The Development of an Information System for Drug Misuse using Self Knowledge Elicitation

by

Rakesh K. Gupta B.Sc., M.Sc., M.B.A.

A thesis submitted in partial fulfilment of
the requirements for the degree of
Doctor of Philosophy

Warwick Business School
University of Warwick
Coventry CV4 7AL

January 1999

Dear Indu (Najni)

Thank you for all your help, encouragement, understanding, love, care and friendship

- all of which I can never repay.

CONTENTS

ACKNOWLEDGEMENTS

The Action Research Project reported in this thesis would not have been possible without the help and co-operation of many individuals and organisations. It gives me great pleasure to be able to acknowledge their support here to show my appreciation. Firstly, very special thanks go to my family and in particular, to my Parents for their invaluable help, understanding and encouragement.

I am grateful to my Supervisor Dr. R. D. Hurrion for his continuous guidance and support during the Project. My sincere gratitude also goes to Dr. R. D. Brittain, Dr. J. McMorran, and Mr. S. McMorran, special friends and colleagues who I have enjoyed working with immensely.

A special thank you also goes to Miss Inderpreet Grewal for her patience and hard work whilst helping to type and proof read this thesis. I would also like to thank the following either for their support through sponsorships or for practical help during the various research phases of the Project:

Mr. D. Haskins, British Telecom Advanced Systems Group;
Mr. E. Davis, Managing Director, AAH Meditel;
Allan and Hanbury Pharmaceuticals;
British Telecom Public Accounts;
North Warwickshire Health Authority;
Mr. Paul Wells, Coventry Community Drug Team;
Prof. R. Tomlinson, Dr. A. Szcepura, Mr. A. Martin - Univeristy of Warwick;
Dr. C. Farthing, St. Stephen's Hospital;
Prof. M. Geddes, Dr. Stableforth - East Birmingham Hospital;

Dr. A. Pinching, St. Mary's Hospital;

Prof. M. Marland, Mrs. H. Fawcett - North Westminster Community School;

Dr. T. Moore, East Anglia Regional Health Authority;

Dr. P. Weller, Birmingham Children's Hospital;

Dr. J. Fox, Imperial Cancer Research Fund;

Mr. S. Thompson, Birmingham City Council;

London Bureau of Hygiene and Tropical Diseases;

West Midlands Regional Health Authority;

Nimbus CD ROM Division;

Miss N. Mistry;

Mr. P. Begley;

Mrs. L. Davies

Dr. N. Harding;

Dr. T. Nomura;

Dr N. Gupta;

and staff at the following teams:

Coventry Community Drug Team

Burton Drugline

Stafford Drugline

Shropshire Drug Help Project, Telford

Kidderminster Community Drug Team

Redditch Community Drug Team

Alcohol Advisory Service, Coventry

Druglink North Staffs, Stoke-on-Trent

Cannock Drugline

Birmingham Drugline

Drug and Alcohol Services Herefordshire, Hereford

Alcohol and Drug Advisory Service, North Warwickshire

Alcohol and Drug Service, Solihull

Rugby Community Drug Team

Worcester Druglink

Alcohol Advisory Service, Rugby

Alcohol Advisory Service, South Warwickshire

Substance Misuse Unit, Shrewsbury

South Birmingham District Health Authority

HIV Network, Coventry

South Warwickshire Drug Advisory Service

St. George’s Hospital, Stafford

LIST OF ILLUSTRATIONS

LIST OF TABLES

DECLARATION

When working in a team it is always difficult to pin-point the contribution that any one member makes. This is especially true of the Expert Systems / Decision Support Unit (ESDSU) during the development of various computerised decision support systems for AIDS/HIV. Each member of the development team was responsible for one main area although all the concepts were discussed in a group on a regular basis. I was responsible for the design, knowledge acquisition and evaluation of the General Public and Counselling Modules of the AIDS Information System and the AIDS Expert Advisory System; Mr. J. McMorran was responsible for the Clinical and Guidelines Modules; and Mr. S. McMorran was responsible for the programming of the AIDS Expert System, AIDS Information System and the AIDS Expert Advisory System.

I wrote the computer code for the batch files which were sent out with the AIDS Expert, Information and Expert Advisory Systems. These were program disks to allow users to install the system with relative ease. I was also responsible for sending out disks regularly and for analysing the feedback received from end-users regarding the various versions of the systems. I presented a paper on the AIDS Expert Advisory System at the 'System Science in Health Care' conference in Lyon (Brittain 1988).

I was responsible for all work with Mr. Paul Wells of the Coventry Community Drug Team (Coventry CDT), as well as for the design, development, knowledge acquisition, implementation and evaluation of their Database Management System (CDTDBase), the AIDS/HIV and Drug Misuse Knowledge Base (ADMKBase), and the Intelligent Database. The CDTDBase contains over 2000 lines of computer code.

All of these systems required regular contact and close involvement with the Coventry CDT and in particular, with Mr. Paul Wells.

I would like to acknowledge the work of Mr. Wells, who was able to articulate his experience and expertise in order to develop a prototype drug misuse system using a self knowledge elicitation tool which is described later and forms an integral part of my research. Although he had very little experience with, or knowledge about, computers he was able to construct a large knowledge base with relative ease. The ability of Mr. Wells, a community drug misuse expert, to articulate his own expertise using this software tool is at the heart of this thesis.

SUMMARY

"What is now proved was once only imagined"

William Blake
The Marriage of
Heaven and Hell, 1790-93

SUMMARY

In the past, information systems have been developed by system analysts and programmers with the involvement of end users being at a minimum. For a long time now, researchers (Lucas 1976, Alter 1996) have been stressing the importance of significant user involvement because it brings a number of beneficial results: involvement can be challenging and intrinsically satisfying; involvement usually results in more commitment to change; the user becomes more knowledgeable about change and so is better trained in the use of the system; a better solution to the problem is obtained because users know more about the present system than analysts; involvement means the user has retained much of the control over operations.

The contribution that this thesis makes is the concept of *self knowledge elicitation* as an approach to prototyping, developing and maintaining information systems. A key feature of this concept is the high degree of user involvement in the design and development process. Self knowledge elicitation allows the user to build an information system using his/her own knowledge and expertise, and then also allows him/her to maintain and update this system. This concept initially emerged following a research project which involved the development of an Expert Advisory System for AIDS/HIV using traditional techniques of development, which were found to have a number of deficiencies including the time-factor.

Both formal and informal evaluations of the self knowledge elicitation concept were carried out at 20 different sites throughout Central England, over a minimum period of nine months. The results of these trials indicated that this concept was acceptable and could be used as a practical, cost-effective way of developing and maintaining information systems - especially for the purposes of training and education.

Significant technological advances in both hardware and software over recent years (advanced word processors, internet/intranet, web browsers, e-mail, etc.), used appropriately, will increase the availability, functionality and acceptability of the self knowledge elicitation concept.

INTRODUCTION

"What we call the beginning is often the end

And to make an end is to make a beginning.

The end is where we start from..."

T. S. Eliot,

Four Quartets.

INTRODUCTION

This thesis describes the findings of a research project carried out by the research team based at the University of Warwick, in the Expert Systems/Decision Support Unit. The structure of the thesis and the inter-relationships of the six chapters into which it is divided are shown diagrammatically in figure 0.1.

