Expert systems and their use in information science

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EXPERT SYSTEMS AND THEIR USE IN INFORMATION SCIENCE

by

ANNE MORRIS

Published works submitted in partial fulfilment of the requirements for the award of the Doctor of Philosophy degree of Loughborough University of Technology.

October 1993

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1. **INTRODUCTION**

**Title: Expert systems and their use in information science**

The overall aim of the work submitted here was to advance and disseminate knowledge in the field of expert systems in information science. More specifically the objectives were:

1. To review the field to date.
2. To develop expert system prototypes which give advice on online database selection and, to a much lesser extent, search statement modification.
3. To examine the roles which information professionals might play in expert system development.
4. To examine the expert systems teaching and research being undertaken in Library and Information Science (LIS) departments in the UK, North America and Australia.

These objectives, although distinct are, in fact, related. It became apparent when investigating possible roles for information professionals in expert system development that the best opportunities for them were in the LIS area itself and not outside. Consequently, the research focused on whether future information professionals had the skills to undertake expert systems research in their own area and on the building of prototypes in a specific LIS field - online information retrieval.

This submission is organised in five sections. The first section contains review papers which give an overview of expert systems and their use in LIS. The next two sections contain papers detailing research undertaken in the expert system/online information field. Pilot research work, undertaken over a five-year period, is described in the first of these. The other section contains papers detailing a comprehensive three-year
programme of research, aimed at developing an expert system to give advice about which online database to use for answering specific queries in the company information field. The fourth section presents papers which were based on research undertaken over a two-year period, investigating the possible roles for information professionals in expert system development. This is followed by a section containing papers describing four separate surveys, conducted over a four-year period, designed to find out what expert systems teaching and research was being undertaken in LIS departments.

The following analysis attempts to synthesise this work, and to show its essential unity.

1.1 SECTION A: Introduction to expert systems

The last decade has seen expert systems develop into one of the most successful aspects of artificial intelligence. Commercial organisations on both sides of the Atlantic have recognised the enormous potential of such systems and have forced the frontier of knowledge rapidly forward. Expert systems are no longer confined to the research laboratory although they are still in an early evolutionary stage. Already, however, they have added a new dimension to information processing. In addition to executing complex computation, computers are now able to offer users advice and solve problems which would normally require human expertise.

Expert systems have been used very successfully in both industry and commerce, reputedly saving some companies millions of dollars a year. Against this background, it is not surprising that the LIS sector, traditionally at the forefront of the application of computer technologies, particularly databases, has been researching, assessing and debating the likely impact of expert systems on the information profession and information service delivery.

The papers in this section provide, as the title suggests, the information professional with an introduction to expert systems technology. The first paper (Item A1) covers most, if not all, aspects of expert system development. It was written to provide the information practitioner with enough background knowledge to take a more informed approach when providing an information service to researchers in the expert systems
field and to evaluate more effectively the potential of such systems in LIS.

The second paper (Item A2) is concerned with knowledge acquisition. This process involves eliciting, analysing and interpreting the knowledge which a human expert uses to solve a particular problem, and then translating it into a form recognised by a computer. Knowledge acquisition is one of the most important aspects of expert systems development. An expert system is, after all, only as good as the expert knowledge that goes into it: systems that can learn from experience and create new rules are rare indeed. This paper, therefore, explains the background to knowledge acquisition and details the various techniques available. As such, it was intended to be helpful to information professionals planning to undertake expert systems work. It has indeed been suggested that knowledge acquisition is the aspect of expert system development to which the skills of the information professional are most relevant. This possibility is explored further in SECTION D.

The third paper (Item A3) discusses the interface requirements of expert systems and offers guidelines to designers of such systems. User-friendly interfaces are essential; without them, systems will either be used grudgingly or not at all. When the first paper was written, in 1987, most of the expert systems and shells then available had very inflexible system-driven dialogue facilities and, in comparison to those of today, had poor interfaces. Expert systems interface design is still a young and exciting area. New products are being launched and old ones, like Leonardo, are being upgraded to Windows platforms.

