The Knowledge Engineering Review

The current impact of expert systems on the accounting profession and some reasons for hesitancy in the adoption of such systems

N.A.D. CONNELL

Department of Accounting and Management Science, University of Southampton, Southampton SO9 5NH

1 Introduction

There is a growing awareness of the potential of expert systems in the accounting profession, although the number of applications is limited. This paper assesses whether the profession is dragging its heels, or whether it is being wisely cautious.

Three issues are addressed. First, the apparent movement of financial expert systems from research to development. Second, the important distinction to be drawn between the development of small systems and large systems. Third, why it seems likely that progress may be slow, and possibly uncomfortable, during the transition period.

2 The movement from research to development

The potential for financial applications of knowledge based systems has been recognized for a number of years. One of the earliest examples of non-scientific expert systems was TAXMAN (McCarty, 1977), which dealt with the taxation implications of corporate reorganization. More recently, influential reviews of the impact of technological change on accountants have cited the potential impact of expert systems on the profession (Clarke and Cooper, 1985; Collier, 1984).

3 Evidence of technology transfer from the research literature

A recent review of the research literature in accounting expert systems (Connell, 1987) identified about twenty such systems. Activity is taking place principally in the domains of audit and taxation. A number of the systems identified were in practical use according to their developers, although most were small or acknowledged to be little more than prototypes. Activity seemed to be more pronounced in the USA than elsewhere. There was some evidence of a good deal of unreported research and development taking place. Most reported research was undertaken by academics, with one or two notable exceptions. However, it seemed reasonable to suppose that accountants within industry, particularly those whose companies had successfully developed non-accounting systems, might be more likely to develop knowledge-based systems than those in accounting firms.

4 Evidence of technology transfer from the profession

In order to gather further evidence, a detailed survey was undertaken under the auspices of the Institute of Chartered Accountants in England and Wales (Edwards and Connell, 1986). Over 600 firms in the UK, USA and Canada were surveyed. Organizations were asked whether or not they were developing expert systems, and if so the scale and direction of their activities. The survey received 189 replies. The conclusions of this research were:

- expert system activity is increasing;
- the USA was consistently ahead of the UK in all aspects of expert system development;

- most system builders were using proprietary shells;
- there was no marked difference in the level of development activity between accountants in firms and those in companies;
- where progress has been slow it is usually because benefits are not sufficiently clear.

These results lead to the conclusion that there is a genuine movement from research to development of expert systems, with many of the organizations surveyed giving examples of systems currently under development. However, a more detailed investigation of some of these systems has indicated that many of them are micro-sized applications. This does not mean that they are trivial. It does, however, suggest that the development of larger, non-micro-based, systems may be presenting (or perhaps are about to present) a very different sort of construction problem.

5 The distinction between small and large developments

It is notoriously difficult to measure the size of an expert system. Possible metrics include number of rules, lines of code, amount of memory required, other hardware requirements, sophistication of user interface, development effort and duration of a typical consultation. However a reasonable working definition of a small system is that it is characterized by being micro (e.g., PC or similar) based, built using a shell, involving a single expert and taking less than 6 man-months to build.

It seems likely that the vast majority of the systems currently in use in industrial and commercial environments, including accountancy, fall into this category. There are a number of reasons why this is so.

- For most organizations, expert system development is still in its infancy. It therefore makes sense to test the water by "starting small".
- Most firms, and perhaps more significantly in an accounting context, most clients already have PCs. Existing hardware constrains the design and size of the system.
- Shells are an obvious choice following from point 1 above. Their lack of power and flexibility soon limits the size of the system as response times quickly deteriorate, but bigger, more powerful shells eat too heavily into an already limited memory, leaving little room for knowledge bases.
- It seems a common feature of expert system development in a variety of domains that developers find the need to revise the scope of their systems. As development progresses, the system builder realises that the range of expertise cannot possibly be modelled and the ambitious early aims are refined down to a system which is much more restricted. The development of some Alvey Community Club systems provided good examples of this.

The implications of the above may be transitory. As more systems are developed, development teams will grow in confidence and organizational commitment to more expensive hardware and software may be less of a problem, leading to the development of "large" systems. But it seems that many organizations have yet to be convinced that the benefits are worth the cost. The most likely motivating factor is the extent to which expert systems are seen to be successful. There are a number of criteria of success (Connell, 1987a), but it seems likely that the most persuasive will eventually be "the bottom line", the extent to which using the system saves or makes money. It is difficult to apply the metric of cost/benefit analysis to many of the small systems currently being built. The hardware is usually already available, the software is sufficiently cheap to be purchased from a consumables or similar budget. Development costs are masked by the expert working in his or her "spare" time and not formally booking time against a particular project. Under such circumstances, the benefits of such systems are almost certain to outweigh the costs, and even if the systems do not prove successful a useful lesson has almost always been learned.

6 Why progress towards the construction of large systems may be slow

Why has it taken so long for large successful systems to appear? The situation is not unique to accountancy. The problems seem to centre around five areas:

1 organizational infrastructure problems
2 lack-of-expertise problems
3 application (domain) problems
4 construction problems
5 user problems.

6.a Infrastructure problems

Most organizations have little experience of building expert systems. Where a corporate policy exists, experts system development usually becomes the responsibility of the data processing (D.P.) manager or perhaps the IS manager. However, there is the risk of development becoming fragmented as individual enthusiasts build their own systems. Some organizations welcome, even encourage, such a policy amongst the user community, working on the principle that a single volunteer is worth ten pressed men, and accept the fact that this approach gives plenty of scope for wheel-reinvention. Other firms have taken a more top-down approach, even to the extent of establishing knowledge-based systems groups. Research in other areas (Connell, 1987b) indicates that an increased awareness of the technology has led to the appearance of expert system user groups, the chairmanship of which allows some scope for guidance, monitoring and possibly even control of the development of applications. The need for a focal point for expert system development may soon become acute within many organizations, particularly those adopting a "bottom-up" approach.

