTER SYSTEM SUPPORTING INFORMATION ACCESS, EXCHANGE AND MANAGEMENT DURING BUILDING PROCESSES

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ABSTRACT

During the last two decades, a number of research efforts have been made in the field of computer support systems related to the building construction industry. Most of the projects have focused only on a part of the entire design process and have typically been limited to a specific domain. Different approaches in developing these computer systems have been taken during the years. These approaches have, to a certain level, mirrored the level of available computer technology at the time the different projects were made. Further, standardization attempts have been made in relation to improve information exchange between different computer systems [Björk and Wix, 1991]. However, its a very limited number of these research projects that have succeeded in penetrating at a commercial level.

This paper presents a newly developed computer system based on the World Wide Web on the Internet. The focus is on the simplicity of the system`s structure and on an intuitive and user-friendly interface. The accessibility and the exchange of information are brought into focus. I.e. it is important that participants in a design process have easy access to internally and externally placed project information.

Keywords: Information access; Information exchange; Shared information; World Wide Web; Internet; Web-accessible information bases; Communication; Distributed Web-servers; Human-machine interfaces

1. INTRODUCTION

The objective of this paper is to present a newly developed computer system which supports information management, information access and exchange during a design process and the succeeding construction and maintenance processes. Thus the system enables a project team`s participants to get access to each others´ information created during the design process. Further the system gives the design team access to some design tools (agents) connected to the system. By one click on a button from the system`s graphical oriented user-interface (GUI), a user can execute and run an agent and edit a selected document or create a new one.

The design team is separated into professions known from today, i.e. *architecture*, *structural engineering*, *HVAC engineering*, *building owner*, *contractor* etc. During the computer systems GUI, the participants can select a case, a domain or profession and access information needed in

the proceeding process. Eventually, the system gives a user access to a total of three Web-accessible types of information bases. These bases are named *product bases, profession/knowledge bases* and *case bases*. Each of which gives access to different types of information that can be incorporated into the actual building project.

1.1 Background for information access and interfaces in connection to the Web on the Internet

The information society can make vast information resources available to anyone, at any time, from anywhere in the world. Business competitiveness increasingly depends on timely access to the right information and on the capability to use it effectively and efficiently.

The huge volume of information that is there to be accessed, and the diversity and complexity of applications and services, present problems of usability, manageability, of potential information overload. Information technology has enabled us to make very large amounts of information available - the next challenge is to enable us to make sense of it, build knowledge, and, as a result, boost our creativity and capacity to create value, both for organisations, companies and individuals.

There are three main dimensions to these problems. First, the way in which information is structured and organised. Second, how users will find their way through the global information "ocean" to satisfy their needs reliably, securely and safely. Third, the interfaces that people will use to access, process and create information and knowledge.

2. PRESENTATION OF THE SYSTEM´S ARCHITECTURE AND THE GRAPHICAL USER-INTERFACE (GUI)

In this section the system architecture and the graphical user interface (GUI) for the computer system are presented. The architecture is shown in figure 1.