The first part of the paper discusses six controversial aspects of user interface design: the separate requirements of end-user and knowledge engineer (a problem then because most shells combined the two); natural language interfacing; dialogue control; adaptivity; error handling; and explanation facilities. Research in each of these areas is continuing but greater emphasis is now being placed on natural language interfacing. The general guidelines, at the end of the paper, were based on unpublished research investigating the evaluation of expert systems shells, by the author, as well as on the literature. They are still relevant and useful for designers of expert systems.
The fourth paper (Item A4), written in 1988, compares and contrasts expert systems with database technology and gives projections for the future. Harnessing expert systems technology to databases has now become fairly commonplace. As the paper predicted, expert systems have moved from being merely stand alone PC-based products; they are now being integrated into many different types of programs, including online databases.

The last paper (Item A5) in this section reviews the research that has been undertaken in several key LIS areas: online information retrieval, cataloguing, abstracting, reference work, and indexing and classification. Much expert systems research has been undertaken in the LIS area, and although it is largely of an experimental nature, there is evidence that real progress is being made. There are a few commercial systems available in the online information retrieval field, for example, that incorporate the use of expert systems technology. In the area of cataloguing also, there are already prototype systems capable of producing "automatic" descriptive cataloguing from title pages. Similar successes can also be reported in the other major areas in LIS.

1.2 SECTION B: The development of small prototype expert systems for database selection and search statement modification

The research detailed in SECTIONS D and E indicates that, to gain credibility in the expert systems field, LIS professionals need to contribute to the design of systems in their own area. This has been happening; indeed many prototypes now exist across the whole spectrum of LIS topics, (see Item A5). The publications in this section concentrate on the application of expert systems technology to online information retrieval and describe the development of prototype expert systems, during the period 1987-1990.

The study focused on database selection and search statement modification, both generally regarded as needing improvement in existing commercial information retrieval software. Two prototype database selectors were developed, one for company information (see Item B1) the other for marketing information. As with so many other
expert systems projects, the recording of knowledge gleaned from experts proved to be as useful as the systems themselves. Two papers outlining the selection process, in the two areas mentioned above, are included here, (see Items B2 and B3).

Two prototypes, giving advice on how to modify online search statements after failing to retrieve the desired information, have been built using two different shells, Xi-plus and Leonardo. Only the findings of the first project have been published, however, (see Item B4), because it was the author's intention to extend this work at a latter date. Both systems work well but were rather too general to give advice to anyone other than a complete novice. Nevertheless, the research showed that the approach worked and that the ideas could be developed. One way of doing this would be to tailor a system to a specific host, such as Dialog. Eventually, if proved useful, the system could be incorporated into the host's standard retrieval software.

Much of research outlined in this section was pilot work, testing expert system shells, assessing methodologies and investigating the general feasibility of using expert systems technology to assist in database selection and search statement modification. Three expert system shells were used, Xi-Plus, Crystal and Leonardo. Of the three, Leonardo was found to be the most sophisticated and flexible, although usable systems were also produced using the other shells. All prototypes were tested in teaching situations and the company database selector was demonstrated to the online retrieval experts who had assisted at the knowledge acquisition stage. While the evaluations were qualitative rather than quantitative, the results were encouraging enough to suggest that development in these fields was feasible and worth further investigation.

To this end, a much larger expert system was developed to assist searchers in the selection of online databases when answering queries about company information. This work is analyzed in SECTION C.
1.3 SECTION C: The development of CIDA - Company Information Database Advisor

All the papers in this section were based on a single piece of research carried out over three years in two phases. The overall aim was to develop a prototype expert system which could give advice on the choice of online databases when answering specific queries about company information.

The objectives of phase one were as follows:

1. To undertake a literature survey of the use of expert systems for information retrieval in general and business information in particular, and the heuristics of searching in this area.

2. To identify, as fully as possible, databases that are used by UK intermediaries for business information retrieval of the chosen type, their coverage, costings and availability on different hosts.