Chapter 1 describes the development of an Expert Advisory System (EAS) for AIDS/HIV. This was a decision support tool designed for multiple user-groups with varying levels of expertise within each user-group. The EAS attempted to provide a rich and valuable source of advice, information and guidance for clinicians, other health professionals, counsellors and members of the general public. The information could be accessed using menus, keywords, differential diagnosis and free-text search. A facility was provided for users to enter their comments interactively to provide continuous feedback.

The aim of the first chapter is to motivate the theme of the thesis and to provide a background for positioning succeeding chapters. Chapter 2 provides a review of the literature relating to the subject matter of the thesis including current research approaches used in information systems. The first two chapters then lead neatly into chapter 3, which describes how the self knowledge elicitation concept: (a) emerged from previous work undertaken including the Editable version of the EAS; and (b) was used to develop an information system on drug misuse. The need to evaluate the self knowledge elicitation concept, which is at the heart of this thesis, was established.

Chapter 4 reviews the methods and techniques that have been used to evaluate information systems in the past. This is then followed by chapter 5 which describes how the self knowledge elicitation concept was evaluated at 20 different organisations from Stoke-on-Trent to Hereford. Both formal and informal evaluations were carried out over a period of nine months. All of these were similar teams providing counselling, advice and information to drug and alcohol misusers, their relatives and friends, and other health professionals. The purpose of the trials was to evaluate:

(a) how useful the information system on drug misuse was;
(b) how useful the self knowledge elicitation concept was itself.

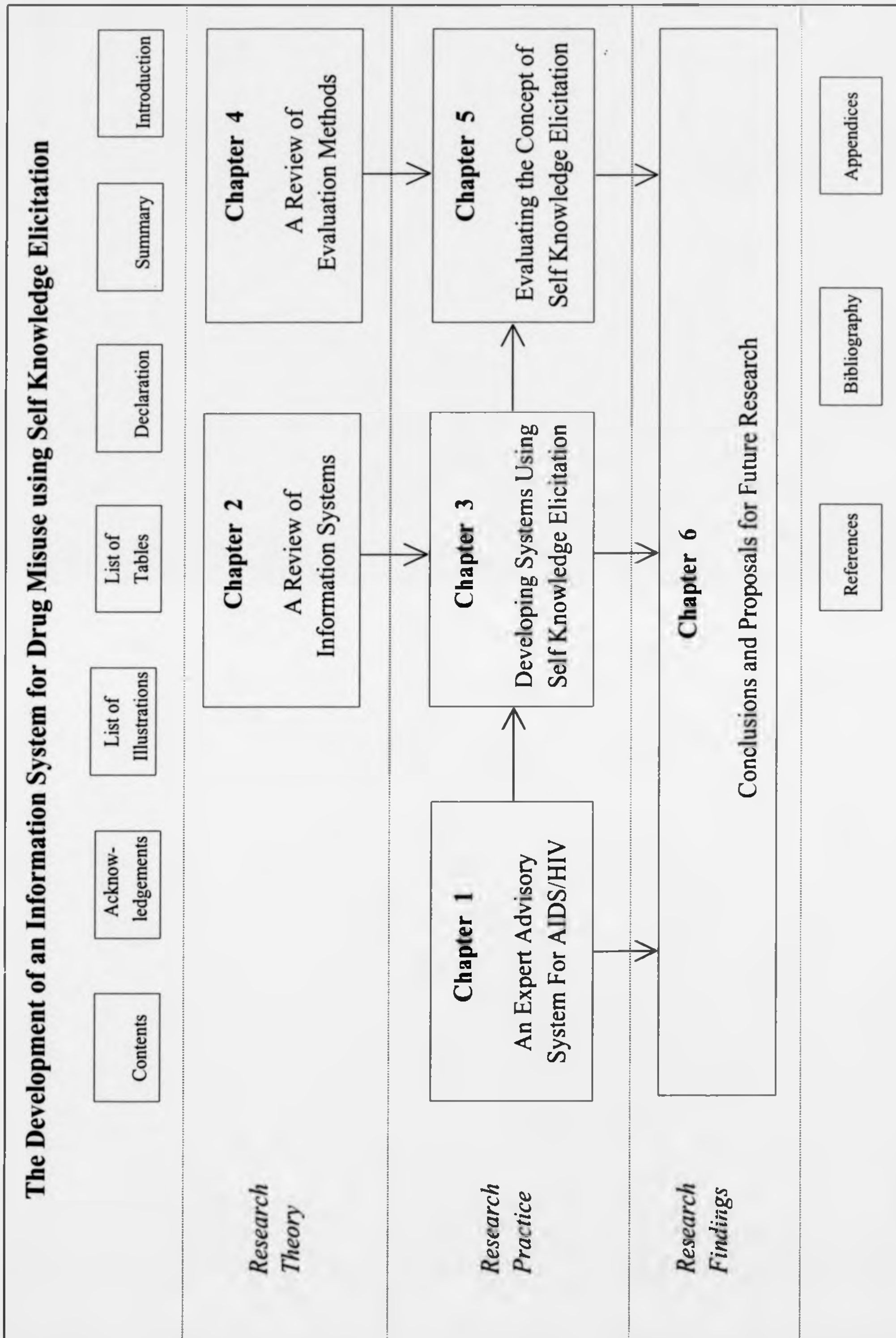


Figure 0.1
Structure of Thesis

The evaluation was carried out using informal visits and discussions, together with a formal evaluation using a structured questionnaire completed by each unit. Fourteen units had built new information systems using the Self Knowledge Elicitation concept as their development tool. This included systems on alcohol, prescribing, community mental health, regional drug misuse statistics, and ecstasy tablets (in liaison with the Government Forensic Science Laboratory). The results of both the formal and informal evaluations are presented and discussed in detail in Chapter 5.

Chapter 6 is the final chapter and this surfaces the key findings and conclusions from the whole research project. It also points out the limitations of the work carried out and proposes a number of further research projects.

The reader may find it helpful to know the approximate dates for the various development stages of this longitudinal research project. It should be noted that many of the stages overlapped. Work on the AIDS/HIV EAS started in January 1987 and was completed in September 1988. This EAS itself emerged as a result of integrating features from the AIDS/HIV Expert System and the AIDS/HIV Information System, both of which were developed initially (see Chapter 1).

The Editable EAS was developed and used as a prototype between October 1988 and December 1988. This editable version was developed to give the user more flexibility and control over system development. This had a number of advantages but there were a number of deficiencies and the user still had to rely on the developer to a large extent. This led to the development of another tool or concept. This was initially referred to as Webofax and then as the *self knowledge elicitation* concept. This concept gave the user total control and flexibility, and he/she could use this to capture his/her expertise in a structured manner (see Chapter 3). The development of the self knowledge elicitation concept began in January 1989 and there was a prototype version after approximately three months. From April 1989 the Drug Information System developed using this concept was used by the expert who helped to develop it as well as his staff at the Coventry Community Drug Team (Coventry CDT), where he was based.