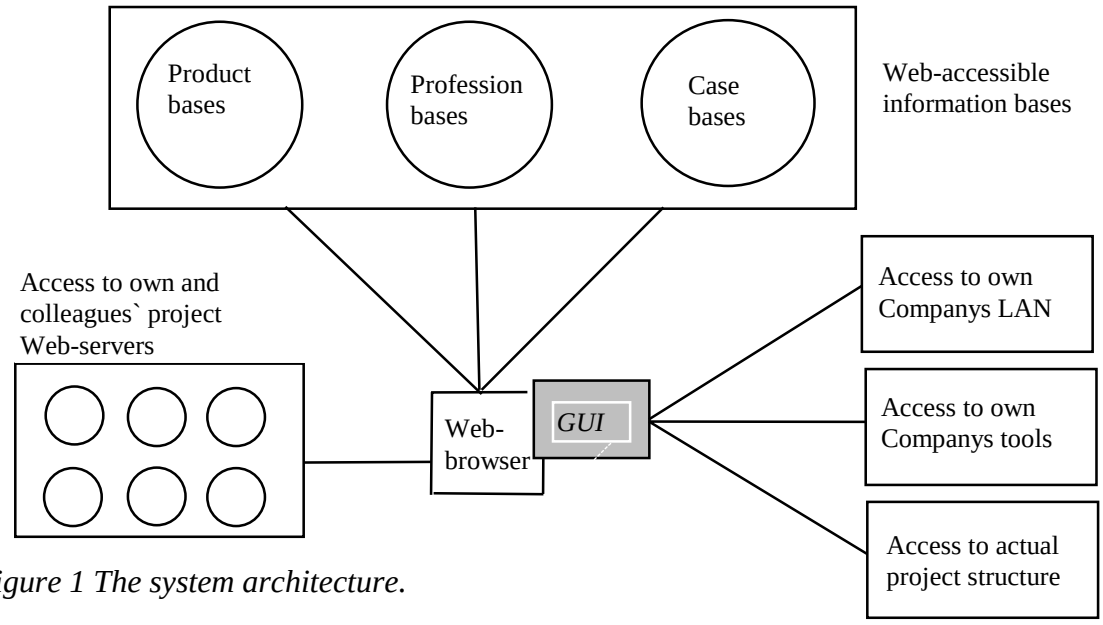

Figure 1 The system architecture.

The system consists of a graphical user interface (GUI) as the central part. From this GUI access is given to project information placed on own company´s LAN and to external placed project Web-servers. Further, access is given to a total of three types of Web-accessible information bases containing non-project specific information. Eventually, access is given to design tools available on the company`s LAN or on the current workstation in use. The architecture of the different available project Web-servers, i.e. the project servers that constitute the entire project information corresponding to the project in progress, is shown in figure 2.

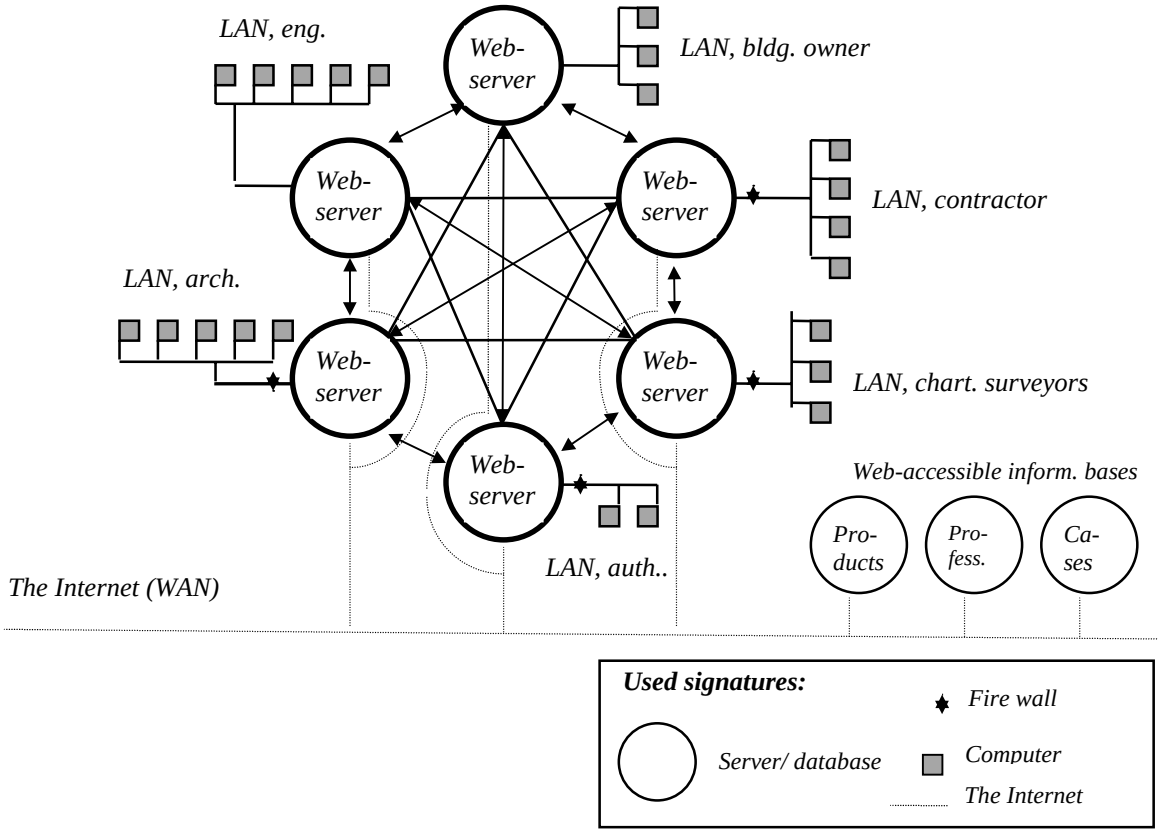

Figure 2 The approach with distributed project data bases placed on project Web-servers corresponding to each firm responsible for the different domains. The new computer system is placed on each company`s LAN-computers (or on workstations). Together the bold marked Web-servers constitute the project information corresponding to an actual project. The fire walls secure the companies` local area network (LAN) against unauthorized users.