3. To determine, using a variety of knowledge acquisition techniques:

   - the types of information query that characterise the chosen domain

   - how experienced information retrieval experts select online business databases to meet requests

   - how experienced information retrieval experts select an online host in cases where the selected database can be accessed via two or more hosts.

4. From 3, to identify what information about hosts and databases needs to be embodied within a knowledge base for database selection, and to determine how this can best be represented.
5. To assess a variety of expert system shells which run on microcomputers as potential development tools for this type of application.

6. To design and write a prototype expert system program for online business selection using an expert system shell.

7. To evaluate the prototype expert system program.

All the objectives were met and papers have been written to reflect this. Item C1 gives brief background information about why this particular area was researched while Item C2 reviews the use of expert systems as information intermediaries. The use of online databases providing company information has been investigated, with key online sources identified (see Appendix 2, Chapter 3), and an evaluation of printed sources of information about business databases published (see Item C3). Knowledge acquisition about the selection of online databases was conducted with business intermediaries, which resulted in rules modelling the selection process (see Appendix 2, Chapter 4). Expert system shells for PC-based hardware platforms have been evaluated, with an evaluation published (Item C4) and a prototype expert system database adviser, Company Information Database Adviser (CIDA), developed to select suitable sources of company information (see Item C5). Finally, the prototype expert system was evaluated initially for accuracy, usability and the presence of bugs (see Appendix 2, Chapter 7).

A number of conclusions were drawn from the first phase. These included the following.

First, the study found a consensus about the key online sources providing company information but little published guidance on how to distinguish between sources for various types of business query. Extensive information about databases exists, though it dates rapidly, and is often not in a form which is easy to assimilate or to use in comparing similar databases. Guidance in database selection is not only needed by end users; it is just as vital to those handling business information professionally. Indeed, it is perhaps more important, since discussions with intermediaries suggest that the current trend is towards actively marketing information services to end users, which necessitates adding value to retrieved information.
Secondly, despite the existence of a core of key online business sources, the research showed that variations existed between business intermediaries' approaches to database selection. By restricting knowledge acquisition to a few intermediaries, however, the study demonstrated that expertise in business database selection could be distilled into a number of rules which could then be applied by an expert system application.

Thirdly, although a range of useful criteria for choosing an expert system shell were identified by the evaluation, resulting in the choice of Leonardo, the best shell for the target platform and research budget, many problems were encountered during the development of CIDA. Most of these were due to the shell's restrictions on the size of the application rather than the nature of the application itself, and were resolved by the extensive use of external files. Unfortunately, this aspect of the shell could not be evaluated independently of actual application development and it is quite possible that similar problems could have occurred with the other shells that were possible candidates at the beginning of the study.

Finally, the user evaluation of the prototype was favourable, with an acceptable level of accuracy for a first development phase. Inevitably, some problems were identified. One of the main difficulties was that subjects had difficulty in matching various business queries to categories of business information as defined in CIDA. This pointed to the need for more work in examining the use of company information in business, by looking at the scope and range of queries that may arise within specific sectors, to enable the categories to be defined more precisely.

Overall, the work completed in phase one showed that an expert system for online database selection was both valid and feasible. It was realised, however, that a second phase was necessary to bring the study to a successful conclusion.

The aims of the second phase of the study were to develop the prototype further, incorporating the recommendations made by the evaluators during the first phase of the research, and to undertake additional evaluation once changes had been made. The specific objectives of this phase were:
1. To enhance the user-interface of the prototype in accordance with evaluators' recommendations

2. To refine the system advice

3. To field test the system in an organisation where online company information searching is frequently undertaken

4. To compare the accuracy and efficiency of CIDA to that of directories giving details of online company databases.

A full report of this work can be found in Appendix 3 and Item C6 describes the comparison of CIDA to that of two printed directories and an electronic directory.

