An Expert System to Advise Industrial Clients

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KEYWORDS

Consultant, Expert system, Industrial client

ABSTRACT

The authors have recently undertaken research into the provision of industrial buildings focussing particularly on the design and construction processes, the building team and the client's input. During this research a need was percieved for a pre-briefing advisory system for the less sophisticated client. Evidence pointed to a microcomputer-based "Expert System" as the best means of providing this. The knowledge base was built up using the previous research and the advice of expert clients and practitioners. A major element of the system is a comprehensive explanatory system which has developed from testing on "guinea-pig" clients. Response to the system has been promising but problems have been encountered in the commercial application of the system. A Prestel-type system is under consideration as a means of contact with prospective clients.

Une Expert Systeme pour Conseiller les Clients Industriels

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MOTS-CLES

Client industriel, Consultant, Expert systeme

ABSTRACT

Les auteurs ont recherches la provision des batiments industriels, en particulier le desin et le construction, l'attelage du construction et la contribution du client. Pendant la recherche on s'a appercu de la necessite d'un system pour conseiller les clients naives. L'evidence a indiquee la meilleure solution etait l'"Expert Systeme" execute au microcomputer. Le savoir contenu dans le system a emane de la recherche precedente et des clients et prctitioners experts. Le system peut expliquer les decisions et les questions posees. Le systeme marche bien mais ce n' est pas utiliser commerciallement en ce moment. Peut-etre, le systeme "Prestel" fournis la meilleure methode d'utilisation.

INTRODUCTION

A three year research programme into the comparative performance of different procurement forms in Great Britain[1] concluded that a contingency approach could be adopted in determining building contract strategy i.e. that certain strategies are most suited to particular clients. The major factors influencing this strategy are listed in Table I, each of these factors having been investigated in detail for 30 case studies during the research programme. It can be seen that both client and contractor characteristics form major components in the work as well as the contract administration and building project itself.

Whilst conducting the research many clients were interviewed and a good proportion of these admitted that they knew and understood little of the options available to them as far as contract strategy was concerned. Two key facts emerged: clients had little time available to adequately explore and understand the way the building industry worked; the majority of clients took their advice on construction from one source alone. This state of affairs lead the research team to consider how the would-be client could be educated as to what the construction industry could offer and how he could be advised as to the best course of action.

Existing U.K. literature, such as client guides produced by the Department of the Environment[2] and CIRIA[3], were obviously having a limited effect and so a different medium was required. The expert system was thus chosen as an alternative to traditional literature as a means of advising and educating the client, the system reported here being named BROKER.

BROKER, THE CONCEPT

The brief devised for the system is as follows. The primary user of the system will be the prospective building client who has limited knowledge of the construction industry. The user will be at a very early phase in the development of his project with little more than an outline concept of the building that he requires. The user will be drawn from the manufacturing sector of industry (the earlier research programme was based on this sector). The system will be interactive and will ask the user a series of questions which will investigate:

- the user's knowledge of the construction process
- the user's organisation and its personnel resources
- the project under consideration
- any physical, financial and temporal constraints imposed on or by the project
- priorities and objectives of the user as far as the management of the construction process is concerned

The system will use this information to determine a profile of the client which will lead to advice being given as to how he can best approach building procurement. This advice may range from suggesting the building professionals who should be employed to expedite the project through to giving details on the terms and conditions of contract that would most suit the client and project in question and how he should organise his project team to ensure a smooth running project. The level of information and advice given will directly reflect the amount and certainty of information that the client provides. An important aspect of the system will be its ability to explain why a certain line of questioning is being followed and how a particular conclusion or piece of advice was arrived at. This attribute will help fulfil the educational role of the system.

SOURCES OF KNOWLEDGE

The original research programme, referred to earlier, is the primary source of deterministic knowledge along with the numerous client guides produced over the years in Great Britain. This knowledge must be enhanced by the heuristics of the expert if the system is to be relevant and up to date. Bearing this in mind an example system has been built using the deterministic knowledge and this is to be appraised and evaluated by construction management specialists for accuracy and completeness. These experts are drawn from a number of professions and this presents the first major obstacle, for seldom do experts agree! By limiting their number and allowing the research team the final say on the content of the knowledge base this problem can be overcome.