A user in a company is able to “communicate” with cooperation partners` project Web-servers during the GUI placed on the LAN -computers and connected to the Internet. The approach with distributed project Web-servers is in contrast to an approach focusing on a central and common project Web-server, on which all the project information is stored. The system`s GUI is shown in figure 3.

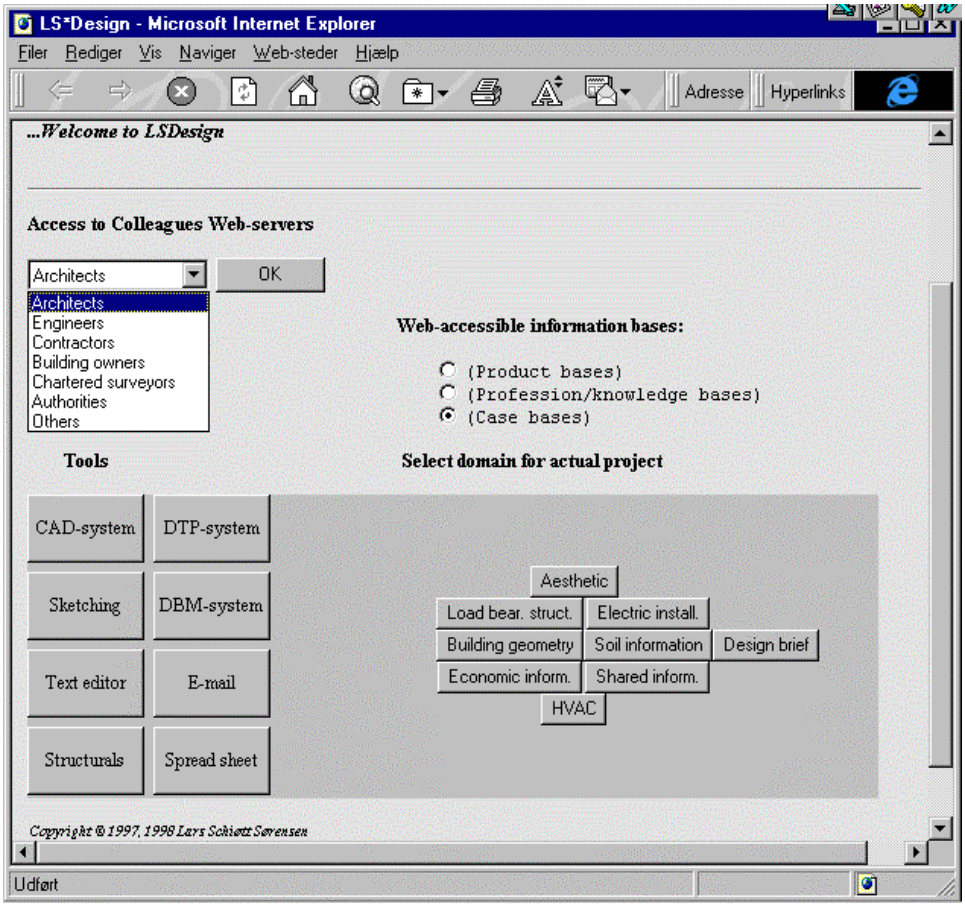

Figure 3 The graphical user interface (GUI). The user interface is designed corresponding to the logical structure of that being modelled. Users have access to the distributed Web-accessible information bases and access to each others´ information in general, through the system. Further, a tool-box is available.

Design processes, in real life, require joint efforts of individuals and synchronisation of the information streams between them [Maher *et al*, 1996]. Then, individuals in a collaborative design process, using a networked design computing system, evaluate the design problem acting in a computer-supported *common electronic workspace*. Further, according to [Maher *et al*, 1996] a distinction is made between two types of collaboration: *single task collaboration* and *multiple task collaboration*:

- In *single task collaboration* the resultant design is a product of a continued attempt to construct and maintain a *shared conception* of the design task. In other words each of the participants has his own view of the entire design problem and the shared conception is developed by the "superposition" of the views of all participants.
- In *multiple task collaboration* (i.e. the selected) the design problem is divided among the participants in a way where each person is responsible for a particular portion of the design. Thus, multiple task collaborative design does not necessarily require the creation of a shared design conception, though designers work cooperatively in a common electronic workspace. Single task and multiple task collaborative designs are two extreme cases.