There were a number of other systems developed for use by Coventry CDT and these are all described in Chapter 3. The Database Management System (CDTDBase) was developed during the period from May 1989 to September 1989, and the team have been using this for their clients and services since then. A Needle & Syringe Exchange Management System (NSXDBase) was developed and integrated to form part of the CDTDBase in December 1989 after two months of development. During the period from May 1989 to December 1989, the Drug Information System continued to be used, developed and maintained using the self knowledge elicitation concept. An Intelligent Database was developed from January 1990 to June 1990 by integrating all of these systems (see Chapter 3).

From July 1990 until December 1995, Coventry CDT continued to use the concept although there was now less contact between them and the researcher. Nevertheless, informal evaluations were carried out at regular intervals during this period. The concept of self knowledge elicitation was being used mostly for education and training purposes.

From January 1996 until March 1996, the self knowledge elicitation tool was installed at 20 sites throughout Central England in order to extend the evaluation to more organisations. Formal and informal evaluations were then carried out during the period from April 1996 to December 1996, as mentioned above and described in detail in Chapter 5. It proved useful in the post-evaluation study to have at least one organisation (Coventry CDT) who had used this concept for several years. Even now in 1999, many of the 20 organisations are still using this concept for a range of different systems, some of which they have maintained and developed themselves.

Significant technological advances in both hardware and software over recent years (advanced word processors, internet/intranet, web browsers, e-mail, etc.), used appropriately, will increase the availability, functionality and acceptability of the self knowledge elicitation concept. Although the system is currently DOS-based it is still being used today. This longitudinal study has shown that this concept has stood the test of time and it is just as important and relevant today as it was ten years ago. This concept of self knowledge elicitation ties in with the latest management thinking in information systems. For example, in his book '*The Knowing Organisation*', Choo (1998) describes how the knowing or intelligent organisation can create, share and manage knowledge for effective decision making.

CHAPTER 1

AN EXPERT ADVISORY SYSTEM FOR AIDS/HIV

"What we have to learn to do

we learn by doing..."

Aristotle,

Ethics.

1.1 Introduction

By April 1988, a total of 86,954 cases of the Acquired Immune Deficiency Syndrome (AIDS) had been reported to the World Health Organisation (WHO) from 130 countries around the world (Mann 1988). Around this time, WHO estimated that there were five to ten million people in the world infected with Human Immunodeficiency Virus (HIV), which causes AIDS (CDSC 1988). The next chapter gives a review of information systems. It was believed by the Expert Systems/Decision Support Unit (ESDSU – see section 1.2 below) that information technology, expert systems in particular, could play a part in helping to solve some of the problems related to AIDS/HIV (see section 1.4.2).

This chapter gives an account of the approach taken and the methods used in the development of computerised decision support tools in order to help stop the spread of AIDS/HIV. The systems that were developed were action research led. The ESDSU worked with end-users as far as possible and continually used their feedback to refine and update both the contents and the design of these systems.

The AIDS/HIV pandemic and its problems are highlighted under section 1.3, and this is followed by three sections which describe the different approaches that were taken in this action research project. Initially, a classical Expert System was developed along the lines of past expert systems like MYCIN (see chapter 2). When this was rejected by the experts, the ESDSU adopted a completely different approach and developed an Information System. Although this was received more favourably than the Expert System, it still contained a number of important deficiencies. After studying and comparing the features of both the Expert System and the Information System from the result of trials, it became apparent that the deficiencies of one system complemented the deficiencies of the other.

Consequently, there followed a third system which, by combining features from each of the two previous systems, not only reduced most of the deficiencies but also provided the user with greater flexibility. This new system was termed 'An Expert Advisory System'.

This chapter gives details of all the tools developed, with an outline of the development process including the knowledge acquisition techniques used, the multi-user groups catered for and the multi-modes of access. The systems contained four different modules directed at different users (clinicians, health professionals in general, the general public including school-children, and counsellors). The contents of each of these modules is described briefly as well as the different modes of access (menus, keywords, differential diagnosis and free text search) to the same information. Other features like the facility to enter comments while using the system are detailed together with their importance.

This chapter also lists and details the places where the prototype systems were installed for evaluation and feedback. A detailed study was carried out at a school in Nuneaton and the results and findings of this formal trial are also included. The final section deals with the overall findings and conclusions of building computerised decision support tools for AIDS/HIV. The positive features that resulted out of the systems during and following their development are discussed and the problems encountered are highlighted.

1.2 The Expert Systems/Decision Support Unit

In January 1987, the University of Warwick, in collaboration with the North Warwickshire Health Authority (NWHA), set up the Expert Systems/Decision Support Unit (ESDSU). This Unit (i.e. the ESDSU) formed part of the Institute for

Management Research and Development within the Warwick Business School (previously known as the School of Industrial and Business Studies). The Unit comprised of two directors, Dr. R. D. Hurrion, a senior lecturer at the University, Dr. R. D. Brittain, District Medical Officer at NWHA, and three Research Associates, Stewart McMorran, James McMorran and myself.

Dr. Brittain had initially approached the University of Warwick in June 1986 expressing an interest in developing an expert system for the diagnosis and treatment of Rabies. This work was given to a suitable student as a summer project which formed part of his Master of Science degree. The system that finally emerged was received favourably by health professionals and indicated the feasibility and usefulness of information technology in health care (McMorran, 1986). As a result of the success of this system, the ESDSU was set up a few months later to develop expert systems in infectious diseases.

Initially, the plan was that the three Research Associates would each develop an expert system for one of the various infectious diseases. Therefore, work was started on three separate expert systems in Methicillan Resistance Staphylococcus Aureus (MRSA), Rabies and AIDS. However, even before a rudimentary system had been developed in any one of these areas it was decided that all three Research Associates would work together as a team to concentrate on the development of an AIDS/HIV Expert System. AIDS/HIV was chosen for a number of important reasons which are described in the next section (1.3.3).

The Unit decided to work as a team in order to accelerate the development process. Each member of the team was given an area which he was primarily responsible for although all the concepts were discussed as a group on a regular basis. Stewart McMorran was responsible for the programming and system design; James

McMorran was responsible for the Clinical and Guidelines modules of the system; I was responsible for the General Public and Counselling modules of the system.

1.3 The AIDS/HIV Pandemic

1.3.1 The Evolution of AIDS/HIV

The Acquired Immune Deficiency Syndrome (AIDS) is a term used to describe individuals who are infected with the agent responsible for AIDS, the Human Immunodeficiency Virus (HIV), and who have one of the diseases stated by the World Health Organisation/Centre for Disease Control (WHO/CDC) in their definition of AIDS (WHO 1986).

AIDS, which seemed to appear from nowhere in the spring of 1981, attracted considerable world-wide attention within the space of only a few years. Today, after more than seventeen years, the AIDS pandemic still remains a phenomenon of unusual importance and great concern. 'Acquired' means that the condition has been caught as opposed to being inherited; 'Immune Deficiency' implies poor body defence mechanisms against infection; 'Syndrome' is the particular pattern of illnesses which help to identify a particular disease (in this case AIDS). HIV is a retrovirus which can be transmitted via semen, vaginal fluids, blood and materno-foetal contact.

AIDS was first reported by the CDC in Atlanta, Georgia, USA (CDC 1981). CDC is a public health body which is responsible for investigating epidemics as well as reports of new or unusual diseases. CDC described the cases of five young homosexuals who had been treated for Pneumocystic carinii pneumonia (PCP). Pneumocystic carinii is a small organism (protozoan) which parasitises the lungs and so makes breathing very difficult.