During phase two a number of changes were made to the user interface. The main enhancements were:

- providing (optional) introductory screens explaining the process of database selection

- improving the descriptions of each category of company information on the main system menu, and giving clearer advice on the choice of categories

- providing better backtracking and re-routing facilities.

The user interface enhancements were considered to be an improvement by users; fewer complaints were received during the second phase evaluations and the overall accuracy of the system increased from 82% to 87% when used by non-expert users, however, a few evaluators, with extensive knowledge of other software products, did voice the opinion that the interface looked a bit dated. This suggests that any future development work should include the serious consideration of the use of either a Windows platform or some type of natural front-end.

The use of a natural language front-end, in particular, might help in reducing the
number of errors being made by the wrong selection of business categories when faced with the main system menu. Categorising queries using menu selection and explanatory text is unlikely to be totally successful since it is simply not possible to frame menu options, explanation and descriptions to cover all the possible variants for non-experts. A natural language front-end would, perhaps, provide a more effective means of identifying the type and content of such queries.

Significant refinements were made to both the reasoning processes and the recommendations offered by CIDA. Detailed discussions were held with expert intermediaries and all the database and host details were checked against current directories. The refinements of CIDA took place during January to March 1993. Obviously, to keep such a system up-to-date, it would need periodic revision. Online information retrieval is a fast moving area and, if CIDA were to be made commercially available, this would have to be taken into account.

CIDA was field tested at the London Business School with mixed success. On the one hand, the independent evaluation of CIDA's advice was extremely encouraging; the recommendations given by both the experts and CIDA were in close agreement. On the other, very few end-users opted to use CIDA when it was made available. There could be several reasons for this: lack of user motivation, bad timing of field trials, an inappropriate institution and so on. Whatever the reason, however, user acceptability, organisation utility and overall usefulness could not be adequately assessed. Without these measures it is extremely difficult to form a fully informed view on the commercial viability of CIDA. Further field trials are, therefore, recommended. Ideally, these should involve large commercial institutions where a significant amount of end-user business searching takes place.

The results of the comparative trials of database directories (CIDA, printed manuals and the electronic directory, called The Online Manual or TOM for short) clearly showed that, when used by novice online searchers CIDA was superior in many respects:

- accuracy of recommendations
- consistency of recommendations
- overall ease of use
- consistency and functionality
- the degree of confidence users have in the recommendations
- time taken to learn to use the system.

CIDA was also found to be slightly quicker to use than the printed directories and significantly quicker to use than TOM.

The results are encouraging. Not only do they show that CIDA might be commercially viable as both a training aid and as a practically useful guide to company information databases, but that expert systems technology can play a successful role in the development of aids for novice online searchers.

1.4 SECTION D: Roles for information professionals in expert system development

The papers in this section are the outcome of three different, but related, research projects. The first paper (Item D1) presents the findings of a pilot in which 15 leading expert systems researchers working in universities and the former polytechnics in the U.K. were interviewed to seek their opinions about possible roles LIS professionals could fulfil in the expert systems development process.

The findings of a much larger project are reported in Items D2, D3 and D5. Expanding on the theme of the pilot, this research was in three stages. Stage one involved a questionnaire survey directed at the software houses in the U.K. thought to be specialising in expert systems work, of which there were 52. This was mainly a familiarisation exercise to identify the major players in the field, and to get a feel for the type and number of expert systems projects being undertaken. Stage two was concerned with interviewing in-depth 50 expert systems developers from universities, industry and commerce. The survey was designed to obtain information about the number, nature and scope of expert systems in Britain, the methodologies used in their development, and the background, experience, skills and attributes of those working in the area. The objective was to explore whether there were any potential openings for LIS graduates in the expert systems field. Visits to all U.K. LIS schools to find out the
extent of expert systems teaching and research being achieved, and thus current knowledge of graduates in this area, formed the final stage of the project.

Item D4 in this section reports the findings of a study designed to assess the expert systems job market by examining the availability of jobs in this field, the type of personnel sought by employers and whether any demand was being met. The study itself took the form of the identification and analysis of all national advertisements for expert systems posts over a six-month period and follow-up surveys involving the employers and agencies who placed the advertisements.