In general, the real case depends on the complexity of the design problem. In a simple design project it is most likely to have the single task extreme. In complex design projects there are times when the multiple task extreme is applicable and times when there is a combination of both types. These two dimensions are, however, used in the analysis of the networked design phenomena.

In a computer supported, and networked, collaborative design process two modes of communication of design information can be identified : *synchronous* and *asynchronous* [Maher *et al*, 1996].

- A *synchronous mode* implies the simultaneous presence and participation of all designers involved in the collaboration.

- An *asynchronous mode* (i.e. the selected) gives the designers the freedom to work at different times. Further, they can work on different parts of the design and do not require the simultaneous presence of all team members.

3. A SHORT DEMONSTRATION OF THE NEW SYSTEM AND THE BENEFITS FOR THE USERS, THE TEAM AND THE PROJECT

Project information is continuously developing and moving during a design process and the succeeding construction process.

The GUI shown in figure 3 acts primarily as a common search-engine for the users of the system and as the engine to create and store new design documents through. The creation of new project documents can be done via the system by the support of different software tools preferred by the different domain specific designers.

If we look at the user-interface on figure 3 once again, a domain can be selected for the actual project. When this is done, the next thing that has to be done when a new document is going to be stored or found, is to select the right destination for the present document. That can be done, passing through a procedure like the one shown in figure 4.

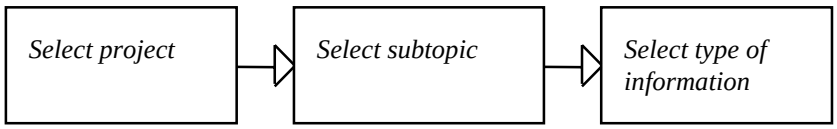

Figure 4 The general procedure for storing and searching for domain specific project related documents.

An underlying hierarchically project library corresponds to the procedure presented in figure 4.

When a document (or a number of documents) is created, the time is ready to make the document available and accessible for the other (externally placed) colleagues. Therefore, documents ready for exchange are uploaded to the project Web-server, corresponding to the particular domain. That is done by support of the system in a formalized form (not shown in this paper).

From the GUI shown on figure 3, it is possible to access colleagues` project Web-servers. On these servers it is possible to get needed information from other project domains. On the other hand your colleagues have access to project related information placed on your Web-server as well. The way to access others` project web-servers is straightforward. Click on the desired colleague-type (see figure 3) let´s say “Architects”. A new window then appears, see figure 5. When a selection is made the system prompts for login-identification.

Figure 5 The window that gives users access to cooperation partners` project Web-servers.

When creating a new document the system gives the user the possibility of opening several tools and documents simultaneously and to use “cut and paste”, references, blocks etc. between these documents. An example of a design situation of that kind is shown in figure 6.

