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Knowledge acquisition to facilitate organisational problem solving

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Abstract

This paper examines the introduction of knowledge acquisition techniques to facilitate managerial and administrative problem solving. The characteristics of such problem situations do not lend themselves to normative approaches such as simply introducing expert systems. However appropriately performed knowledge acquisition can still be of benefit by providing a better understanding of problem situations and it can provide a suitable basis for the process of negotiation and compromise needed to resolve organisational problems. This emerging role for knowledge acquisition differs from that of systems analysis, for example, in that it focuses on improving the understanding of the location, ownership and impact of available organisational knowledge rather than the data flows and tasks performed within the organisation. The paper provides guidelines for performing knowledge acquisition for organisational problem solving.

Introduction

Organisations today are facing increasingly demanding and rapidly changing environments in which they are asked to operate, serve and perform. People attribute this to a multitude of factors spanning from global competition and the struggle for innovation (Porter 1990) to the emergence of the information society (Strassman 1985). By reviewing the characteristics and requirements for organisational problem solving in this context, we will argue that these activities go far beyond the scope of support offered by expert systems today. Knowledge acquisition is the most critical activity in the expert systems life cycle and it is there that efforts to build systems that will make a bigger impact in organisational performance should be placed.

Poulymenakou *et al.* (1990) in another paper at this conference, specifically deal with the requirements placed upon knowledge acquisition in the case of developing business expert systems and put forward some suggestions for more effective practices in this context. This approach, however, is still within the framework of developing a system designated to support managerial and administrative problem solving. Even a business expert system developed following open and flexible knowledge acquisition approaches remains a hard and formal structure. Embedding this in an organisational and/or managerial environment implies overlooking the soft and informal nature of a large proportion of the activities carried out in these contexts. This contrast remains despite efforts for more effective knowledge acquisition practices for business expert systems. In many cases of organisational decision making, the introduction of any system hard-wired to the processes is unrealistic. Having said this, any support to improve performance that is offered by old and new technologies alike is welcomed, provided that it does not clash with existing managerial decision making practices.

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In this paper, we will argue that the option offered by techniques developed and used in knowledge acquisition can provide some of this much sought after support if they are taken out of the context of expert systems development. To support this argument, we will review some aspects of organisational problem solving and will suggest ways in which these could be served by knowledge acquisition. We will then describe the type of services that can be provided. Finally, we will discuss how such activities can be set up and carried out by organisations.

Characteristics of managerial and administrative problem solving

Organisations are increasingly relying for their performance upon their collective knowledge and recognise the activities of their workers as being **knowledge intensive tasks**. 'Knowledge' in an organisation is the collection of experience, skills, talents and information that each individual has and utilises when he or she is at work. Important knowledge also exists at the level of the group, function or division and does not reside in any one individual. The advances of the information systems and communications technology have drawn significant attention to the impact of storing and disseminating information in organisations as well as supporting the knowledge processes of the people in them (Strassman 1985). Many believe that these are the first signs of the emergence of the 'knowledge organisation'.

Solving problems in organisations is a complex, knowledge based activity. It entails taking decisions that vary enormously in nature. It goes through various phases from setting the initial requirements to reaching the final objectives. It is influenced by a multitude of factors and it involves a variety of actors. All these issues need to be considered before any realistic effort to facilitate organisational problem solving can be initiated.

Brenda Wroe (1987) differentiates three types of managerial decisions: operational, tactical and strategic. **Operational** decisions relate to everyday, narrowly focused problems in an organisation relating to the type of question: how much would this product cost? The data and resources that would be required in order to deal with such issues are more or less standard within an organisation. The process followed for problem solving is also basic. The overall objective of operational decisions is the implementation of a selected course of action. **Tactical** decisions are those which deal with selection. They are the frequently required decisions of the type: how many units of this product should be produced? The scope of tactical decisions is wider and the background and processes followed in problem solving are less apparent, standard or readily available. **Strategic** decisions are characterised by their exceptionally wide scope and their relative infrequency. They are mostly one-off, high level decisions aimed at providing actors with directions, for example: what types of products should we produce? Strategic decisions are based on a broad platform of evidence, the nature and amount of which change according to the situation at hand. The process of decision making is subjective and is influenced by the perceptions of the few individuals of the issues considered.

From the differentiation of types of decisions, it is clear that the nature of managerial decision making changes according to the requirements of the problem that it is set to resolve. Different problems trigger different types of decisions and hence different methods must be used for their investigation and support. As we move from operational to strategic decision making, the data and standard procedures give way to more complex considerations of

alternative contingencies and associated risks. The methods that can be used to investigate and support different types of decisions should vary accordingly.

