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DARC
A knowledge based Design Assisting Representation Concept.

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KEYWORDS

Architectural Design, Knowledge Based Systems, Expert Systems, General Data Base, frame concept.

ABSTRACT

DARC is a knowledge based representation and consulting model to accomodate the initial stages of the architectural design process. The building specification are translated into a frame based modular represntation model. With the DIALOG system new information may be added ro the various modules. The DIALOG system also supplies an internal and external consistency enforcer, i.e. if the stored information is not in contradiction to itself, and if there are information items violating external rules, regulations or data.

DARC
Une conception à l'aide de la réprésentation de projet à base de connaissance

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MOTS-CLÉS:

Project architectural, conceptions à base de connaissance, systèmes compétents, base de données générales, conception de cadre

SOMMAIRE:

DARC est une réprésentation à base de connaissance et un modèle de consultation pour adaptation aux stades initiaux du procédé de projet architectural. Les spécification de construction sont traduis en un modèle modulair de réprésentation à base d'un cadre. Il est possible d'ajouter de l'information nouvelle aux modules divers par le système DIALOG. Le système DIALOG accomplit aussi un enforçeur de consistance interne et externe, c'est à dire si l'information emmagasinée n'est pas contraire à elle-même, et s'il y a sujets d'information qui violent des règles, règlements et données externes.

Les ordinateurs sont en train de devenir des outils normales en l'industrie de construction des bâtiments et en l'industrie de construction. Des stades diverses du procédé de construction des bâtiments sont changés considérablement par les applications de l'ordinateur. Et cette tendance sera continuer sand doute même avec une influence plus grande. Pourtant dans tous les stades du procédé de construction des bâtiments les ordinateurs n'ont pas eu une même influence. Dans le procédé de projet architectural les systèmes CAD par exemple reçevons beaucoup d'attention. Mais sont ces systèmes en réalité dirigés vers projets à l'aide des ordinateurs, ou bien 'seulement' vers esquisses à l'aide des ordinateurs?

Une des problèmes majeures de l'application de l'ordinateur, sinon LE problème majeur, c'est la nécessité d'information complète et consise. En pratique, cet effet se manifeste du développement d'un large nombre d'applications orientées vers l'aspect, par exemple frais, chauffage, tension, etc. Les programmes développés dans ces territoires sont en soi-même des outils très valables, mais en relation avec l'industrie complexe de construction des bâtiments chaque programme est raisonnablement limité. Aussi la teneur des programmes de projet est limitée dans ce sens. Pour être capable de produire un projet d'ordinateur, ou une autre image quelconque, il est impératif de savoir exactement ce qu'on doit dessiner.

INTRODUCTION

Computers are becoming normal tools in the building and construction industry. Various stages of the building process have changed considerably because of computer applications. And this trend will undoubtedly continue, with an even larger impact. However, not in all the stages of the building process computers have had a similar impact. In the architectural design process e.g. CAD-systems are getting a lot of attention. But are these systems really directed towards computers aided design, or 'only' towards computer aided drafting?

One of the main problems with computer applications, if not THE main problem is the necessity for complete and concise information. In practice this effect is shown by the development

of a large number of aspect orientated application, e.g. costs, heating, stress etc. The programs developed in these fields are in it self very valuable tools, but in relation to the complex building industry each program is rather limited. Also the scope of drafting programs are limited in this sense. To be able to make a computer drafting, or any other visualization, it is imperative to know exactly what should be drawn.

INTEGRATION

In daily practice, the use of a growing number of isolated computer programs is not feasable. This has resulted in a trend towards integration. Each special purpose program, however, was developed for that special application. The object, i.e. the building, was therefore simplified to an application relevant model. Each model accomodating the demands for that application. For the integration of computer programs it will be necessary to combine, or better, to integrate all these various models. Various programs however, will have different (data) structures, which are mostly not compatible. The present state of the art is not complete integration, but a partial integration of a limited number of programs mostly figured round a drafting system.

To combine all the present available and possible programs for one object, in one system is still very far from reality. Not to speak of a combination of data structures for various, if not all possible objects. The outline of such a future integration is mentioned by Wright (1983), who introduced terminology like: general database, project database and integrated project information systems.

