

DBMS itself, in practice the number of fields and number of characters in each field will be determined by the enthusiasm for typing.

This means that any construction industry application which uses work descriptions could have direct computer input in English, and the need for standard phraseology is much reduced.

#### CONCLUSION

Although the task of writing work descriptions in English directly into a computer, under site conditions, appeared to be particularly daunting, a working method has been achieved and tested satisfactorily in practice. The use of natural (English) language shorthand, and a flexible data entry program has enabled the entry of around 50,000 items without reference to coding manuals. The database management software has enabled the method to resemble manual practise as much as possible, minimising training.

The method of computerisation is not restricted to this application but can be applied to other cast models in use in the industry, for many other applications.

A computerised interactive, interrogative, analytical decision technique for strategic management in construction companies

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#### KEYWORDS

Corporate Strategy, Decision Making, Expert Systems, Personal Construct Psychology, Strategic Management, Tendering Strategy.

#### ABSTRACT

The UK construction industry is one of the largest contributors to the national economy but it is fragmented, with relatively few large firms and little concentration. The fragmentation of the industry means that contracting firms, depending on size, location and service offered, will face different types of business environment and subsequently respond to that environment in different ways. This is largely due to the environment, market strategies, organisation and managerial capabilities. Managers act as a link between the business environment and the construction company and managerial perceptions play an important part in determining the manner in which organisations respond to their environment. In the current recessionary period it is the quality of management's decisions which will determine the survival or failure of construction companies. The paper describes an interactive, computer based, analytical technique which will allow a manager to assess the quality of his assumptions and judgement in a decision making context. Using developments from Personal Construct Psychology, the technique allows managers to make explicit what is implicit and intuitive in their thinking. The decision technique will facilitate the rigorous exploration of agreement, disagreement and misunderstanding between managers in a strategic choice making situation.

Une decision technique informatisee, interrogative, analytique  
et conjuguee pour la direction strategique dans les  
compagnies de construction

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#### KEYWORDS

Strategie de l'entreprise, prise de decisions, systeme d'information par ordinateur, la psychologie de construction personnelle, strategie des affaires, strategie faire une soumission.

#### ABSTRACT

L'industrie de construction du Royaume-Uni est une de celles qui contribuent le plus largement a l'economie nationale mais elle est clairsemee et il y a relativement peu de grandes firmes et peu de concentration. Cela veut dire que les firmes qui veulent entreprendre des travaux a forfait, suivant la grosseur, la localisation et le service qu'on offre, vont rencontrer des especes differentes de milieux d'affaires et par la suite elles repondront a ce milieu de facons differentes. Beaucoup de firmes de l'industrie de construction ont fait faillite a cause du milieu, des strategies du marche et de la capacite de l'organisation et de la direction. Les directeurs se lient entre milieu d'affaires et la compagnie de construction et les vues directoriales jouent un role important pour decider de la maniere dont les organisations repondent a leur propre milieu. En cette epoque de recession actuelle c'est la qualite des decisions de la direction qui decidera du success ou de l'echec des compagnies de construction. Le document decrit une technique conjuguee et analytique basee sur l'ordinateur qui permettra a un directeur d'estimer la qualite de ses conclusions et de ses jugements dans une situation ou les problemes et les decisions sont presents. En utilisant les developpements de la 'Personal Construct Psychology' (la psychologie de construction personnelle) la technique permet aux directeurs de rendre explicite ce qui est implicite et intuitif dans leur pensee. La decision technique facilitera l'exploration rigoureuse de l'accord et du desaccord et de l'incomprehension entre directeurs qui se trouvent dans une situation strategique ou le choix est important.

#### INTRODUCTION

The paper describes the prototype stages of an interactive computer based analytical technique allowing managers to assess the quality of their assumptions and judgements in a problem and decision making context. The technique allows managers to make explicit what is implicit and intuitive in their thinking. The decision technique facilitates the rigorous exploration of agreement, disagreement and misunderstanding between managers in a strategic choice making situation.

#### CONTEXT OF STRATEGIC DECISION MAKING

The construction industry is one of the largest contributors to the national economy but it is fragmented, with relatively few large firms and little concentration (1). The fragmentation of the industry means that contracting firms, depending on size, location and service offered, will face different types of business environment and subsequently respond to that environment in different ways. The recession has had a dramatic effect on the markets for the construction industry. There has been a shift away from new build to repair and maintenance and an increasing regional discrepancy in work load favouring the South East of England. Construction firms are, therefore, facing increasingly hostile environments to which they have to adapt and survive. Common causes of company failure include the environment, market strategies, finance, organisation and managerial capabilities (2,3).