These five, previously healthy men had been treated in Los Angeles hospitals. Shortly afterwards, twenty-six previously healthy homosexuals developed Kaposi's sarcoma (KS), a rare malignant cancer. Within two years of diagnosis, eight of these patients had died.

PCP and KS disorders were now affecting fit, younger men, whereas in the past they had been restricted to much older groups of individuals. This virtually suggested that a new disease entity had occurred. All these cases involved homosexuals and the host response to these infections seemed to be impaired, and therefore the syndrome was termed the Acquired Immune Deficiency Syndrome.

1.3.2 Problems Associated with AIDS/HIV

Even after more than seventeen years since the first report, AIDS is still the subject of considerable misunderstanding and fear. A great number of myths and misconceptions have been established over the years, especially regarding the transmission of the virus, amongst various members of the general public. Also, persons with HIV infection are incorrectly being equated with persons with AIDS.

Another problem is that AIDS is still regarded as a 'gay' disease, with many people believing that they will, therefore, never be at risk. There is also a lot of prejudice against lifestyle and this is being held responsible for the spread of HIV into the general community. This stereotyping of patient groups has stood in the way of greater social understanding and acceptance of those at risk (Miller 1987). AIDS is in fact, unselective in regard to who it infects. Transmission can occur by sexual intercourse, by the receipt of contaminated blood and blood products and can be passed from mother to child. AIDS has now been confirmed on a wide scale in homosexuals, heterosexuals, haemophiliacs, drug abusers as well as children.

Diseases present atypically in AIDS patients which makes them difficult to recognise, especially by those inexperienced in dealing with such diseases. PCP and other diseases which are common in AIDS patients are rarely found in non immunosuppressed hosts. Therefore, an entirely new area of medical knowledge needs to be grasped quickly by many clinicians.

There is no effective vaccine or cure against this virus. Current knowledge suggests that once someone is infected, the virus will remain in their body for life. Those who have contracted the virus are likely to develop AIDS eventually. However, these people are infectious even before they develop the syndrome, and are quite capable of transmitting the virus via sexual intercourse, infected blood and blood products, and materno-foetal contact.

Since AIDS was a relatively new medical condition in the late 1980's, clinicians and other health professionals were not yet familiar with this disease and its presentation. This was true especially in areas away from the major medical teaching centres, where treatment regimes were more practised because of the high number of AIDS patients. David Miller (1987) expressed his concern about this issue: *"To have HIV or AIDS is, in many places, to be a medical novelty. In some instances, this means being a 'guinea-pig' in the formation of particular medical policies and practices".* Now in the late Nineties however, HIV and AIDS are no longer the novelty they were in the late Eighties.

Most of those infected with AIDS are young people aged between 20-40 years, i.e. those people who are socially and economically productive. A test has been developed to test for the virus but this is not completely reliable and is voluntary. Diagnosis of infection is difficult because of the unusual presentation of the disease.

In the UK, historically, infection has occurred at a limited number of locations in the Thames Region of London and in Edinburgh. Through time, physicians at these centres have accrued more experience and expertise in diagnosing and caring for AIDS patients, compared with the rest of the country. Although the infection has now spread away from its primary focus, this has not been accompanied by a re-distribution of knowledge. More resources have been directed to these prime centres and this further distorts the distribution of facilities to care for patients.

Although there is a considerable mass of information about AIDS, this is in a format which most people find difficult to use. Consequently, basic knowledge of the disease is often confused.

1.3.3 Reasons for choosing AIDS/HIV

Many of the reasons why AIDS/HIV was targeted as the knowledge base for the proposed Expert System arise from the problems associated with AIDS, as outlined in the previous section. It is an area of medicine in which there is a vital need for expertise to be shared. This knowledge that is localised in various centres of excellence, needs to be disseminated to other clinicians and general practitioners who need to prepare themselves as they are very likely to meet HIV infected patients in the near future, if they have not already done so.

The medical and social knowledge concerning AIDS/HIV is continually changing and expanding and so must be circulated as widely as possible. Essential knowledge and advice is sought by a large number of groups and individuals ranging from experts to members of the general public.

Potentially, everyone is at risk of becoming infected with HIV. In the absence of an effective vaccine or cure, it is very important to educate people about the virus and the ways that it can be transmitted. A great deal is now known about the methods by which the virus is transmitted, and so adequate education is the best method for prevention, especially since simple behavioural changes can greatly reduce one's risk of becoming infected.

There is evidence that distributing expertise about specialist diseases can result in significant savings. Firstly to the patient in terms of no unnecessary treatment and secondly to the health service in financial terms (Adams et al 1986).

1.4 The Expert System Approach

1.4.1 Introduction

The ESDSU decided that it was necessary to build an AIDS/HIV Expert System (AES) to solve some of the information/ understanding problems posed by the AIDS/HIV pandemic. In order to accelerate the development process, it was decided that an expert system shell (a software programme which allows the user to build expert systems relatively quickly - see chapter 1) would be used rather than a programming language. The shell chosen was Props-2 which had been developed by the Imperial Cancer Research Fund (ICRF) in London.

1.4.2 Reasons for the Expert System Approach

There were several reasons why the Expert System approach was adopted for tackling this terrifying disease. The most significant of these are described below:

1) Invaluable experience had already been gained by a member of the ESDSU during the development of a Rabies Diagnostic Expert System (McMorran 1986). In a computerised model, the Rabies Expert System had encapsulated the expertise of one of the UK's leading Rabies experts, Dr Sylvia Gardener of the Communicable Diseases Surveillance Centre in Colindale. The system was based on factors such as the location of the bite, the animal that had bitten the patient and the country in which the incident had taken place. Based on these factors the system produced advice on proposed actions - suggested therapeutic regimes, listing of various environmental control measures.

It was assumed that the lessons learnt in the development of the Rabies System could be applied to the area of AIDS i.e. the same methodologies and 'type' of system, namely a diagnostic expert system.

Two other features of the Rabies Expert System were used as guidelines for the development of the AIDS Expert System. Firstly, the system should be designed for one user group - the medical practitioner. At this stage, no consideration had been given to the development of a system for a wider audience. Secondly, there would only be one way of interacting with the knowledge contained in the system - in a diagnostic manner.

2) There existed a shortage of expertise in AIDS/HIV and this was concentrated in the larger teaching hospitals. Expert Systems had been cited as a valuable means of disseminating scarce expertise (Szolovits 1982).

3) Medical experts in this field were available and willing to share their knowledge. Dr. R. D. Brittain was the District Medical Officer for North Warwickshire Health Authority, a Consultant to the World Health Organisation on Health Information and a Director of the Expert Systems/Decision Support Unit. He was thus a very valuable and ready source of medical expertise. Many other leading experts were available and they are discussed later in this chapter.

4) An expert system knowledge base would ensure consistency and be easily updatable. As new knowledge is discovered, new facts can be added to the knowledge base. Any changes in the knowledge concerning stored facts would mean that the appropriate facts would be altered. Also, unlike with respect to human experts, responses to a particular scenario are always consistent in a computerised expert system.