The example system has been set up quickly using the deterministic knowledge as a deliberate strategy because no well defined knowledge elicitation methodologies exist at present. Thus the alternate strategy of knowledge demolition is being employed, the expert assesses what already exists in the knowledge base and rewrites or adapts it to his liking. This approach has the advantage of getting a project off to a very quick start and does away with the need for elicitation of much low level background information which cannot be classed as high level expertise. However, it does require a large body of deterministic knowledge and a knowledge engineer with a good understanding of the domain of expertise to develop the prototype system. The two stage development path is outlined in Fig. 1.

SOFTWARE

The system under development is a prototype designed to determine the limitations of such an advisory system and industry reaction to the use of expert systems. Thus the emphasis at this stage is on user reaction and acceptability criteria and not the technical aspects of software development. With these objectives in mind a "shell"

programme was chosen as the vehicle within which BROKER has been developed. Such a choice has a number of advantages. The system can be developed quickly and the knowledge engineer can be a construction specialist with some knowledge of computer programming. The shell chosen was "ESP-Advisor"[4] which provides for easy updating of the compiled knowledge base and has good explanation facilities for "how" and "why" queries from the user, important for the educational component of the system to function effectively. It also has the facility to interface with programmes written in the PROLOG language; this was seen as an advantage as information could be retrieved from databases written in this language during consultation sessions.

The one element the shell does not handle at all is uncertainty. At present this is not considered to be a major drawback as the advice offered is not definitive in that it provides a number of feasible courses of action and their characteristic implications for the user. This appears paradoxical, to offer alternative advice and not attach uncertainty (or probability) to this, but is rationalised as follows. The problem being dealt with is complex and has been researched in a piece-meal fashion until recently. Research findings that exist require corroboration and refinement before probabilities can be realistically assigned with confidence, thus the incorporation of a probabilistic element into the consultation cannot be justified, it would in fact attribute a degree of precision to the advice which is unwarranted at present. As the system develops and comes into general use such an approach could be validated from the cases undertaken. This would lead to the use of a different shell or, more likely, the writing of a new programme in a sophisticated computer language such as PROLOG or LISP.

HARDWARE

The prototype has been developed to run on the Sirius, Apricot and IBM personal computers, these being market leaders in the United Kingdom at present and data files can be easily transferred between these. The Apricot is particularly useful as it is compact and easily transported and so ideal for field testing of the system. In order to produce sufficiently fast response times the software is loaded from hard-disk (Winchester) systems.

APPRAISAL

Critiques of the system are being taken from two sources; the construction industry and its clients. The validity and completeness of the knowledge base is the construction industry's domain of expertise whilst the client users offer criticism of the presentation of the advice and the form of interrogation performed by the system. Criteria identified for criticism are:

- ease of use of the system
- clarity and relevance of the questioning and explanation process
- the depth and breadth of the consultation and thus user information requirements to conduct a consultation
- search strategies adopted and their effectiveness
- usefulness and relevance of advice offered

APPLICATIONS

The prime application of the system is its use in selecting appropriate building team organisation and management strategies and thus improving construction industry performance and so client satisfaction, both of which will enhance the construction industry's reputation. Commercial implementation of the system is problematic. Essentially, it must be operated through an independent organisation which can provide nationwide coverage. Use of a national communication medium as offered by "Prestel" type systems in conjunction with personal computers may prove to be the most effective approach with the current boom in electronic communications. Whatever the final outcome of this development is it should act as a catalyst to generate practitioners' interest in a new technology and lead to more wide-ranging developments in the future.

REFERENCES

1 S M Rowlinson, An Evaluation of Design and Construction Processes (Brunel University, London, 1986)

2 N E D O, The United Kingdom Construction Industry: Guide to Obtaining New Industrial Building (Department of the Environment, HMSO, London, 1982)