6.b Lack-of-expertise problems

There are only a few organizations in the UK which have developed large operational expert systems. Few if any accountancy firms have done so. Those organizations which have developed large systems admit that they are still very much at the learning stage. "Experienced" expert systems staff are typically those with 12–18 months experience.* It is becoming increasingly recognized that the knowledge engineer requires skills substantially different to those of the conventional D.P. systems analyst, particularly during the knowledge acquisition stage of expert system construction. Knowledge engineering is very much a two-way process and expertise (not just domain expertise) is needed on both sides if the process is to be a success. This is as problematic in accountancy as it is in other domains. Perhaps it is hardly surprising that so many systems have been developed by the expert himself. Such a route will not be practical for large systems.

6.c Application (domain) problems

The problem of domain selection is already well recognized and criteria exist to ameliorate it (Prerau, 1985; Chandrasekaran, 1985; Stefik, 1982). However, for some practical systems these criteria are not usually rated as highly as more pragmatic considerations such as the availability of a willing expert. Well structured and well defined domains have proved most successful for small systems. Accountancy may offer large domains with similar properties, but it may be more likely that expertise could become embedded in larger non-knowledge based systems.

6.d Construction problems

As indicated above, most systems have been built in small, well-defined domains where the scope of the development has allowed control of the project to be easily maintained by a single knowledge engineer, or in some instances by the expert. The use of shells encourages this approach. Rapid prototyping is possible, the systems are seen as self-documenting, and issues such as validation and

* at mid 1987

maintenance often do not arise. For small systems with an anticipated local use this methodology may prove reasonably problem-free, particularly if one of the main objectives is to prove the technology rather than create a system which will have long life in a dynamic environment. However, organizations who are developing, or are about to develop, large systems, perhaps using a number of experts or a number of knowledge bases, have recognized potential problems. The problems of knowledge acquisition and representation have already been noted. Even assuming that the hardware and software are available at a reasonable price, expert system projects are proving extremely difficult to cost accurately in advance. Although there are similarities with traditional data processing systems, these can be deceptive. In particular, the problems of system testing, validation and the effects of a dynamic environment on the knowledge base combine to make project cost estimation difficult.

Once a system is operational, systems maintenance presents a real challenge in a dynamic commercial domain, where environmental changes are likely to prove more problematic than in a closed world like computer system configuration.

6.e User problems

The need for a clear user model is well recognized. In practical terms, this may mean some sort of "participative" approach to system development. Early prototyping is seen as essential by most developers, although there is a risk in less technical domains such as accountancy that the prototype system will appear trivial (the "is that all it does then?" problem). Where the domains are characterized by depth rather than breadth of knowledge the user may need to share that deep knowledge of the domain if the system is to be successful. However, a senior accountant's expertise is often characterized by breadth of knowledge, encouraging him to dismiss the efforts of early prototypes. For operational systems, constructing a user interface to handle such considerations may be prohibitively costly.

That often-neglected class of user, the senior manager, still needs to be convinced that expert systems are not just "a solution looking for a problem". Uncertainties over project costing make the task of convincing him more difficult. The problem of the system never being completed may be a difficult idea to sell, although it may not prove as serious as the prospect of the implemented system being deficient in the advice it gives. Even the most successful expert systems continue to make mistakes (Bachant and McDermott, 1984), and whilst such mistakes by human experts are often tolerated, an important change in perspective is necessary before we take a similarly indulgent view of expert systems. Software is expected to be error-free. It is unrealistic to expect this of expert systems.

7 Prospects for the future

The pitfall of applying an inappropriate technology is as present with expert systems as with other forms of information technology (Bakos and Treacy, 1986). In view of the optimism surrounding the use of such systems, particularly by the distributors of proprietary software, there is a need to guard against "seductive reasoning". The circumstances which produce a successful system in a technical or scientific domain are not necessarily likely to produce the same results in a commercial or business domain. There is undoubtedly scope for systems operating at a low level of expertise, as suggested by Dreyfus and Dreyfus (1986), Harmon and King (1985) and d'Agapayeff (1984). Such systems may well be of the "quick and dirty" variety, but no less successful because of that.

Perhaps one of the greatest benefits of expert systems, which may prove to be their most successful feature, is the insight gained into what constitutes "knowledge" or "expertise" in a particular domain during the construction of such systems. The organization becomes aware of those skills and tasks which are important to successfully conduct its business. This can prove invaluable during recruitment and training, for example. The expert can learn during the knowledge acquisition process exactly how he applies and makes use of his expertise in solving problems. This

contemplation most typically takes place during knowledge acquisition, but may re-occur during system testing, and possibly even consultation. Extremely valuable insights into the decision process may be gained both by the knowledge engineer and the expert. Thus the process of building the system becomes more valuable than the system itself. Some accounting systems have even been developed with the aim in mind (Steinbart, 1987). However, the problem of attaching financial value to this process of contemplation may lead to exaggerated claims similar to those made for some management information systems a decade ago, with similar consequences.

Conclusions

There undoubtedly exists a niche in the accounting profession for expert system applications, particularly small systems. Other domains are already indicating that the lessons learnt from the construction of small systems will not necessarily be transferable to large systems, and accountants are unlikely to adopt a pioneering role in addressing these problems. However, whilst they may not wish to be first in the field, some of the larger firms, particularly those with strong management consultancy divisions, are quietly equipping themselves to become a very close second.

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