5) Memory would not be a limitation as with humans because there is only so much that an individual can remember (Brittain 1988). Some knowledge base systems store vast amounts of knowledge. INTERNIST (Miller, Pople and Myers 1982) has a knowledge base that covers 80% of Internal Medicine, containing 2.2 million facts. Users of knowledge would not need to memorise all facts and rules concerning a problem area if working with an expert system.

6) An expert system can be used as a training aid. A good example of this occurred with the diagnostic expert system MYCIN, where NEOMYCIN was developed as a training aid (Clancy and Letsinger 1981). This ability to train and

re-train would be important for the medical practitioner in a volatile field of medicine like AIDS.

7) An expert system can help achieve consensus. Miller, Blumenfrucht and Black (1984) describe how ATTENDING, an expert system for anaesthetic management planning, tackles the problem of conflicting expert judgement. An expert's knowledge is explicit in the process of developing an expert system because it has to be computerised. Consequently this knowledge is demonstrable and can therefore be challenged.

1.4.3 Reasons Against Expert System Approach

According to some expert system practitioners, an AIDS Expert System would not be a suitable application of expert systems technology. Wellbank (1983) is amongst these and he lists several points that imply that AIDS would be a difficult domain in which to develop an expert system. Firstly, no one feels familiar with the domain and experts do not generally agree about it; Secondly, the knowledge includes procedures, spatial relationships or reasoning over time. All of these are difficult to represent. Finally, a lot of action hinges on a lot of conditions. Buchanan (1982) adds to this list of points by saying that if the problem domain contains knowledge that is volatile, then the application of expert systems technology is unsuitable.

By studying these points it can be seen that they are true of AIDS. Since AIDS is a new disease, knowledge about the condition is continually changing. There are temporal considerations too - e.g. the longer an individual is infected with HIV the increased risk of him developing AIDS. Also, there are considerable interactions between factors - e.g. the increased incidence of Kaposi's sarcoma in homosexual males with HIV as compared to heterosexual males with HIV.

Different centres of excellence on AIDS have their own expert strategies on the treatment and management of AIDS patients. An example of this is in the treatment of Pneumocystis carinii pneumonia, a lung infection which is the most common cause of death in AIDS patients. At St. Stephen's Hospital they use Septrin Treatment; St. Mary's they are more likely to use Pentamidine.

1.4.4 Discussion

After considering the reasons for and against the suitability of expert systems technology to this area of medicine, the ESDSU decided to go ahead with the development of an expert system in AIDS. The main driving force behind this decision was the importance and appropriateness of the development of a tool for dissemination of expertise on AIDS.

1.4.5 The Development Plan

Most existing expert systems have been developed using a standard format. Five stages can be identified when looking at the overview of the classical development process (Hayes-Roth 1987):-

(i) Identify the main characteristics of the problem;
(ii) Identify what knowledge is necessary to solve the problem;
(iii) Determine how the knowledge should be organised to solve the problem;
(iv) Encode the required knowledge and its organisation into a format that the computer can interpret;

(v) Validate the knowledge represented by testing against the problem.

Feedback channels are provided between each stage. Development is an iterative process where problems encountered in later stages indicate shortcomings at earlier ones.

The ESDSU decided that the AIDS Expert System would be developed in four stages, and these were similar to those identified by Hayes-Roth:-

(i) Preparation Period - the tools that might be appropriate for the development of an AIDS Expert System would be investigated in this period. Also, possible expert system approaches that might be relevant would be decided. The Knowledge Engineer would need to become familiar with the problem domain, in this case AIDS. Prospective experts would have to be contacted as well as potential end users of the system once developed.

(ii) Development Period - this is where the AIDS Expert System would be developed using the tools and approaches identified in stage (i).

(iii) Implementation Period - end users would be able to use the system as a prototype in this period.

(iv) Evaluation Period - an evaluation of the system would need to be done to test its usefulness.

It should be noted that although these stages are presented here in a sequential manner, they are inter-related and are not independent of one another. They are listed sequentially for convenience in order to divide the development process into identifiable steps.

1.4.6 The Preparation Period

1.4.6.1 The User Groups

Although no programming of the AIDS Expert System was done in this period, it was necessary for the development team to become familiar with the problem area as well as investigate possible tools that may be used for development. It was also important and necessary to identify "user groups" for the developed system. These groups would also provide a means for evaluation of the system.

The three main user groups that were initially identified were clinicians at St. Mary's Hospital, St. Stephen's Hospital and the Middlesex Hospital. Dr Brittain was also aware of the anxieties of the medical community in his role as District Medical Officer. He viewed AIDS as an area in which expertise would be needed in his health authority, although at the time there were no cases of AIDS or HIV in the North Warwickshire Health Authority.

Interest had also been shown by a number of other organisations. Amongst these was the Wellcombe Tropical Institute who saw it as a possible solution to the lack of clinical expertise in the African sub-continent. Professor Zeb Handzel of the Israeli Working Party on AIDS expressed interest in collaborating with the project and was interested in a system for Israel.

1.4.6.2 The Experts

Dr Roger Brittain

It is obviously very important to locate experts who are willing to give up their time and share their knowledge before any proposed development can take place. Dr Brittain was not only medically qualified but had experience with health based computer systems. He was used as an expert in the development of the AIDS Expert System by having twice weekly meetings with him during the initial stages of the project.

Dr Brittain was also a consultant to the World Health Organisation on Health Information. He was able to use his position and influence in order to get experts willing to collaborate in the project.

Dr Susan Drake

Dr Drake, from the Department of Genitourinary Medicine in North Warwickshire Health Authority, agreed to help in the development of the system. Since no cases of AIDS had occurred in their authority at the time, her expertise of the practical management and treatment of AIDS patients was limited.

Dr Marion McEvoy

Dr McEvoy was an Epidemiologist at the Communicable Diseases Surveillance Centre in Colindale, which provides a national resource and expertise in infectious diseases. Dr McEvoy's work on the models of the number of future AIDS cases in the UK has been published in the British Medical Journal and the Lancet.

Professor Andrew Geddes

Professor Geddes was based in the Department of Infectious and Tropical Diseases at East Birmingham Hospital. Most of the cases of AIDS in the West Midlands had been referred to East Birmingham Hospital.

Dr Charles Farthing

Dr Farthing was involved in the treatment and management of patients with AIDS related disorders at St. Stephen's Hospital in London. Dr Farthing and the team of doctors at his hospital had agreed to collaborate with the development team, following a meeting between the two groups.

Dr Anthony Pinching

Dr Pinching, an Immunologist at St. Mary's Hospital in London, was investigating the effects of the AIDS virus and how these could be managed. A meeting was arranged between the development team and Dr Pinching's unit and they agreed collaboration.

Professor Michael Adler

Professor Adler, the only Professor of Sexually Transmissible Diseases in the UK, was in charge of a team of doctors at the Middlesex Hospital. Professor Adler's unit were involved in the treatment and management of patients with AIDS. They agreed to collaborate with the development team after a meeting in London between both parties.

1.4.7 The Development Period

Initially two members of the development team were responsible for the knowledge engineering process, i.e. for making human expertise explicit in the form of a computerised expert system. From the two knowledge engineers, one was responsible for the more clinical and specialist aspects of AIDS whilst the other concentrated on the general aspects.