The final paper (Item D6) attempts to synthesise the findings of all this research. Basically, all the research reported in this section was aimed at finding answers to the two fundamental questions:

Are there realistic roles for information professionals in expert systems development? and, if there are,

What skills and knowledge do information professionals need in order to fill these roles?

A number of potential openings and opportunities for LIS professionals to become involved in expert systems development were highlighted during the research. However, the most promising roles, at the time of the research, appeared to be:

- as a knowledge engineer for building LIS applications

and those of a traditional nature such as:

- as a specialist in information sources
- as an information manager
- as an information intermediary
Developing expert systems for LIS applications, is probably the most creative and the most exciting role. Item 5A reviewed some of the work in this area, and SECTIONS B and C concentrate on the application of expert systems technology to online information retrieval.

The second role involves providing knowledge engineers with the information they need to allow them to make a broad assessment of the relevant literature before starting projects. Information professionals already provide this service and have the relevant skills but research has shown that it is rarely used by expert systems developers. Many of those interviewed didn't know that this traditional service existed in non-traditional settings! Obviously, there is a need to promote LIS services more widely.

The third role involves co-ordinating and managing information between the members of expert systems development teams. When the original research was conducted, in 1988, there were several large project teams. Most of these were in disarray because of the lack of information co-ordination. It was believed that information officers appointed to the project teams would greatly increase the chance of a successful outcome. The situation has now changed: much of the large scale expert systems work disappeared when Alvey funding became no longer available. Consequently, the demand for this type of role, although still needed where large project teams are involved, is now much reduced.

The last role involves acting as an intermediary between the knowledge engineer and the information he or she is supplied with. Obvious examples of this are the sifting of irrelevant information and the assimilation of information from multiple sources. This role could be part of the job specification of an information manager in an expert systems team, where they exist.

Before this research was undertaken, it was generally believed that LIS professionals could make a useful bid for work as knowledge engineers, particularly in the area of knowledge acquisition. The initial research, where expert system developers were interviewed, supported this and, indeed, some LIS graduates have found work in this field both in the U.K. and in North America. Nevertheless, the difficulties of gaining credibility in the field should not be under estimated. The latter research,
Investigating job vacancies for knowledge engineering personnel, indicated that software firms and systems designers were looking for people with wide general computing experience, and technical skills which would enable them to judge when the use of expert systems technology would be appropriate and how to incorporate it into existing systems. They also wanted staff who could work on other projects with the ability to pick up skills in other new areas of technology as they emerge. Few current LIS professionals have these skills or the relevant computing experience. The situation does, however, appear to be changing. Many universities now operate modular programmes which should, in theory, give students greater opportunity to select computing modules. In addition, new degree programmes are being offered by some LIS departments which place greater emphasis on information and technology. One such programme is "Information and Computing" offered by Loughborough University of Technology. Students opting for this programme require them to spend up to half their time taking Computer Studies modules. Many programmes also now include an optional "sandwich" year which could be used to enable students to gain experience in the expert systems field. Despite these developments, one should be careful not to be too optimistic; the number of expert systems being developed in the U.K. remains fairly low and the trend is more towards the provision of integrated systems rather than stand-alone expert systems.

To conclude, it would appear that the best opportunities for LIS professionals are in the development of expert systems applications in their own field. Provision of traditional information services - information collection, collation, organisation, representation and co-ordination - to expert systems teams may also provide some opportunities. It should be stated, however, that there may be a problem in persuading funders that these tasks are essential to good systems development, and that LIS personnel are the right people to undertake them. Ultimately, the extent of LIS involvement in expert systems development outside LIS will depend not only upon the credibility of the profession as a whole, but upon the enthusiasm and commitment of individuals and their own ability to impress their personality and skills upon potential employers.
1.5 SECTION E: Expert systems - education in LIS schools

To assess whether information professionals were being provided with the necessary skills to meet the needs of expert systems employers, four surveys were undertaken in the U.K., North America and Australia. Details of these are presented in this section.