3 Construction Industry Research & Information Association, Client's Guides SP15, SP29 (CIRIA Publications, London,)

4 Expert Systems International Ltd, ESP-Advisor Reference Manual (Expert Systems International Ltd, Oxford, 1984)

TABLE I. Variables Affecting Contract Strategy

VARIABLE/ TASK	EXPRESSION OF VARIABLE/RANGE OF TASK OPTIONS
THE PARTICIPANTS	
The Client	
Charter	Company ownwership, Purpose builder/developer
Context	Company size, group dependance
Awareness	Building experience, building staff
Technology	Production process, specialised building
Finance	Source of finance
Decision Making	Number of levels, timespan, formalisation
The Contractor	
Structure	Company regionalisation, service departments
Service	Procurement form, type of works, specialism
Experience	Previous work, company history
THE PROJECT PROCEDURES	
Building Team Organisation	
Team Form	Traditional ..... Design Build
Leadership	Architect ..... Builder
Scheduling	Overlapping ..... consecutive
Selection	Open tender ..... negotiation
Building Team Management	
Design	Builder ..... Architect
Subcontract Design	Nominations, cost, percentage
Scheduling	Gantt ..... CPA
Operatives	Subcontract..... Direct Labour
Project Management	Decision making staff and mechanisms
Contract Administration	
Contract Form	JCT, BPF, own form
Bill of Quantities	Yes .... No
Documents	Completion at tender, number, sources

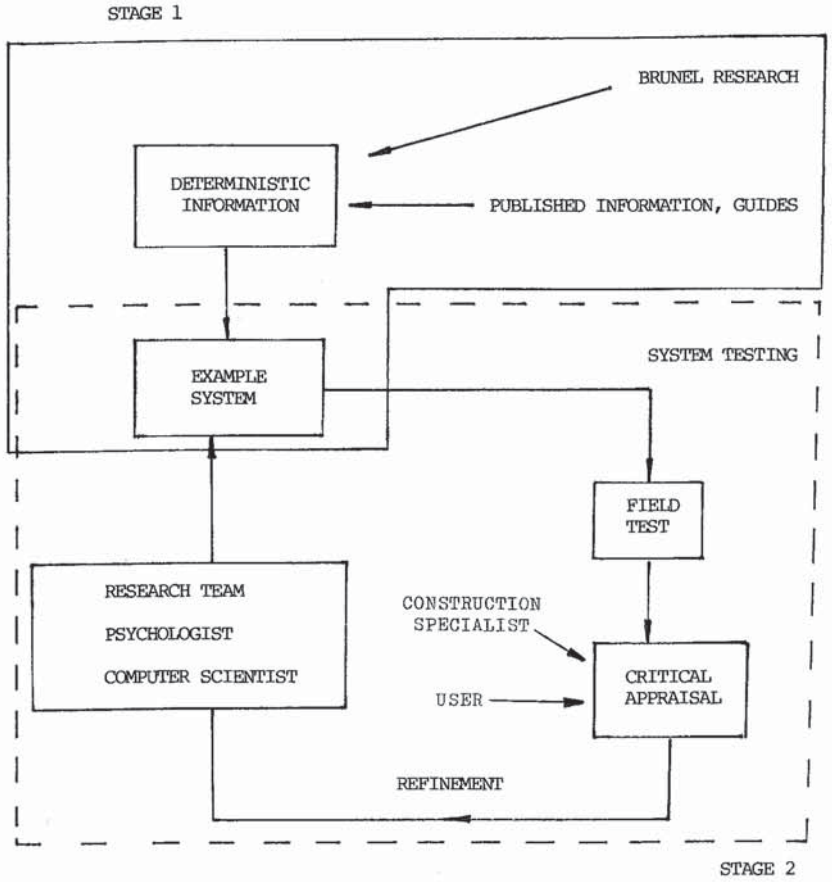

Fig. 1. Expert System Development Path

Optimization and Expert Systems in Building and Urban Design

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KEYWORDS

Optimization, Expert Systems, Building Design, Computer-aided Design.

ABSTRACT

A centre for collaborative research on knowledge-based systems for computer-aided decision has been established at CSIRO Division of Building Research, Australia. The research is an extension of previous Divisional contributions to the mathematical basis for automated optimal design and planning with applications to urban planning, building and industrial layouts.

The research is focussed in two areas: (1) development of expert systems for design and planning and for transfer of building technology, and (2) development of intelligent optimization techniques as engines for CAD systems.

Expert systems being developed are based primarily on the Division's own expertise in the areas of building technology, e.g. sealants, water penetration, and of planning and design methodology, e.g. wind loading code.

Initial optimization research is focussed on seeking improved optima in non-convex quadratic programming problems such as the layout of systems and facilities, including hospitals, commercial buildings, industrial and urban layout problems. The use of the simulated annealing method (SAM) as an intelligent optimization technique (with colour graphics) for building layouts will be illustrated, and its potential for use as a simulated learning tool will be discussed.