It was also important for the knowledge engineers to be familiar with the techniques of knowledge acquisition (see chapter two). The main technique used was interviews. Meetings were arranged with the experts listed above. All meetings were recorded using a voice-activated tape recorder, so neither the Expert nor the Knowledge Engineer would be distracted whilst the interview proceeded. Also, this made the meeting more productive, as the Knowledge Engineer was able to elicit more information in a shorter time. This was important because Experts have very limited time and they are already over-stretched.

After the first knowledge engineering session with the expert, further sessions involved having the computer present too. In this way, previous knowledge that had been encapsulated in the programs could be shown to the expert as a prototype system. This provided a means of refining the knowledge that had been acquired in previous interviews.

During this part of the project, over 40 hours of tape recording had been made. The tapes had to be played so that the information and expertise could be written down, examined and then encoded for the computer system.

Textual material in the form of papers, journals and books were read to acquire some of the basic knowledge concerning AIDS, as well as to become familiar with the terminology used in this area of medicine. A lot of facts and rules were derived from printed text for use in the AIDS knowledge base, and this was validated by the experts.

The acquisition of knowledge is regarded as a major obstacle to success in building expert systems (Hayes-Roth et al 1983). This was confirmed during the development of the AIDS Expert System. The time that the experts could devote to the development of the system was very limited. Nevertheless, one of the biggest problems encountered during the development process was a bottle-neck that occurred during knowledge acquisition. For example, this occurred during several three-weekly periods of stay at St Stephen's Hospital when working with Dr Charles Farthing. The stays were not longer because the developers of the system could not keep up with the knowledge that had been acquired and the changes demanded by the experts. This was frustrating for both the expert and the development team. As mentioned above, over 40 hours of tape recording had been made during the development of the AIDS Expert System.

The Development Methodology used and the way knowledge was represented are described below. The programming environment used for the AIDS Expert System was PROPS-2. This is a PROLOG based expert system development environment for personal computers, which has been developed by the Imperial Cancer Research Fund (ICRF). PROPS-2 is a rule based PROLOG shell which encourages additional forms of knowledge representation. This particular shell was chosen because of (a) availability; (b) the need for a tool that would enable rapid prototyping; (c) the need for the AIDS Expert System to remain compatible with the Oxford System of Medicine (OSM). The OSM was being developed by ICRF in PROPS-2. It was an attempt to computerise the widely acknowledged Oxford Textbook of Medicine. This textbook, however, lacked in-depth coverage on topics such as AIDS and the development team were hoping to fill that gap.

There were a number of problems with using PROPS-2, the main one being that the software was unsupported. Consequently, there was no assistance available when run-time errors were encountered, which hindered the development process. There was little scope for manipulating the design of the screen and for referencing the knowledge in different ways. Another problem was that PROPS-2 was slow and memory intensive. The importance of speed was not realised until the AIDS Expert System was shown to end-users and the experts involved in the development. A number of lessons can be learnt from this. It is important to choose a development environment which is well established and supported. The knowledge engineer needs to balance the advantages and disadvantages of using an expert system shell against a programming language. Both of these are discussed in detail in chapter one. Shells allow rapid prototyping because it is easier to represent knowledge, and they are easier to learn and use. A programming language has more flexibility and the user is not restricted to pre-defined structures which are built into Shells.

Knowledge Representation

One of the most frequent diseases that occurs in AIDS is pneumocystis carinii pneumonia (PCP). In a case of suspected PCP only the identification of the pneumocystis carinii organism in eg sputum from the patient, would confirm the diagnosis of PCP. However, based on the symptoms and signs that a patient presents with, a physician might suspect that the patient has PCP. The physician might also suspect that the patient is suffering from infection with another disease. He would be unable to confirm conclusively that the patient was suffering from PCP without a positive laboratory test for pneumocystis carinii. Even if a laboratory test of e.g. a patient's sputum, were negative for pneumocystis carinii then a physician might still consider that PCP was the most likely cause of a patient's symptoms and signs. The list of likely diseases that a physician is considering as possible causative agents for a patient's presenting symptoms and signs is called a differential diagnosis.

By constructing lists of factors and actions from recorded interviews with experts, tentative semantic networks of some of the AIDS diseases were drawn up. The one for PCP is shown in figure 1.1. This representation was to be used in a differential diagnosis or diagnostic classification. It was also hoped that parts of the network could be represented as Attribute-Object-Value (AOV) triples.

A knowledge base containing AOV triples was constructed and used in the prototype AIDS Expert System. The experts were used to specify the relevant importance of AOVs in relation to including diseases in a differential diagnosis or possibly even in confirming the diagnosis of a disease.

Both textual material and interviews were used for the derivation of facts and rules that were used in the knowledge base. As an example, consider the following extract from "AIDS - etiology, diagnosis, treatment and prevention" by Devita, Hellman and Rosenburg (p181) discussing central nervous system (CNS) disorders:

> *".....Patients may present initially with cognitive disorders, seizures, or focal motor and sensory defects. If a computer Tomography (CT) scan shows any contrast-enhancing lesion(s), the differential diagnosis includes toxoplasmosis, lymphoma - or less likely but conceivably - cryptococomma or tuberculoma. If there are multiple hypodense lesions that do not contrast-enhance, progressive multifocal encephalopathy is the most likely cause."*