The first two papers (Items E1 and E2) present the findings of two surveys that investigated expert systems teaching and research in LIS schools in the U.K. and in North America. At the time of the surveys, 1988 and 1990 respectively, expert systems technology was being taught in all LIS schools in the U.K. and in over half in North America. Many of the LIS schools were also undertaking research in the expert systems field. Educators in the U.K., (who were interviewed as opposed to being sent a questionnaire like their counterparts in North America), were generally enthusiastic about expert systems but said there was a need to be realistic, however, both about the technology and about what can be achieved within the limitations of an LIS course. Several stressed the importance of representing expert systems as another step along the computing continuum, and as an integral part of the information system development process. Some felt that, although expert systems were new enough to warrant special treatment at the time of the surveys, they would be absorbed into the "mainstream" once the current interest in them died down. There is some evidence that this is happening in North America. Some of the LIS schools that were very active in the field, such as the University of Hawaii at Manoa and the University of California, Los Angeles, have cut back both on expert system teaching to make room in the curriculum for other subjects, and on research because of lack of funding, but this does not appear to be the case in the U.K.

The third paper (Item E3) summarises the possible role of information professionals in the development of expert systems, compares expert systems teaching and research in LIS schools in the U.K., North America and Australia, and gives insight into the teaching practices at Loughborough in this area. The data relating to Australian LIS departments were collected by a questionnaire survey. At the time of the survey, in 1990, almost all of the Australian LIS departments, offering undergraduate and postgraduate programmes, taught expert systems to students. Most gave between one and four hours instruction but two departments offered electives in knowledge-based
systems totalling in excess of 50 hours. Compared to the U.K. and North America, little research in the expert systems field had been completed. Nevertheless, an encouraging start had been made.

The final paper (Item E4) presents the findings of a questionnaire survey designed to determine the extent of IT teaching, including expert systems, in U.K. LIS schools. The survey showed that the teaching of expert systems expanded during the period 1988-1992. In 1988, expert systems were mainly taught to undergraduate students. In 1992, a large number of postgraduate programmes (16 out of 18) also included the topic. The teaching of expert systems was still regarded as desirable by the respondents (IT lecturers), particularly for students taking Information Studies, but there was less conviction than in 1988 that there is a market niche for LIS graduates with expert systems experience, presumably because of the general trend away from stand alone expert systems towards integrated computer systems. Compared to other IT topics taught, expert systems appeared to be regarded as one of the core topics; it was not taught as frequently as online IR, databases, wordprocessing or spreadsheets but, as frequently, or more so, than other IT topics such as desktop publishing, hypertext, text retrieval, library housekeeping, e-mail, viewdata, records management and decision support systems. Just over half of the undergraduate and postgraduate programmes included practical work; in the more popular IT topics practical work was given greater emphasis. The most probable reasons for this are first, lack of time and secondly, the high cost of expert systems software. Unfortunately, the pilot study had proved that it was unrealistic to expect respondents to give details about the number of hours spent on individual topics. Consequently, despite the teaching of expert systems being regarded as "desirable" and included in most programmes, it is possible, that, in some cases, only a few hours may be allocated to the topic. Where this is true it would not be surprising to find only theoretical aspects being taught. Expert systems software is expensive and, although over half the departments have either Crystal and Leonardo, for some departments the high cost of obtaining such systems may be prohibitive.

What then are the trends in the teaching of expert systems in LIS departments? In the UK it appears that the teaching of expert systems is still popular. It was, for example, among the biggest "increases" in the number of teaching hours over the period 1990-1993, particularly on undergraduate programmes. This is encouraging, not least
because of the investment in staff training, the procurement of expert systems shells and in the development of supporting courseware. However, it is possible that the future growth areas of text retrieval, multimedia and records management, as identified in the survey, may oust expert systems teaching in the future. Only time will tell.