Managers, as decision makers, act as the link between the firm and the external environment. Their perceptions play an important part in determining the manner in which the organisation strategically responds to the environment (4). Furthermore, there is strong evidence to support the idea that managers have different perceptual models of people and organisations and these models do lead to different conclusions about managerial action (5, 6,7,8). These models, of their company and its members, are usually implicit, intuitive, flexible and are rarely explicit or documented (5). The effectiveness of management's decisions is, therefore, dependant on the quality of their managers' mental models. In order that companies may survive and respond flexibly to the more uncertain future that faces contracting firms, their managers must actively seek to understand the environment and adapt policies and practices to take advantage of this understanding (8). However, to reach consensus on survival strategies, implicit and intuitive managerial models must be made explicit and subjected to rigorous analysis (9).

#### EXPLORING MANAGER'S MENTAL MODELS

The general theoretical perspective for the decision making model was provided by the work of Kelly (10) and as developed more recently by Fransella and Bannister (11) and Bonarius (12). The appeal of this approach was that it dealt with an individual and his perceptions, values and beliefs.

Because of the uniqueness of an individual's past experience he will perceive decision making situations in different ways. Furthermore, his choices and judgements will depend on the quality of his past experience. It is knowledge that has been assimilated by the individual which is important in any decision making situation (13). Procedures for reflective analysis on this 'subject referenced knowledge' should be seen as complementing, not replacing, other analytical methods at the manager's disposal which focus on 'object referenced knowledge'.

There are two important practical consequences of these ideas which were incorporated in the decision model. First, through interactive computer techniques, utilising the above theory, a manager's beliefs can be made EXPLICIT and the value of his past experience in a problem context explored. This aspect of the theory has led to proposals that the method should be used in the knowledge acquisition phase in building expert systems, where the source of information is the human expert (14). Making explicit the manager's belief system enables him to compare his past experience with that of other managers and to discover areas of agreement, disagreement and misunderstanding between them. Second, the decision model enables a manager to examine strategic options and to compare, through interactive feedback, his judgements with those of his colleagues. Both facilities increase a manager's personal awareness of his own judgements and those of others and should lead to increased confidence and better quality decisions.

For any interactive decision model to be effective the analytic technique should be flexible. A computerised decision system provides such flexibility and allows a personal data base of past decisions and evaluations to be made and updated. This will allow the manager(s) to develop a frame of reference for any future decisions. A combination of a number of analytical techniques, for various stages of the decision making process, were used in developing the model. These were;

- (i) the generation of personal frames of reference and the exploration of alternative actions. It is central to the approach that the medium through which we see the world and anticipate action is a set of individual hypotheses called constructs. Constructs arise from our ability to discriminate events as similar or dissimilar from each other. The first objective, therefore, is to use the computer interactively as a means of generating constructs. For this we have used the triad elicitation method common to personal construct theory applications. In addition to generating constructs, the programme allows opportunities for moving through the construct system to higher or lower levels of the hierarchy (15). Because the programme is intended to be conversational, the user is informed at various stages as to the implications of his constructs. Towards this end correlational analysis is carried out and the results fed back to the user together with further questions for reflection. In this respect the approach parallels the conversational heuristics of other programmes (16).
- (ii) a goal directed model enabling the use of natural language as opposed to numerical input. In this programme Kelly's approach to decision making is united with other approaches which have been

based on the linguistic properties of fuzzy sets (17). The decision maker defines his problem subjectively using imprecise or fuzzy linguistic statements. He also defines the alternative that he requires. This "goal" alternative or "ideal" is seen to fulfil the role of both weights and utility in the decision making process (18). Through the use of empirical work on the frequency of positive and negative construct poles (19), and a translational programme (20), linguistic hedges are mapped onto normalised scales. From the mappings, a dissimilarity matrix is established between the goal and the alternative which shows how close the alternatives approximate to the goal.

- iii) a cluster analysis producing pictorial output in the form of decision trees showing the relationship between options and decision criteria thought relevant to the problem. The general formulation of cluster analysis is to determine a set of clusters from a set of entities such that, entities in the same cluster are similar and those in different clusters are dissimilar. Of the many methods of clustering that are available, the one used here is a hierarchical tree diagram called a dendrogram (21). This provides an easily understood pictorial structuring of the ways in which a problem area is seen or of the attitudes and judgements relevant to the problem context.

#### CASE STUDY

In the early development stages of the computer based system it was necessary to gain an insight into individual reactions to the decision making model. In order to gauge the degree of interaction and feedback that may be required a post facto decision situation was recreated. The subject was a senior estimator who had previously worked for a Canadian provincial construction company and was attending a Masters degree course in the Department. The decision taking situation related to assessing the competition for a tender submission on the subject's last job. The case study, whilst being atypical in that it refers to work undertaken in Canada, highlights the processes and output available to the decision taker. The job in question was a \$50m(1984 prices) high rise office building for a prestige client located in a Canadian provincial capital. Six companies were on the tender list;

Company A, the Subject's own company, was a provincial contractor who tendered for jobs up to a maximum of \$50m, the normal range of jobs for the company was \$5m-\$20m. Projects consisted of light Civil Engineering work such as water treatment and sewerage plants, reservoirs and general building contracting. The company did not undertake heavy civils work such as roads and sewers.