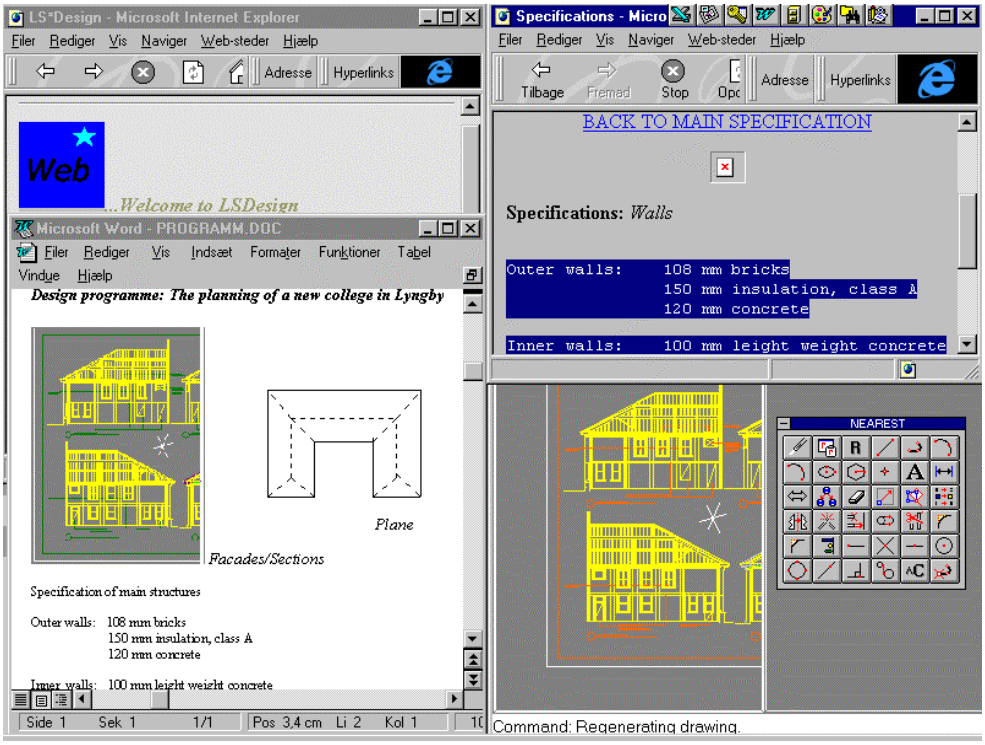

Figure 6 An example of creating a new document (bottom left) by integration of information from two other documents.

From the systems tool-box a little Web-application supporting sketching is available. See figure 7, below.