Decision making in organisations has been extensively discussed from many different perspectives. For Simon (1976), organisations are just ordered, social ways for making decisions. He describes three stages in the overall process of making a decision. These can be associated with stages in problem solving.

Table 1: Stages of decision making and problem solving

Decision making	Problem solving
<i>Intelligence</i> •Finding occasions calling for a decision	•Identifying the problem
<i>Design</i> •Inventing, developing and analyzing possible courses of action	•Formulating possible solutions
<i>Choice</i> •Selecting a particular course of action from those available	•Determining the correct solution

If this perspective is adopted, decision making and problem solving can be viewed interchangeably. We make decisions by solving problems that arise in the process of meeting our objectives.

In the complex environment of organisational problem solving, groups and their activities have a special role. The benefits of sharing and exchanging information, ideas and responsibility make groups very powerful decision making agents. Groups, teams and committees serve a variety of purposes in organisations as presented in Table 2.

Table 2: Working in groups (Handy 1985)

Purpose	Mode
•Distribution of work	•Bringing together skills, talents and responsibilities
•Management and control of work	•Allocate work to the appropriate individuals
•Taking decisions	•Applying all available capacities to the process by combining skills, talents and responsibilities
•Data and information collection	•Gather ideas, information or suggestions
•Information distribution	•Passing on information and decisions to those who need to know
•Testing and authorising decisions	•Testing and authorising actions taken outside the group
•Coordination and liaison	•Coordinate problems and actions between functions and divisions
•Negotiation and conflict resolution	•Alleviation of disputes and arguments between levels, functions and divisions
•Inquest into the past	•Examination of past cases or organisational performance

The function of group decision making does not come free of problems. The process is complex and difficult to monitor, support or control. The benefits in devising ways of doing so focus on avoiding group behaviour producing the type of output described by Handy as "A camel is a horse put together by a committee".

In this section, we have attempted to present some of the characteristics and phenomena associated with problem solving in organisations. As we have argued in the beginning, problem solving in its various forms is based on the knowledge of every individual who take part in it. The process of acquiring knowledge developed in the field of expert systems has provided analysts with a variety of methods, techniques and tools that could be used in the investigation of these knowledge processes.

Knowledge acquisition performed in the context of developing an expert system however, will sooner or later resort to the reductionist, rationalist approach required in order to transform knowledge into an operational structure (Winograd and Flores 1986). The collective knowledge and experience underlying the processes described here cannot be accommodated in such a structure. One could consider for example, the difficulty in representing in a system the implications of obtaining feedback on a report or an action. An effort to do so requires the incorporation of cultural, contextual, situational and organisational evidence. Therefore, before knowledge acquisition assumes a facilitator's role in organisational problem solving, we need to set the requirements that knowledge acquisition will seek to fulfil in this context.

The requirements for organisational problem solving

The increasing complexity of the nature and context of organisational problem solving urges organisations to consider new enabling mechanisms to support their efforts. The objectives that underlie this quest are the development of more effective practices, the improvement in understanding of the nature of managerial tasks and support in the development of strategy in organisations. Techniques that are structured, narrowly focused and thinly spread across a managerial domain would not work for these types of activities.

To achieve these objectives we need techniques that are able to adapt to the requirements of the environment of investigation as different organisations develop different cultures and styles of performance. Also, the techniques used should allow the elicitation and examination of a large variety of factors that may affect the way people deal with problems in an organisational context. Finally, the techniques used to investigate organisational problem solving should direct the analysis towards a deep search behind occurrences and phenomena towards causes, effects and impacts of actions (Suchman 1987). Sir Geoffrey Vickers (1973) has summarised these arguments by saying: "I hope not for greater efficiency in our problem-solving, but for better understanding in our problem-setting".

Managers are basing their decision making performance on a complex web of acquired abilities: perceiving and recognising patterns, dealing with abstraction, coping with uncertainty, adapting to change, learning from experience, assessing situations and most of all dealing with people. Knowledge acquisition should start off by examining the hows, whats and whys of this performance by putting it in the context of organisational problem solving on the one side and that of available methods and tools for investigating knowledge processes on the other. We now present an agenda of requirements which will be suitable for this area.

Problem representation: Clarifying what is the problem is a difficulty people face up front in organisations. The objective is to make problems more explicit by eliciting and creating representations of them. Hence, information related to a problem situation is made commonly available, the views of multiple sources can be incorporated in an explicit manner and progress in dealing with the problem can be monitored. Decision tapping methods such as the ones discussed in Poullymenakou *et al.* (1990) can be used here. Once the problem is resolved, these representations can also serve as stores of knowledge and experience documenting past problem solving cases for future reference.