ARCHITECTURAL DESIGN PROCESS

The realisation of a design starts with a creative idea by a human (!) designer. This idea is then developed, during an interactive process, into a final design, which might then be constructed. During this design process, ideas and solution are becoming more and more defined. The better (partial) design solution are defined the more computer programs are available.

For the initial stages of the design process, however, not much computer support is available. The starting point will be the building specifications, as it is formulated by the principal. But in addition numerous specifications, rules, regulations and restrictions have to be evaluated. The first problem for the designer is to find out which regulations should be evaluated. And if an applicable regulation is found, the design has to be evaluated in accordance to that regulation.

EXPERT SYSTEMS

To evaluate all kind of effects, rules and regulations a new type of computer program is being developed, the so called expert systems. Expert systems are an application of artificial intelligence. Other applications includes: pattern recognition,

general problem solving, games, language understanding etc. Feigenbaum (1981) has defined Expert Systems as:

> An Expert System is an intelligent computer program that uses knowledge and inference procedures to solve problems that are difficult enough to require significant human expertise for their solution.

But expert systems are not interested because they are new, but because they provide tools for new applications. The advantage of expert systems is that make it possible to to ..... problems, which are not clearly defined (in algorithems, formula's etc.), but which depend for a large part on knowledge and experience.

Although the final impact of expert systems could be very large, the present state of the art is still in its infancy. Hayes-Roth e.a.(1983) have introduced a divison in 10 types of different expert systems application categories. The application concerning the construction industry are mainly directed towards diagnostic, advisory and front end systems. An important restriction concerning the above quoted definition is that expert system applications in the constuction industry should be considered as new tools for the designer, i.e. the professional user, and not for the laymen.

A DESIGN ASSISTING EXPERT SYSTEM

But also these expert systems are mainly directed at solving aspects, or estimating effects. They are neither directed towards assisting the designer concerning his selection of relevant data, i.e. which rule, regulation or restriction. Nor are they supplying the user with a direct tool to represent his design process. The Design Assisting Representation Concept (DARC)is developed to supply the designer with a tool to accomodate these lacunes. It is a combination of three concepts (fig. 1):

- a project representation model;
- a dialog system;
- an external knowledge base model.

The project representation model is based on the frame concept by Minsky (1975). It is specially developed to accomodate the initial stages of the architectural design process.

The first step is to translate the building specifications, as they are defined by the principal, into an initial project model. In this project model these specifications are devided in logical modules, i.e. functional and/or physical recognizable units. Each module may be devided into sub-modules, sus-sub-modules etc. The number of sub-module levels depends largely on the size of the project or the desired level of detailing.

Each module will be extended by a number of properties. In these properties the various demands, facts and requirements will be described, which belong to that module. For each property a so called property-frame should be available, i.e. a frame to represent the values for a specific property.

With the DIALOG SYSTEM the designer will develop the initial project model into more advanced stages, ending in a final project model, which should contain all the information necessary for construction. This DIALOG SYSTEM consists of the following four mechanisms:

- a review mode, which will supply an overview of; the information in the project model or the external knowledge base;
- a control mode, which will check the internal consistency of the of the project model;
- an edit mode, for updating and changing the project model;
- an consult mode, which will check the project model in accordance to the information stored in the external knowledge base.

In the EXTERNAL KNOWLEDGE BASE (fig.2), information is stored concerning the design requirements. To accomodate the design process various levels and subparts should be recognizable.

In the GENERAL knowledge base information is stored about rules, regulations and external. This should contain "objective" information, which should be obtainable for all the users. Also a USER dependable knowledge base may be created, in which each designer may store his or her preferences, attitudes, priorities etc.

This general and user dependent KB are divided in three subparts deviding the information in its applicability to a groups of building types, and/or special design solutions. These three subparts are:

- an irrevocable part, which should be true for all situations;
- a project dependable part, which is only applicable to a group of building types;
- an user dependable part, for which the solution is up to the user at that moment.

Also a hierarchical divison has to be made. This division has to be created, because not all the information available is of importance in each stage of the design.