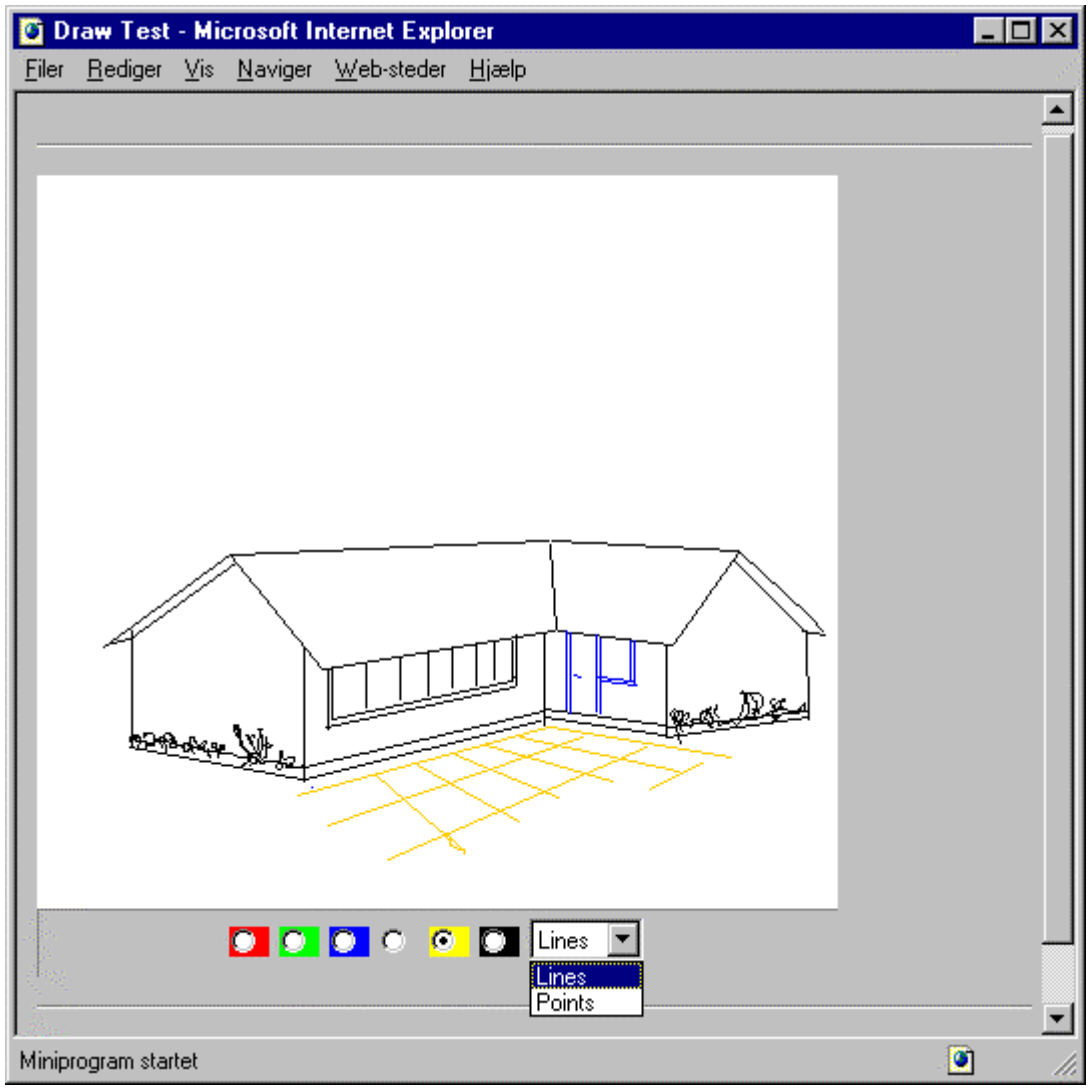

Figure 7 A Web-application accessible during the systmes GUI shown on figure 3.

3.1 Web-accessible information bases

The computer system gives the user access to information placed on some external Web-bases. The three types of Web-accessible distributed information bases named *product-*, *profession-* and *case bases* must be given some more attention.

3.1.1 Product bases

These data bases will typically contain product data at a level that is independent of the actual building being designed. The product could be created by manufacturers of the products that the database contains information about. The structure of the product data must be defined and to a certain level standardized. This to ensure a high accessible level by users of the stored informa-

tion and independent of which product base they are searching in. Collected information from these data bases constitutes parts of the information-bricks that the further project-specific design makes use of.

An example of product-information accessible from these product bases is shown in figure 8.

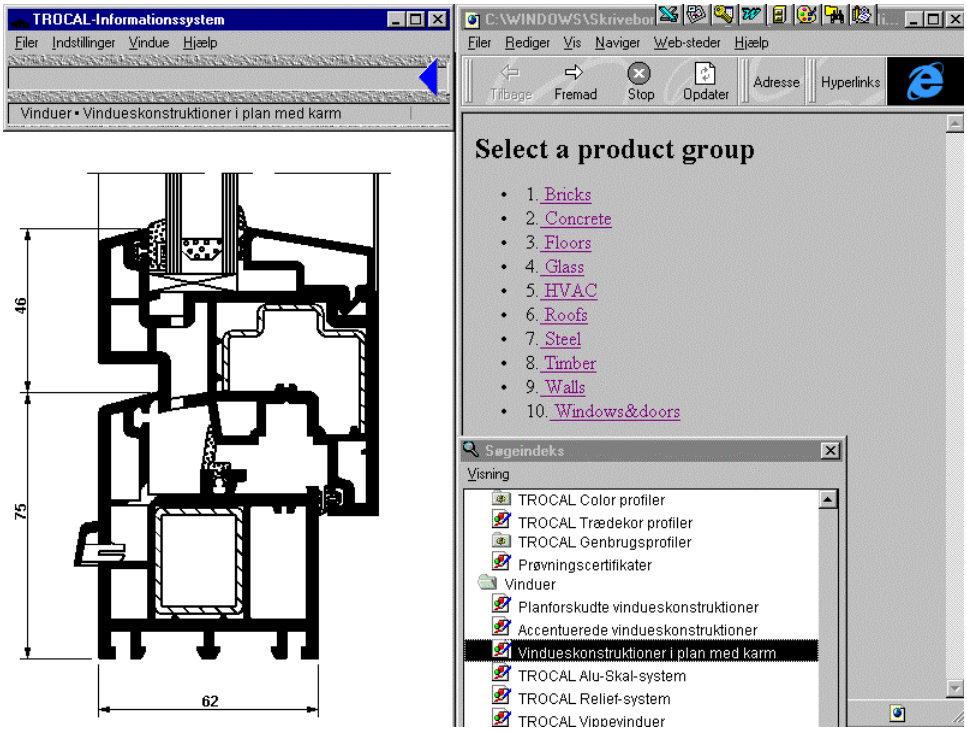

Figure 8 Example of information available from Web-accessible product bases.

3.1.2 Profession/knowledge bases

Information bases of this type contain information/knowledge specific to the different disciplines or professions, and the bases could be developed by standardization organizations, universities, and other research organizations. Publications, codes and rules specific to different countries, and professions are examples of information placed in these bases. Domain specific calculation tools/-applications could be another example.

A couple of examples of available Web-accessible profession-specific knowledge/information are presented in figures 9 and 10.