PCP Semantic Network

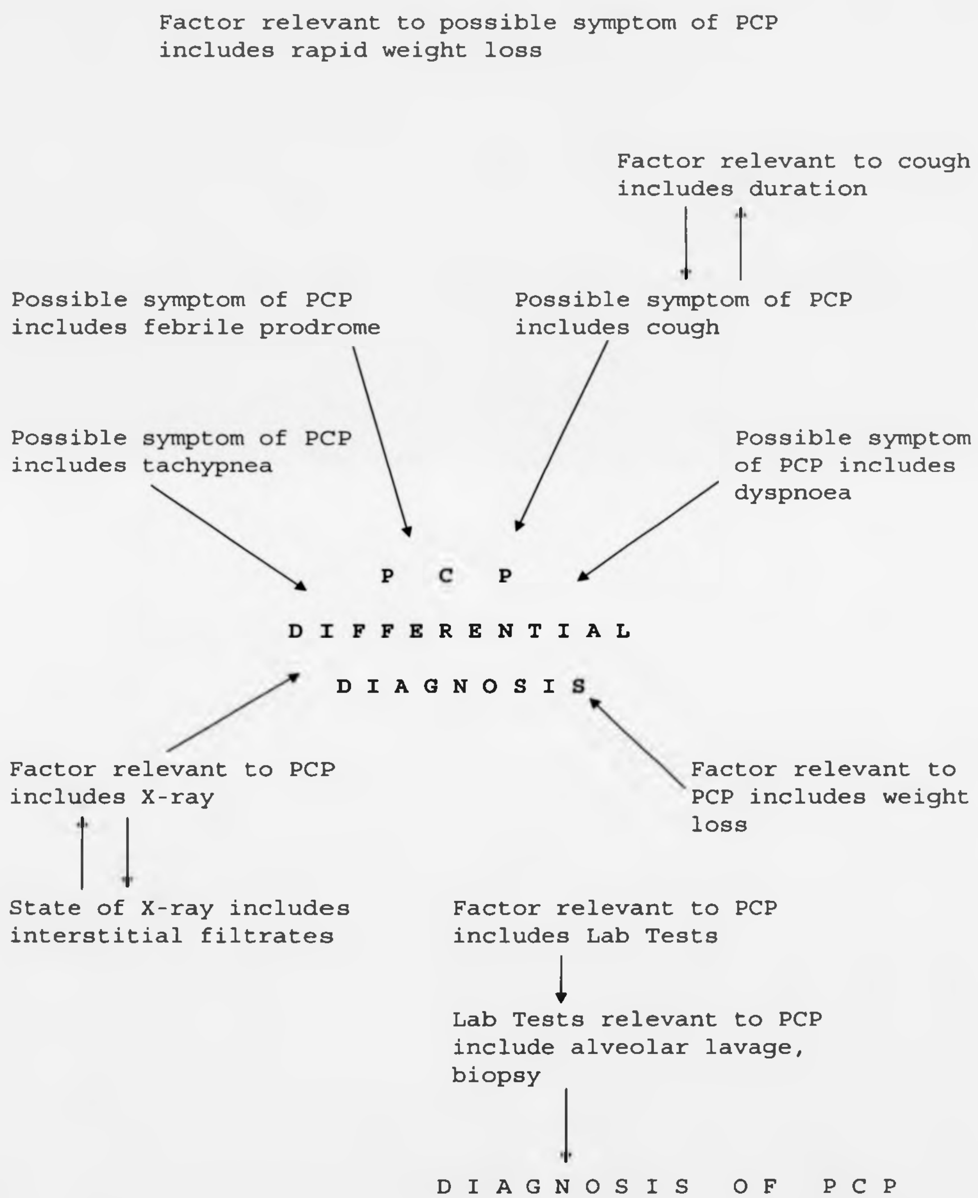


Figure 1.1

Semantic Network Representation for Recognition of PCP

Facts that were extracted from this text were:

- Symptoms of CNS infection include cognitive disorders
- Symptoms of CNS infection include seizures
- Symptoms of CNS infection include focal motor defects
- Symptoms of CNS infection include sensory defects
- Results of CT scan include contrast enhancing lesions (CEL)
- Results of CT scan include non contrast enhancing lesions (NCEL)
- Symptoms of toxoplasmosis include CEL
- Symptoms of lymphoma include CEL
- Symptoms of cryptococomma include CEL
- Symptoms of Tuberculoma include CEL
- Symptoms of progressive multifocal encephalopathy include NCEL

Rules were also constructed so that the increased likelihood of CEL being found in e.g. toxoplasmosis compared to tuberculoma was represented.

Development Methodology

A prototype of the AIDS Expert System was constructed using information obtained from textual sources and interviews with collaborating experts. This prototype was then extended, refined and re-refined by using an iterative development cycle. This is represented diagrammatically in Fig 1.2, showing the interaction between the Knowledge Engineer and Expert.

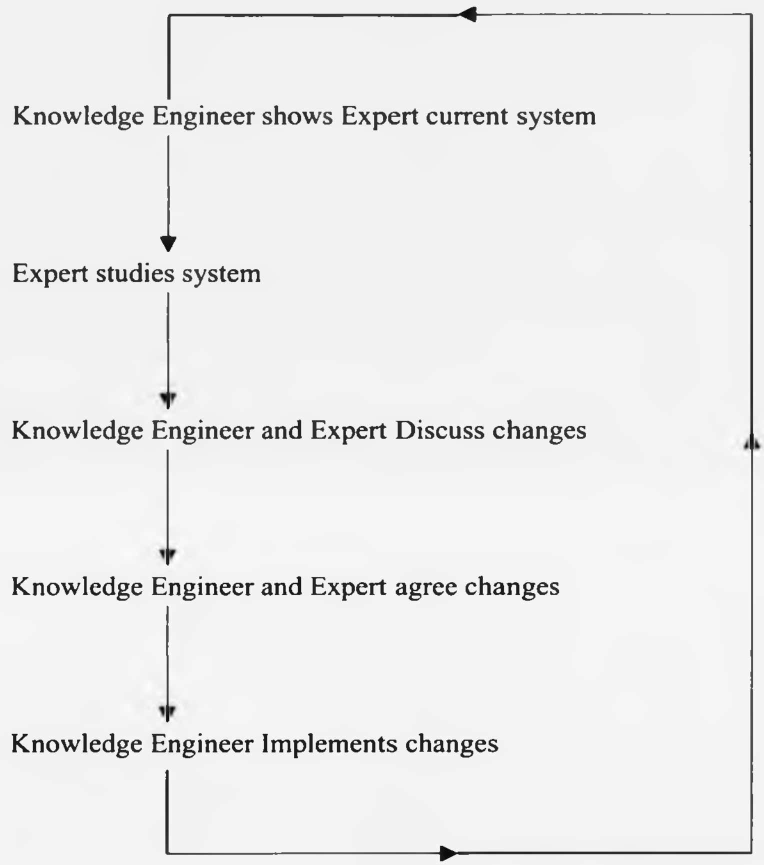


Figure 1.2

The Interaction between the Knowledge Engineer and the Expert

1.4.8 The Implementation Period

Once an initial prototype of the development of the AIDS Expert System had been developed, it was installed in several locations in order to receive feedback. Only groups that were involved with the project were targeted at this early stage of evaluation.

A facility was incorporated in the system which allowed the users to type, using the keyboard, any comments they had about the overall system or specific sections of it. These comments were stored as a text file which the development team could access later.

Due to the lack of suitable computer hardware, all the experts were not able to have access to the system. Those who were able to evaluate the system included Dr Brittain and Dr Drake at North Warwickshire Health Authority; Dr Farthing at St. Stephen's Hospital, Dr Handzel at both the London school of Hygiene and at the Hebrew University after his sabbatical.

1.4.9 The Evaluation Period

The evaluation of the AIDS Expert System was carried out by demonstrating and receiving feedback from experts and end-users.

As discussed earlier in this chapter, the project objective was to resolve some of the problems associated with AIDS by developing and implementing an expert system in AIDS. In the initial evaluation of the problem, it appeared that an expert system was the most appropriate tool.

As the AIDS Expert System development progressed, it became apparent from the participants that a traditional diagnostic clinical expert system was not the answer. The participants included the experts and the user groups as well as the development team themselves. The reasons for this are discussed below.

There were four principal points that the experts made against the development of a diagnostic AIDS Expert System:

(i) AIDS was only one area of medicine - Professor Geddes noted that any diagnostic medical expert system was of use only if all areas of medicine were covered by the system. It was therefore, unlikely that a clinician would use an expert system for one specific area of medicine only.

(ii) The complex nature of infection with the AIDS virus - as the effects of the AIDS virus become more severe there is an increasing range of diseases that a patient may present. Also, the relationship between HIV infection and the diseases that a patient might suffer are still not very well understood. All this made it difficult to build a knowledge base.

(iii) A diagnostic AIDS Expert System was not "wanted" - Professor Geddes was against the idea of doctors using a diagnostic expert system, saying that they had not been used by physicians in the past, e.g. MYCIN.

(iv) Other areas of AIDS related advice were equally in need of dissemination - these views were expressed in particular by Dr Drake, Dr Farthing and Dr Pinching. For example, Dr Drake was a 'clinical' AIDS expert but was required to give advice to health professionals and the general public much more frequently.