IMPLEMENTATION

In this paper no description was given of the actual stage of implementation. DARC is a research project in a still experimental stage. The various DIALOG modes are available in a rudimentary version. The main problem however is to built the various knowledge base sections. At this moment the available DARC-version programmed in CPROLOG. Prolog is extremely suitable because of its describing character, which makes it rather easy to implement a flexible knowledge representation model. The backtracking mechanism supplies the user more or less with an automatic search facility.

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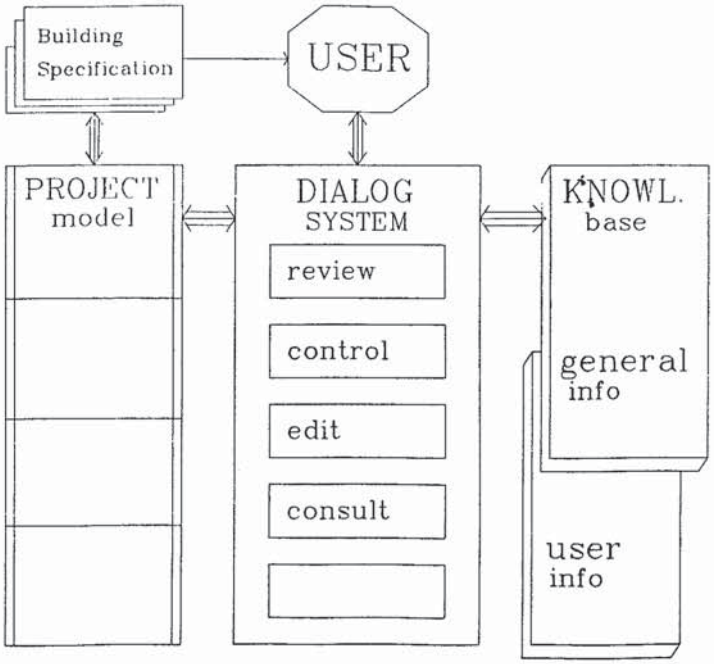

fig. 1: DARC-model

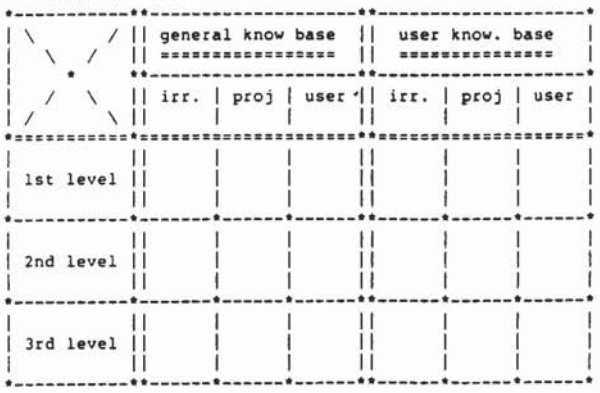

fig.2: General and User dependent
Knowledge base structure

Automated Architectural Detailing: A Knowledge-Based Approach

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KEYWORDS

Working Details, Expert Systems, Knowledge Engineering.

ABSTRACT

Working details are the means by which an architect describes how the parts of a building are to be fashioned and assembled, and they are therefore central to the design and construction process. Their purpose is to ensure both functional sufficiency and aesthetic standards. The automated or semi-automated production of details within or linked to computer-aided drafting systems can lead to improvements in quality and consistency as well as productivity, and systems are available to facilitate detailing for steelwork, reinforced concrete, pipework, system building and other aspects of construction. Where the context is well defined and there are few appropriate solutions, automated detailing can be reduced to the selection of a correct procedure or pattern from a library of possibilities. Where there are many feasible solutions and the scope of the detail is large, automated detailing systems must make use of knowledge about the way parts of a detail can be assembled, what is good practice, and how a particular form of solution fits within a desired style or grammar of design.

This paper describes a knowledge-based approach to automated detailing using production rules as design generators. It is argued that a design model which makes explicit the assumptions and limitations of the knowledge it contains is necessary in the development of practically useful detailing systems in architecture. An extensive example and its prototypical implementation is described.