Enablers for problem visualisation: Solutions to problems are only as good as the knowledge of those who provide them. Knowledge in organisations is distributed among many agents and on many occasions it is not readily available where and when a problem occurs. Problem solving is often a time critical activity and managers do not have the time to go around and interview people about their experiences as the need occurs. Knowledge acquisition can provide means for incorporating knowledge available in different parts of organisations thus providing the managers with different perceptions of the issues they are considering in every occasion.

Agenda and basis for negotiation: The perceptions of a problem by individuals in group decision making are seldom uniform in depth and breadth. Apart from differences in knowledge and experience, this is also due to the different needs and requirements people have when they deal with a problem. Suppressing or abolishing the arising conflict simply postpones the resolution of the real problem and provides less than optimal interim solutions. Knowledge acquisition can help here by making the differences clear and explicit and by tracing some of the reasons behind them. One can suggest here the use of many knowledge acquisition tools currently available. We will discuss two candidate tools later in this paper. We can also use diagrammatic investigation methods like repertory grids, not for encoding knowledge, but for introducing different perceptions of it.

Problem solving support agents: Knowledge acquisition has been traditionally involved in this area by supporting the process of building expert systems. However, here we adopt a different view of the process to achieve the objective. Instead of knowledge acquisition 'to build a system to solve the problem', we propose knowledge acquisition to support the people who deal with the problem. This can be achieved by helping them refer back to their own experiences through critical incident interviews, holding investigative discussions or compiling and using an inventory of past cases.

Knowledge acquisition techniques to facilitate organisational problem solving

The supply of the type of support to organisational problem solving that has been outlined so far predicates a new perception of the utilities offered by existing knowledge acquisition techniques. We present here some techniques and tools that look promising for investigations of this nature. As an overall starting point and guide we use the methods that have been developed for tapping decision making knowledge. This seems appropriate since the considerations of these methods cover at least in part, the first, second and fourth points on our requirements agenda.

An investigation on decision making practices starts off by looking at the environment in which decisions are taken. This can be done by observing decision makers in the course of a working day taking notes on major activities, interacting with other people, consulting documents, recording the constraints encountered and the time taken to reach a decision. This type of observation is good as a familiarisation exercise with the organisational environment but it leaves the analyst in the dark about the factors, alternatives and processes in decision making.

After the initial observations, analysis can turn to the consideration of the important features of decisions. A possible way for doing so is to discuss with the decision maker the scenario of a case where the information available, or the nature of the problem or the features of the solution are restricted. Then, as the interviewee is trying to deal with the case, priorities and alternatives considered can be isolated. Similarly, data from a problem already tackled can be used to prompt discussion on what makes a 'common' or 'unusual' case, what decision making strategies would fit each of them. These simulated scenarios could take the form of a critical incident interview whereby revisiting difficult or exceptional cases can help to reveal effective courses of action and some of the reasons behind them.

Managers develop skills like that of perceiving and recognising structures specifically because these can help them establish similarities between current problems and previous ones and thus decide where analogous action would be beneficial. Episodic analogies can help reveal the 'benchmarks' managers are using when comparing two problem situations. These indicators, apart from pointing to specific courses of actions can also double as problem representation primitives.

Table 3: Methods for investigating decision making processes (Hoffman 1987)

Technique	Benefits
<ul style="list-style-type: none"> •Environment observation •Constrained scenarios 	<ul style="list-style-type: none"> •Overall view of tasks and area orientation •Reveal salient features of a problem and strategies for problem solving •'Post mortems' in actions, archiving data •Pictorial view of past experiences, sensitivity analysis in problem features •Infrequently used data, data combination and prioritisation
<ul style="list-style-type: none"> •Simulated scenarios •Episodic analogies 	
<ul style="list-style-type: none"> •Difficult cases 	

The techniques described so far work well on defining and refining various aspects of decision making of individuals. In the context of problem solving in organisations though, we have seen that groups have an important role to play. Group decisions are either the result of a necessity, for example if a case is too difficult for an individual to tackle, or of convention if a decision is regarded as being too critical to be left in the hands of a single person which is often the case with strategic decisions. Knowledge acquisition can help group decision making in two ways. One is to create a common basis of understanding for the group members. The other is to support the exploitation of the combination of human resources that exist in a group.

