Computer Supported Knowledge Based Cooperative Work

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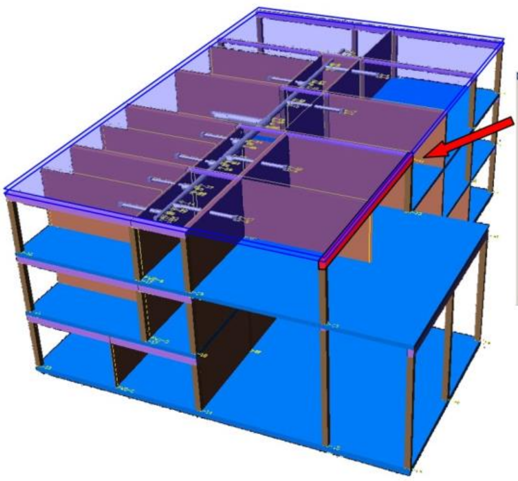
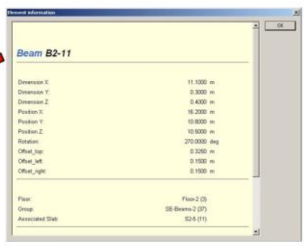
Abstract

One of the crucial demands of today’s AEC industry is to reduce the duration of the design process. Due to the fact that usually several different parties are involved in the design process (architectural design, structural design, HVAC etc.) software tools which support design processes within distributed computer environments are urgently needed. Today’s software however mainly supports a simple document based exchange of information. This conventional approach is time- and cost-consuming and may still lead to considerable inconsistencies in the design. Therefore tools for ‘real’ Computer Supported Cooperative Work (CSCW) where the different design parties commonly work on one and the same digital building model are in the focus of many research projects today and will be in use for construction projects in the near future.

In the present research work a knowledge based approach of CSCW is used. The knowledge bases of the different design parties are distributed among the local workspaces of the designers. They are based upon an object oriented model for knowledge representation (Knowledge Data Model (KDM)) and basically contain the “knowledge” of the respective relevant design codes. Since the different knowledge bases can be edited it is also possible for their users to add more specific design methods and approaches. During the design process the knowledge bases of the different parties involved are concurrently applied to one central Building Information Model (BIM). This digital building entity again is based on an object oriented model called the Product Data Model (PDM).





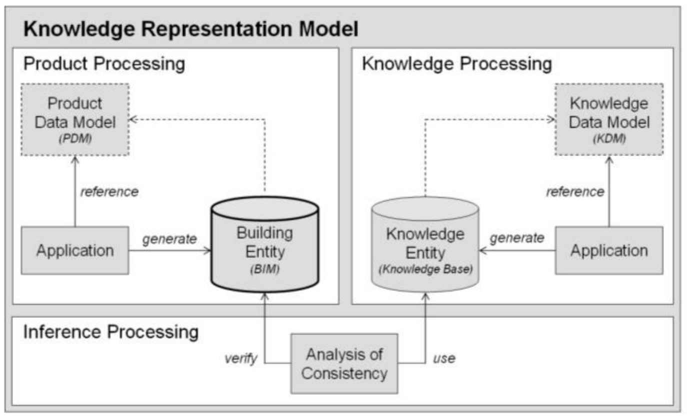


Figure 1:Graphical display of a BIM with edit dialogue & basic structure of the Knowledge Representation Model

Figure 2 shows the system architecture in a distributed design environment. The server originally solely contains the central database with the Building Information Model and the central inference mechanism. The various knowledge bases are located separately at the distributed workspaces of the involved design parties. Simply for reasons of performance these local knowledge bases are replicated to the central server during the actual design process. One integral part of the system is formed by an open source FE system which is used for the calculation of the internal forces and the reaction forces.

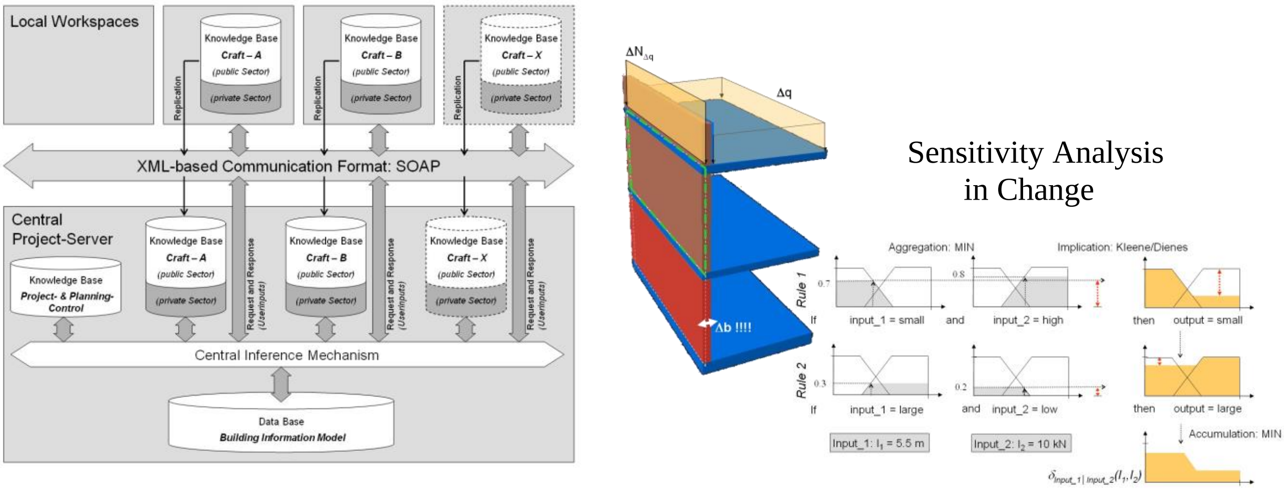


Figure 2: System Architecture in a distributed environment & use of fuzzy models for sensitivity analysis in change management

Within a CSCW design environment where all designers work together on one digital model one of the most important problems is to identify all relevant consequences for one party (e.g. for the structural designer) induced by the change of another party (e.g. the HVAC designer). In the present research work the central inference engine keeps track of all operations that are performed by the various knowledge bases on the common building information model. All dependencies among the elements of the various knowledge bases are thus recorded during the inference process and it is therefore easily possible to identify all consequences if one parameter is changed.

On the other hand it is essential to separate relevant changes from irrelevant ones. For instance the position of a column might be changed by a few centimetres. Of course this induces a change in the reaction force of any other column in the building but it will usually not affect the whole design of all other columns. It is therefore important not to highlight such irrelevant changes which might distract the designer from the relevant ones. In the present research work such complex decisions are supported by fuzzy logic models (figure 2) in the scope of a sensitivity analysis in change management. Another example for complex design decisions where fuzzy logic models are used is the choice of suitable structural components (e.g. a suitable slab system for a given floor layout) and the choice of suitable dimensions of these components.