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KNOWLEDGE - BASED SYSTEMS FOR BUILDING TECHNOLOGY: STRATEGIC IMPLICATIONS

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BUILDING RESEARCH ASSOCIATION OF NEW ZEALAND bronz

KNOWLEDGE-BASED SYSTEMS FOR BUILDING TECHNOLOGY: STRATEGIC ASPECTS

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ABSTRACT: BRANZ is in the business of providing information to the large and diverse building industry. This paper will discuss the potential uses of knowledge-based systems in this information transfer. In the medium term BRANZ will be looking at providing knowledge-based systems for a computerised information resource (BRANZINFO), available to the building industry on demand via PACNET.

The paper will discuss resource requirements, and policy implications.

1.0 INTRODUCTION

BRANZ's mission is:

> "To benefit the New Zealand community by identifying and satisfying the technological information needs of the Building industry."

In many regards BRANZ research cannot be regarded as completed until it is used as information by the building industry. It is a large and diverse industry which is often disinterested because like most other industries it is already swamped by information. It is necessary therefore to be able to provide the information that is needed, when it is needed, in an acceptable form.

Much of this information is knowledge in a linguistic rather than numeric form. The essence of expert systems or knowledge-based systems (KBS) is their potential ability to handle linguistic rules. So they offer the potential of presenting this knowledge in a way suitable to support the judgements required to be made in a user's work.

BRANZ is at present developing a computerised information resource (BRANZINFO) which is now available to the building industry via PACNET as one of the means of providing information. KBS could be one of the range of information products on our shelves. BRANZ also has a long term wider general interest in the use of KBS and other artifical intelligence techniques for building information. Long term, this computerised information transfer will not necessarily be limited to the online BRANZINFO service.

BRANZ currently has experimental or prototype versions of KBS under development for diagnosing moisture problems (DAMP), selecting

sealants (SEALANT), and checking conformance with parts of a building code (FIRECODE). All these KBS are based on the CLASS language being developed under contract by Auckland University (Buis et al 1986).

2.0 THE TRANSFER OF BUILDING TECHNOLOGY INFORMATION BY KBS

What are the advantages of KBS?

- They can make available rare expertise.
- They allow knowledge to be stored until it is needed.
- They can incorporate the knowledge of one or more experts.
- They are available 24 hours a day.
- They are available to many people at any one time.
- They can be readily updated.
- They can be easily distributed.
- They give consistent advice.
- They can explain what they are doing.
- In demanding rigorous logic, they show up inconsistencies and gaps in the knowledge base.
- They can potentially handle uncertainties or incomplete information.
- They free experts from routine problem solving.

What can they be used for?

- Text interpretation (or animation), explaining rules and regulations.
- Product or material selection, customer services.
- Diagnosis, determining faults or causes of defects.
- Planning, managing resources.
- Design.

One of the most exciting potential uses for KBS is assisting in the use of building codes and regulations. This is particularly timely with moves in New Zealand towards a rationalised system of building controls. BRANZ needed to evaluate the potential of expert systems for animating building codes, to develop expertise in this area, and establish a knowledge engineering tool designed to handle this type of problem. To this end BRANZ selected part of a draft revison of the fire code, and contracted the Computer Science Department of Auckland University to develop (FIRECODE) a KBS based on this code, and the CLASS language referred to above.

This code was selected because:

- It was complex enough to be a good test of expert systems,

- Two members of the code drafting subcommittee were able to assist in the preparation and checking of the knowledge base,

- The thinking behind the code made it amenable to be broken down into rules,

- It was being developed as a replacement for a code which is mandatory.

It has been a valuable exercise in the way it has demonstrated the potential of KBS for building codes, and the difficulties and problems which will need to be overcome. For unrelated reasons the draft code itself is unlikely to be adopted in its present form, but it is hoped the existence of the KBS will be of value in future revisions.

BRANZ receives several hundred enquiries each year on moisture problems in buildings and has built up expertise and knowledge in this area with several years of research. The DAMP KBS referred to later in this conference (Trethowen 1987) uses that expertise in the diagnosis of these moisture problems.

BRANZ has also built up over several years an expertise in building sealants (e.g. Sharman et al 1983). This information is already available to the industry in the form of Building Information Bulletins (BRANZ 1984). The SEALANT KBS is aimed to be an alternative way of making some of this information available in advising particularly about sealant selection, which is confusing to the uninitiated.

The potential of KBS in the transfer of building technology information is being recognised worldwide. Several other building research and building related organisations are investigating KBS for building information transfer:

> In Great Britain the Building Research Establishment (BRE) is developing BREDAMP, an expert system to diagnose moisture damage in houses and the Building Services Research and Information Association (BSRIA) is investigating expert system building tools available on PCs (Hamilton and Harrison 1986).
>
> In Australia the Commonwealth Scientific and Industrial Research Organisation (CSIRO), has established a national centre for collaborative research on knowledge-based systems. The Division of Building Research plays a big role in this and has been working on a number of expert system projects, including weather penetration, and the wind loading code (Sharpe et al 1986). Both these systems make excellent graphical presentations of information.
>
> The Department of Architectural Science, University of Sydney, NSW, has been involved with developing expert systems related to building regulations and other aspects of the building industry (Gero and Coyne 1984, Radford and Mitchell 1986).
>
> National Bureau of Standards, USA, are promoting the preparation of Standards which are amenable to machine representation (Wright and Lyons 1986).