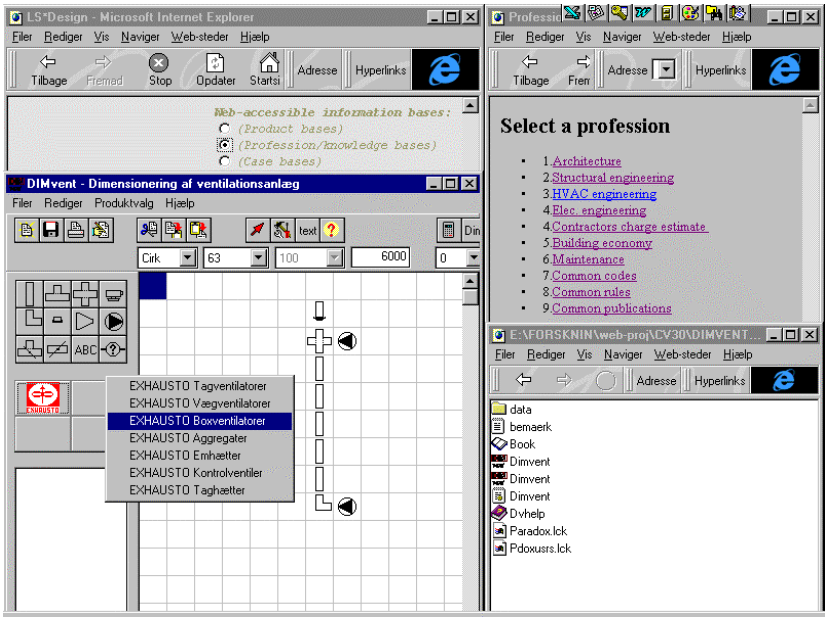

Figure 9 An example of profession-specific knowledge (an application intended for calculation of ventilation) available under the topic "HVAC engineering".

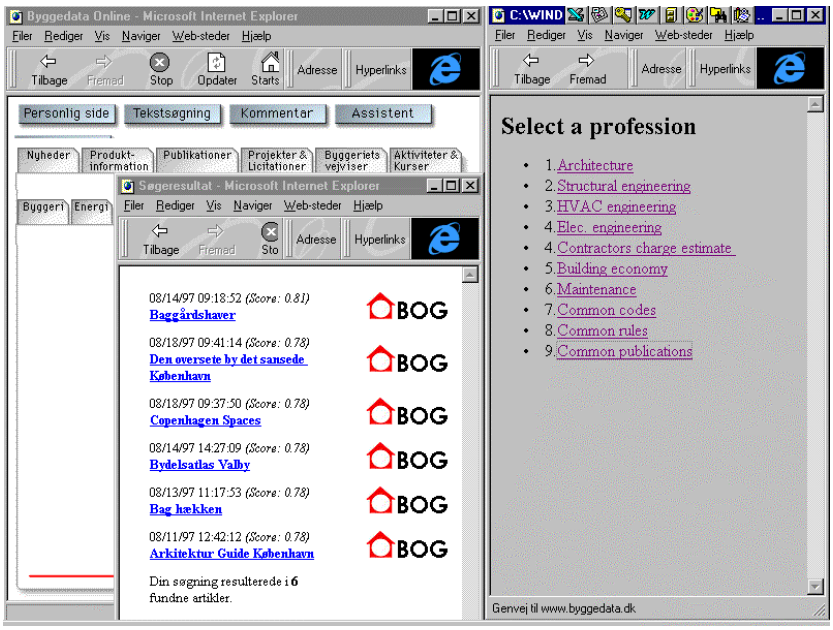

Figure 10 An example of profession-specific information available under the topic "Common publications".

3.1.3 Case Bases

These bases contain information specific to previous projects (cases) grouped into different classes. Information, such as photos, memos etc. specific to each case, is stored here. Furthermore, standard drawings, specifications and calculations made by means of software applications such

as CAD, database management systems, spreadsheets etc. would be a part of these data bases. The representation of the cases has to be done in a uniform manner. This to ensure easy access to the different cases or parts of cases. Further, the structure of the case information has to be in a way that secures easy adaptation of the collected information into a current project. An example of available information in this type of Web-accessible bases is shown on figure 11.