In the mean time it is right that LIS educators continue to teach expert systems. As stated in the previous section, LIS professionals could be expected to provide a service function for researchers and/or developers in the field. In addition, there is still considerable scope for applying this technology to LIS itself, and the chance, albeit much more remote, of being part of a team developing expert systems in the commercial sector. Giving introductory lectures about expert systems/AI still seems sensible therefore, but whether practical "hands-on" teaching is necessary for all LIS students is debatable. One could argue that there is not enough time for all the essential core subjects to be taught as it is. Perhaps the ideal would be to include compulsory practical instruction on courses with a technical bias, the students of which are more likely to have programming experience and interest in the field, and to offer the same opportunity, in the form of optional modules, to all other LIS students. This would enable each student to have an equal chance to do more expert systems work should they wish to do so at either a dissertation level or beyond.

1.6 Conclusions

The overall aims of the research agenda have been met. Several prototype expert systems have been developed to assist, in the main, business database selection. CIDA, the biggest of these, took three years to develop. The system was evaluated using different methodologies: user trials investigating interface issues, experimental comparison with other database selection tools, field testing, and demonstration/feedback sessions with expert intermediaries. The results were encouraging, suggesting that systems such as these may have an important role in the development of aids for online searchers. Further work on CIDA is now needed to develop the user interface, a natural language front-end might be the way forward, and to extend the coverage. There is also scope for more field testing to verify the
commercial potential of CIDA.

In addition to the development of prototypes, several literature reviews have been undertaken both in the general area of expert systems and, more specifically, in the application of this technology to online information retrieval. The roles information professions might fulfil with respect to expert system development have also been examined together with the extent of expert systems teaching and research being undertaken in LIS schools in the UK, North America and Australia.
2. LIST OF WORK SUBMITTED

SECTION A: Introduction to expert systems

Item A1 MORRIS, A
Overview of expert systems.

Item A2 NEALE, I.M. and MORRIS, A.
Knowledge acquisition for expert systems: a brief review.

Item A3 MORRIS, A.
Expert systems - Interface insight.

Item A4 O'NEILL, M. and MORRIS, A.
Database and expert systems - the way forward.

Item A5 MORRIS, A.
Expert systems for library and information services - a review.
SECTION B: The development of small prototype expert systems for database selection & search statement modification

Item B1 MORRIS, A., TSENG, G. and NEWHAM, G.
The selection of online databases and hosts - an expert system approach.
Proceedings of the 12th International Online Conference, 4-6 December, Oxford: Learned Information, 1988, 139-148.

Item B2 NEWHAM, G., TSENG, G. and MORRIS, A.
Choosing a business database: the expert approach.

Item B3 DRENTII, H., TSENG, G. and MORRIS, A.
Expert selection of marketing databases.

Item B4 MORRIS, A, TSENG, G.M. and WALTON, K.P.
MOSS: a prototype expert system for modifying online search strategies.
SECTION C: The development of CIDA - Company Information Database Advisor

Item C1  MORRIS, A. DRENTH, H. and TSENG, G.M.
Expert systems for online business database selection.

Item C2  DRENTH, H., MORRIS, A. and TSENG, G.
Expert systems as information intermediaries.

Item C3  DRENTH, H. TSENG, G.M. and MORRIS, A.
Tracking online business information: a guide to the guides.

Item C4  DRENTH, H. and MORRIS, A.
Prototyping expert solutions: an evaluation of Crystal, Leonardo, Guru and ART-IM.

Item C5  MORRIS, A. DRENTH, H. and TSENG, G.M.
The development of an expert system for online company database selection.

Item C6  MORRIS, A.
Online company database selection: an evaluation of directories and CIDA (an expert system)
In press.
SECTION D: Roles for information professionals in expert systems development

Item D1  MORRIS, A. and O’NEILL, M.
Information professional - roles in the design and development of expert systems?

Item D2  O’NEILL, M. and MORRIS, A.
Expert systems in the United Kingdom: an evaluation of development methodologies.