For the first objective, the most relevant technique involves the comparison of conceptual structures of different individuals. Shaw and Gaines (1989), who have worked on this, have described four possibilities in the use of concepts and terms as referred to by different people.

People may use the same term to describe different concepts, different terms to describe the same concept, the same terms for the same concept or different terms for different concepts. Eliciting and recognising which of the four cases is true in a particular situation will form a basis for resolving potential conflicts that refer to mere terminological disagreements. One step further, the technique can be used to create a rich framework for examining a particular problem situation. Brainstorming is proposed here as a suitable investigation technique.

The second objective of knowledge acquisition in group decision making picks up the situation where the first leaves it. After the comparison of conceptual structures, other techniques can be used to follow up brain storming. Consensus decision making, for example, shifts the focus from the quantity of answers collected to their relative quality for the problem at hand (McGraw and Harbisson-Briggs 1989). All alternatives are judged in terms of their advantages and disadvantages, weighted and measured by every person in the group.

Finally, the most significant contribution of knowledge acquisition in organisational problem solving could prove to be that of using the multi-technique tools that have been developed for the support of the knowledge acquisition process. These tools incorporate diagrammatic techniques that can prove valuable for the representation and visualisation of problems as well as for the investigation of different scenarios. One of the most sophisticated tools available is AQUINAS (Boose *et al.* 1989), the newest product of long research in the area. The tool uses repertory grids, which are tables of problem characteristics mapped against solutions, used to represent what people know about problems. The characteristics used can be observations, preferences or constraints. Repertory grids can be used for decomposing problems, eliciting distinctions and combining uncertain information. Multiple sources can work together on the same problem using this tool. They can select what they think as an appropriate course of action such as combining the evidence, considering the constraints or rating their own preferences. The developers point to a number of ways in which such a tool could be used, apart of the obvious of building an expert system. They include the facility of having a source of knowledge different than its user, the inclusion of multiple contributions to what is known about a problem, the ability to serve many 'knowledge users', the ease of updating the stored material and the use of the tool for archiving.

In this section, we have pointed to a number of alternatives available through advances in knowledge acquisition, that can serve the cause of organisational problem solving by bringing to the process some of the insight gained by advances in the knowledge acquisition field. We argue that it could only be to the benefit of the organisations to consider and try the options we have presented here.

Epilogue

The objectives of this paper has been to introduce a different perception in terms of the approaches used to investigate organisational problems and to provide support for dealing with them. We propose the dissemination of practices relating to the new technology of knowledge based systems, in particular knowledge acquisition, to harness the underlying knowledge resources found in organisations, without the restrictive, hard-wired format found in expert systems. Such an endeavour would not provide simple and easy answers but we believe it is a worthwhile research ambition.

REFERENCES

- Boose, J.H., Shema, D.B., Bradsi, J.M. "Recent Progress in ACQUINAS: A Knowledge Acquisition Workbench" *Knowledge Acquisition* (1:2), June 1989, pp.185-214.
- Handy, C.B. "Understanding Organisations" Middlesex, England: Penguin Books, 1985.
- Hoffman, R. "The Problem of Extracting the Knowledge of Experts from the Perspective of the Experimental Psychology" *The AI Magazine*, (8:2), 1987, pp.53-76.
- McGraw, K.L., Harbisson-Briggs, K. "Knowledge Acquisition: Principles and Guidelines" NJ: Prentice-Hall, 1989.
- Porter, M. "The Competitive Advantage of Nations" New York: The Free Press, 1990.
- Poulymenakou, A., Cornford, T. and Whitley E. "Pragmatic considerations for effective knowledge acquisition: The case of business expert systems". Proceedings of SIGBDP conference Trends and Directions in Expert Systems, Florida, 1990.
- Shaw, M.L., Gaines, B.R. "Comparing Conceptual Structures: Consensus, Conflict, Correspondence and Contrast" *Knowledge Acquisition* (1:4), December 1989, pp.341-364.
- Simon, H.A. "Administrative Behaviour" Macmillan, 1976.
- Strassman, P.A. "The Information Payoff: The Transfer of Work in the Electronic Age" New York: The Free Press, 1985.
- Suchman, L.A. "Plans and Situated Actions: The Problem of Human-Machine Communication", Cambridge: Cambridge University Press, 1987.
- Vickers, Sir G. "Making Institutions Work" Associated Business Press, 1973.
- Winograd, T., Flores, F. "Understanding Computers and Cognition: A New Foundation for Design" Reading, MA: Addison-Wesley, 1986.
- Wroe, B. "Successful Computing in a Small Business" London: NCC Publications, 1987.