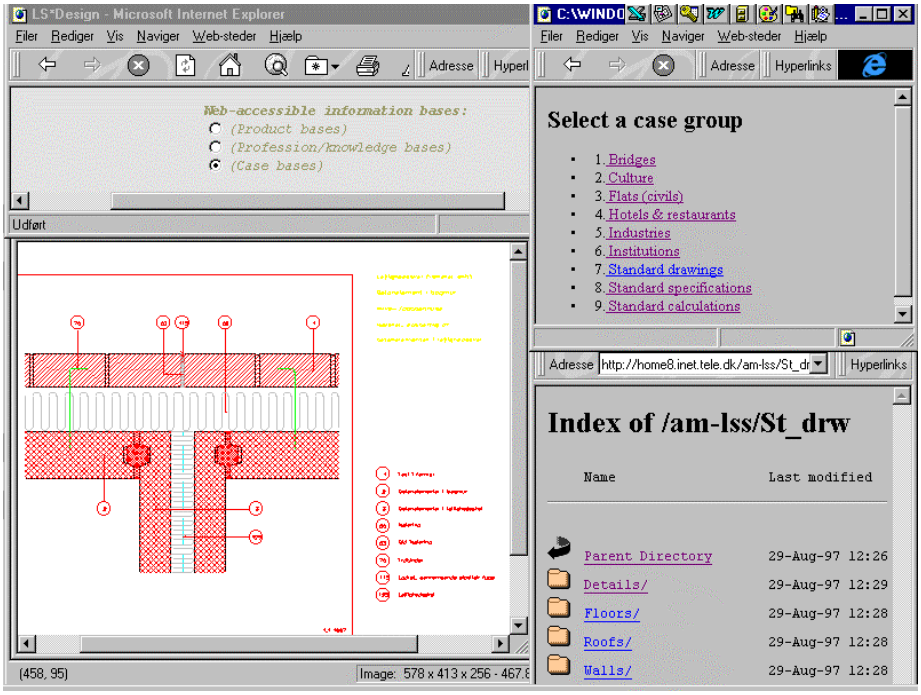

Figure 11 An example of information connected to a case base.

Advantages from the CBR-field could be incorporated in the bases.

3.2 Benefits

Some of the most important achieved benefits obtained by using the system are outlined in a short form. The benefits are separated into benefits corresponding to the users, the project team and the project.

3.2.1 Users

The system gives each of the users:

- An uniform platform which is common when users access, exchange and create internally and externally placed project information in the project organisation.
- Access to a total of three types of information bases placed on the Internet. From these bases information is available to the user in an uniform and well structured manner.
- An overview over the created project information (documents) and the information structure.

3.2.2 Team

The system supports a project team the following ways:

- Gives a basis for a more smooth and uniform information exchange process between different participants and between different project phases.
- A foundation to achieve more information integration between the different professions, because of the easy access to and good overview over project information in the different domains.
- A better accessibility to project information in general, also with respect to the building owner, the authorities and the contractor(s).

3.2.3 Project

The system benefits the project in these ways:

- A higher chance of achieving consistence in the project information, because of the easy information access and the good project overview. An engine to present the latest project/-document changes is available.
- The project is supported during the entire process from the early design, during the construction process and the succeeding maintenance process. This may result in reduced design and thereby construction costs.
- All the project information is available in a digital form after the design and construction process. None (or a reduced amount) of the information has to be translated afterwards.

4. CONCLUSION

This paper presents a newly developed Web-based computer system supporting information management, information access and information exchange during building processes. The system is developed as a part of my Ph.D. project. A description of the background and the rationale for the new computer system is given. Presentation of the distribution platform, the system architecture and the user-interface are given. Furthermore, a proposal to establish some Web-accessible distributed information bases is given. Founded on this, the new system resulted in an integrated and Web-based computer environment supporting information access and information exchange in a building process. A *communication model* approach is taken supporting *a multiple task collaboration* in an *asynchronous communication mode.* The planning of the system was made using knowledge and experience gained from previous research projects in the area of integrated design computer systems. These previous research projects were categorized into a total of three *transitions* named geometric, product and communication systems. This categorization was made during the planning process on the basis of information collected from [Björk, 1994; Dubois *et al*, 1994; Fruchter, 1996; Galle, 1994]. Further, results from an IT-Investigation [Sørensen, 1996] made in the Danish construction industry at the end of 1995 were taken into account during the planning of the computer system.

The program coding was made using *SUN´s JAVA developer* - an object oriented Web-programming environment. Further, the system`s user-interface was coded in Visual Basic scripts and

html- a markup language. FrontPage 97 has partly been used as a tool to structuralize the system. The system is placed on an MS Internet Explorer, rel. 3.02 Web-browser installed in a Windows 95 and -NT environment.

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