Item D3  O’NEILL, M. and MORRIS, A.
The contribution of library and information science to expert system development.

Item D4  MORRIS, A. and WALTON, K.
Shortage of expert system personnel in the UK - hype or reality?

Item D5  MORRIS, A. and O’NEILL, M.
Library and information science professionals and knowledge engineering.

Item D6  MORRIS, A.
Information professionals: roles in expert systems development?
SECTION E: Expert systems - education in LIS schools

Item E1  O'NEILL, M. and MORRIS, A.
Expert systems: the United Kingdom's educational approach.

Item E2  MORRIS, A. and HUTTON, S.
Expert system teaching and research in North American LIS schools.

Item E3  MORRIS, A.
Expert systems teaching: the needs of information professionals.

Item E4  MORRIS, A
The teaching of information technology in departments of Information
& Library studies in the UK.
3. NOTES ON JOINT AUTHORSHIP

In accordance with the University requirements to stipulate the involvement and responsibility for jointly authored works, the following information is given:

(i) SECTION A: Introduction to expert systems

Item A1: Sole author.

Item A2: This paper was a joint effort between the two authors and, as such, both take joint credit.

Item A3: Sole author.

Item A4: This paper was a joint effort between the two authors and, as such, both take joint credit.

Item A5: Sole author.

SECTION B: The development of small prototype expert systems for database selection & search statement modification

The papers in this section were based on research undertaken at MSc level and supervised by myself and, in two cases, also by Gwyneth Tseng. They have been included here because the original ideas for the research were mine, in each case. In addition I designed a large part of the methodologies and reworked raw data for the purpose of the papers. Much of this research was regarded as pilot work for the research detailed in the next section.
SECTION C: The development of CIDA (Company Information Database Adviser)

The papers in this section are the outcome of three years work on the development of CIDA, Company Information Database Adviser. The work was sponsored by BLRDD in two phases. The proposals, the first draft of which were written by me, are given in Appendix 1, Items 1 and 2. The original idea for the research was mine and I was responsible for the detailed methodology for the project, including the selection of the expert system tool, the overall design of the system and its evaluation. Hilary Drenth was responsible for the knowledge acquisition and the programming. Gwyneth Tseng's principle role was as an advisor on online information retrieval, business sources and database selection.

Full reports of the research can be found in Appendices 2 and 3. I wrote a substantial amount of both reports and personally undertook all the work reported in Appendix 2, Chapter 7 and that described in Appendix 3, Chapters 5 and 6.

SECTION D: Roles for information professionals in expert systems development

Item D1: I wrote this paper which was based on postgraduate research undertaken by Margaret O'Neill under my direction and supervision.

Items D2, D3, D5: The formulation and writing of the proposal on the roles of information professionals in expert systems development (see Appendix 1 Item 3), which culminated in these research papers, was the author's sole responsibility and attracted funding from the British Library Research and Development Department (BLRDD). I assumed responsibility as the project leader and worked with Margaret O'Neill. The papers were written in close collaboration by both authors.

Item D4: This paper was a product of the research project examining expert
systems manpower requirements in the U.K. sponsored by BLRDD. I formulated and wrote the proposal, (see Appendix 1, Item 4), and assumed overall responsibility for the work as project leader. Kathryn Walton undertook some of the routine work under my general guidance and supervision. I wrote the paper.

Item D6: Sole author.

SECTION E: Expert systems - education in LIS schools

Item E1: See explanation above under D2, D3 & D5.

Item E2: This paper outlines the results of a research project sponsored by BLRDD. The project proposal, (see Appendix 1, Item 5), was formulated and written by myself and I assumed responsibility for the work as project leader. Susan Hutton undertook some of the routine work under my direct supervision. I wrote the paper.

Item E3: Sole author.

Item E4: Sole author

(II) The co-authors have been consulted about the specific wording in respect of joint authorship and have agreed the relevant wording as stated above.

(III) None of the publications contained herein has been previously submitted for a higher degree.