At a recent international building research and information conference (CIB 1986),the potential of KBS was identified for a number of functions including:

- Assessing contractors,
- Decision making in construction projects,
- Building design,

- Energy efficient building,
- Strategic evaluation of designs,
- Construction risk analyses,
- Building procurement,
- Anti seismic design,
- A learning tool for house designers,
- Automated architectural detailing,
- Estimating costs,
- Economic strategies for building design,
- Economic selection of building components.

3.0 MARKET RESISTANCE

What are the limitations of KBS?

- They are only as good as the knowledge in the knowledge base.
- Full natural language capability is not yet practical.
- They require real computing power for real applications.
- They require a well defined area of knowledge.
- Human expertise is generally not in a form in which it can be readily converted to a structured knowledge base.
- Like all computerised information, users need access to a computer.

The success of KBS will depend on recognising these limitations and developing KBS which will satisfy two distinct groups of users, the person who wants to disseminate the knowledge, and the person who needs that information.

They must prove to be the most efficient way for the expert to disseminate information. BRANZ experience with DAMP, SEALANT, and FIRECODE have highlighted that it is no simple task to prepare the knowledge necessary to take a KBS from the trivial to the useful state. Trethowen (1987) looks at the knowledge transformation difficulties that need to be addressed. Experience so far indicates that as soon as KBS become of worthwhile size they begin to take significant computer resource. Dechapunya (1987) looks at the kind of computer environment needed so that the experts and knowledge engineers can develop KBS efficiently.

It is essential that KBS are attractive to the end users. They should not be seen as a repository for knowledge, but as an information product a user will consult to meet a need, in preference to reading a book or brochure or asking a colleague or expert directly. The KBS must therefore be reasonably capable of being able to provide the complete answer to significant questions without insulting the user's intelligence with a mass of basic background information. It follows that the detail of the KBS must be prepared with the end user in mind. Preferably the KBS should be in a well defined problem domain, for which there are definitive answers.

DAMP system is a diagnostic system, with a central core of knowledge. Trethowen (1987) points out that the knowledge domain of the consultant is not well defined. They have a great deal of general knowledge, not all of which can be included in a KBS. Thus some interpretive skill is still often required by the user.

It is primarily for this reason that BRANZ at present considers that it should be used by the "doctor" (BRANZ technical advisors) rather than the "patient" (the building owner). The structure and detail of the KBS will need to be developed with this class of end user in mind.

Similarly with SEALANT the user must be defined, whether it is the architect designing glass-clad highrise buildings, or the home-handyman in the local hardware store. Different levels of information will be necessary. No doubt it will be possible to include several layers of information in a KBS. It will, however, considerably increase the task of building the knowledge base.

There is a need to be aware of the strengths and weaknesses of the distribution system. Using BRANZINFO will allow BRANZ to supplement an already established service. It will allow good control and easy updating and maintenance. But it will be limited by the restrictions in service (e.g. format and speed) imposed by PACNET. The Division of Building Research, CSIRO, has adopted a strategy of producing KBS for PCs. It will have the large PC market open to it and will be able to take advantage of the flexible formatting and graphics presentation. Many of these users will already be using CAD systems. Disadvantages will include problems with KBS development, size limitations, and the difficulties of distributing updates.

4.0 IMPLICATIONS

Before an organisation such as BRANZ makes a serious commitment to the use of KBS for building technology information, it is necessary to be aware of the long term implications.

What legal liability will there be for answers given by the KBS? How difficult will it be to audit them, and will the Association be expected to? How important will it be to keep a record of every consultation?

Knowledge will become dated. The existence of a KBS will not relieve BRANZ of a need to maintain expertise in that area. The opposite will be the case, with a successful KBS there will be a responsibility to keep expertise up to date in that area.

On the plus side is the discipline which is required to convert an assembly of knowledge into the collection of rules necessary for a KBS.

Dealing with problems is one of the ways experts maintain their expertise. What will be the effect of isolating the expert from the end user? A feedback loop will be important. Possible with a centralised system but not with PC based KBS.

What are the resource implications? Without good response times and the features of the latest software the user will go elsewhere. This means an ongoing commitment to expenditure on hardware and software.

5.0 ARE THEY GOOD ENOUGH?

At present none of the KBS discussed is ready for use. Before we would consider making them generally available we recognise that further developments of the knowledge bases will be necessary.The response times available for even relatively small KBS using the present interpretative version of CLASS are inadequate. It is anticipated that a compiler version under development will give substantial improvements.

Given these improvements and having resolved the implications detailed above, it is hoped we will be able to meet a medium term objective of one or two KBS available for market trials on BRANZINFO within the next year or two.

6.0 CONCLUSIONS

1 KBS provide one means of making BRANZ building technology information available to the building industry.

2 They could be suitable for a number of tasks such as checking compliance with codes, materials selection, and diagnostic problems.

3 To be selected as the information transfer mechanism they will need to be the most efficient and appropriate information mechanism available.

4 The user will want to achieve a worthwhile answer to their query. Problems should not be trivial, and subject areas should be well defined.

5 It is necessary to be aware of the implications of using KBS. These include legal liability, and the cost of keeping knowledge bases up to date.

6 The success of expert systems will depend on building up substantial user-oriented knowledge bases. This will require advances in knowledge engineering, and hard work.

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