Company B was a national company tendering for projects up to a maximum of \$200m. Their normal range was also up to this figure. They primarily dealt with structures, a small amount of light Civils work and no roads and sewers.

Company C was a national contractor tendering for projects up to a maximum of

\$100m. Their normal range of operations was \$5m-\$100m. They bid for most types of work except roads and sewers.

Company D was a national contractor who tendered for projects up to a maximum of \$200m with their normal range lying within this figure. They primarily concentrated on structures, a small amount of light but no heavy Civils projects.

Company E was a national contractor who tendered for projects up to \$50m. Their normal range was up to \$15m. They primarily undertook structures work and did not tender for light or heavy Civils projects. In order to qualify for the tender short list they had to form a joint venture company to satisfy bonding requirements.

Company F was a national contractor tendering on projects up to \$200m with their normal range within this figure. They primarily concentrated on structures and preferred not to bid on light Civils projects.

The Subject assessed each contractor, including the "ideal" company, on criteria he considered important in the competitive situation described above. The criteria elicited by the Subject (Programme i) were; volume of work in hand, staffing, company expertise, availability of finance and company image. For each criterion the Subject provided two anchoring points which were equivalent to the opposite poles of a construct. Different positions on the criterion were obtained by applying linguistic hedges to the opposite poles, as illustrated below;

#### Staffing

Very Over	Over Staffed	Fairly Over	Fairly Under	Under Staffed	Very Under
		Not over and Not under staffed			

On subjecting the results of the company versus criteria rating to analysis the following dendrograms were produced as computer output. Dendrogram A below (Fig 1) shows that the Subject sees his own company (A) in a poor competitive situation to that of the ideal company. Furthermore, companies F and D are perceived by him to be in the strongest position. From these perceptions the Subject may direct his actions towards narrowing the gap between his own company and his competitors. Dendrogram B below (Fig 2) reflects how the subject has used the criteria of relevance to him. For him volume (value) of work is closely linked with levels of staffing. Again the image of the company is linked with the ease of obtaining finance. Neither of these is closely related to the perceived expertise that company has of undertaking the project. By reflecting on the way that he has used these criteria the subject gains insight into his own perceptions, choices and judgements. These will increase his awareness in new situations.

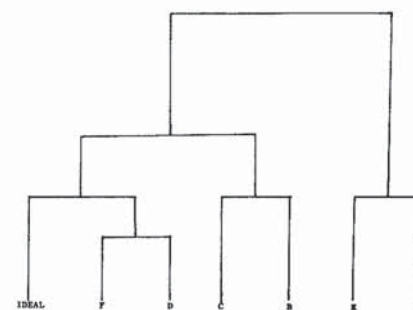


FIGURE 1 DENDROGRAM A THE SUBJECT'S PERCEPTION OF OWN COMPANY (A) IN RELATION TO COMPETITORS AND THE IDEAL

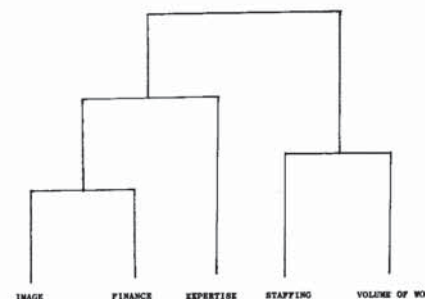


FIGURE 2 DENDROGRAM B SUBJECT'S USE OF DECISION CRITERIA

#### SUMMARY

The paper has presented an approach to strategic decision making, by means of a case study example, that uses the facilities offered by a prototype interactive computer programme to explore and make explicit the perceptions, value system and beliefs of managers. The computer programme initially elicits constructs (or personal hypotheses) that are used to generate a matrix of options versus criteria. Subsequently, the matrix is analysed to produce pictorial decision trees showing these relationships. These decision trees can be used to guide further action and enhance the decision takers awareness of his own choices and judgements.

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## MACROMODEL OF BUILDING PRODUCTION Changes in the building industry and their technological and economic impact

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### KEY WORDS

Construction economics, forecasting, systems analysis, input-output analysis, building construction, production mix, production technology, employment

### SYNOPSIS

The paper is based on the input-output method which is an excellent tool in analyzing the effects of construction on the industries and enterprises of the economy.

In the construction sector the utilization of the input-output method has been quite limited, because in the input-output tables the information concerning the inputs of construction is usually quite unreliable and its upgrading is very laborious or even impossible.

The paper introduces one suggestion on how to improve the input information by developing a so-called input model, which calculates the inputs of building construction and analyzes the impact of the changes in the production mix, quality standard and technology of building.

Then using the input-output method the author examines, how the changes in the inputs affect the demand for the production of other industries and their use of primary inputs.

This so-called Macro-Model of Building Production has been successfully used in estimating the impact of construction on employment, energy consumption and the use of other primary inputs.