Dr Brittain as a user of the AIDS Expert System became aware that the development of a diagnostic system was a 'blinkered' approach to the problem of shortage in expertise. A diagnostic system would only help in identifying the problem but not help to resolve that problem, e.g. treatment advice.

The development team also identified areas of difficulty during the development of the system:

(i) HIV infection was assumed by the AIDS Expert System;
(ii) Knowledge of HIV was volatile;
(iii) Some experts were not very willing to develop a diagnostic system;
(iv) Some relationships concerning AIDS and HIV infection were time dependent;
(v) Areas of advice other than diagnostic advice were required;
(vi) A diagnostic expert system required the inputting of data from the patient's medical record.

A number of lessons can be learnt from the results of these evaluations of the prototype AIDS Expert System. It is important to consider the context in which any expert system will be used. How much of the work carried out by the user or expert is represented by the application of the expert system ? The smaller this amount is, the less likely it is that the expert system will be accepted and used by the user or expert.

The area of application for the expert system needs to be well established and understood. It is difficult to represent knowledge in an expert system when a relatively new phenomenon like HIV infection has a lot of grey areas and where a lot of the latest knowledge is not documented.

An expert system needs to be considered in terms of its practical use in a working environment. The expert system needs to go beyond just identifying or diagnosing the problem and be able to give advice on how to resolve that problem.

The informal evaluations by the participants involved in the project have been discussed. These indicate that the provision of an AIDS Expert System needs to be reconsidered.

1.4.10 Discussion

There were a number of problems in the representation of knowledge because textual material is dominated by qualitative terminology, being written in a descriptive rather than prescriptive way. This results in potentially ambiguous descriptions of diseases and conditions. For example, the term 'likely' does not mean the same thing to different clinicians, nor to the same clinician on different occasions.

There is a lack of causal knowledge concerning HIV and this is highlighted by unanswered questions put to the experts. One of these is *"why can someone have been infected with the virus for several years without developing AIDS whilst another person might develop AIDS only months after contracting the virus?"*

Another problem in the representation of knowledge in the AIDS Expert System is that the system is designed so that it assumes the patient is HIV positive. This means that the user must know what problem area he is dealing with.

The question and answer interface used in a diagnostic expert system seemed to lack the flexibility offered by a human expert. There appeared to be a need for computerised tools to address audiences of varying abilities as well as in a variety of different ways.

The collaborating experts highlighted the need for the AIDS computerised system to provide advice on AIDS and HIV to health professionals, members of the general public as well as to clinicians. In other words, multiple areas of advice needed to be supplied by the system as opposed to being constrained to one small area.

Although users could make a note of any feedback they had for the development team, there needed to be a better feedback mechanism. Ideally, this would automatically record where the user was in the system and this would be stored in the computer beside his comments.

One of the lessons learnt during the development of the AIDS Expert System was that it was very important to have a prototype system to show to the experts before any formal knowledge engineering sessions were arranged. This was to give them an appreciation of how the computer system can act as a potential problem solver in the dissemination of AIDS expertise.

By seeing the prototype system the experts could see how they would make use of it in their area of work. If they could not see a use for it, the reasons for this would be noted. This, in itself, provided a good feedback mechanism. For example, some of the experts were more concerned about the number of enquiries they were receiving from the general public rather than how to diagnose someone with HIV infection. Although the latter was more important, a lot of their time was spent on dealing with the former. Therefore, they saw more of a need for a general information system.

By seeing a prototype system in operation, the experts could see how their knowledge could be implemented into the system. They could also see the importance and urgency of the project since the work had already been started.

By having a prototype system containing knowledge about AIDS, which had not been published to date was also a significant factor when demonstrating it to experts. This knowledge had been acquired from one of the leading experts in the field, based in one of the London hospitals, where a large number of HIV infected individuals were seen. The experts to whom the system was being shown could put themselves in a particular scenario to see what advice or conclusions the expert system came to. They would then compare this to their own knowledge in the area.

It was also learnt that the experts were not interested in what the systems were called or what tools were being used (e.g. expert system shell). They were more concerned about the job or function that these could do, in particular how it could help them to do their own job. Showing the experts a computer system was also an opportunity to show them how easy computers were to use.

Another important lesson which was confirmed during the development was the importance of the knowledge engineer becoming familiar with the problem domain. This meant that the expert could talk more freely using his own language, and not have to keep stopping to explain his terminology and the knowledge engineer can ask sensible questions which makes the expert think about the problem being discussed.

On a couple of occasions earlier in the project, the knowledge engineers had not prepared themselves by becoming familiar with the subject domain being discussed. Although this initially saved the knowledge engineers time, the interviews were not very productive. The expert was stopped quite frequently to explain the terminology he was using.

When these recorded interviews were later transcribed, they contained very little information which could not have been obtained from published material. It is therefore, important to become familiar with the subject area to be discussed with the expert and to extract basic facts and information from readily available material. This way, the expert can even be asked questions relating to the printed material in order to clarify or supplement it. This also gives the expert confidence that he will be understood in his own language.

The AIDS Expert System had been written in an expert system shell for reasons already described. The functionality of this programming environment was appropriate during the early stages of development, and it did prove to be a quick and easy to use tool for prototyping. It was also invaluable as a method for extracting and formalising knowledge. However, these features were traded for inflexibility. Many of the facilities requested by users and identified by the development team could not be provided, e.g. searching knowledge by keywords; a user-friendly interface. It was also found that users had to wait four or five minutes while the expert system came up with a diagnosis. The experts indicated that this was far too long for practical use. There was a need to explore alternative programming environments for future developments.

Finally, there were several management issues that needed consideration during the development process. Management of the project was mainly the responsibility of the two directors of the Expert System/Decision Support Unit, Dr R Hurrion and Dr R Brittain. Management of time with experts was the responsibility of the knowledge engineers. This involved preparation before interviews with experts, transcribing interview tapes, representing knowledge by liaising with the programmer, reviewing and analysing feedback received from users.

Management of the user groups involved finding interested parties willing to use and evaluate the system, installing software, encouraging feedback and handling problems encountered by the users whilst using or trying to use the system. Two other operational considerations of the project involved management of the computer system design and the management of the knowledge base.

1.5 The Information System Approach

1.5.1 Introduction

The previous section described the development of an expert system for the dissemination of expertise on AIDS. It concluded that this tool was not the best solution for the problem area being studied. It was clear that a more flexible system was required, one that would provide a wider range of information which could be used by clinicians as well as other health professionals. This section describes an alternative approach that was used for solving the AIDS problem - involving the development and evaluation of an information system.

Following research from the literature searches (see chapter two), it was decided by the development team that database / information systems would provide the most appropriate solution. The main reason was because these systems needed less extensive representation of the knowledge. Information systems provide passive information and although they contain expertise, they are unable to interpret it like expert systems. The user determines what knowledge is required and the information system is used to retrieve it. In an information system all the different access paths are pre-defined by the programmer.

It was hoped that the development of an information system for AIDS would resolve some of the problems that were posed by the expert system:

(i) Different modules for different types of uses could be designed. Although an expert system only contains a single representation of some knowledge, it is able to manipulate and present it in different ways to the user. If the system needs to address a wide range of audiences, designing this flexibility becomes complicated. In an information system however, the different forms are stored explicitly.

(ii) Different modes of operation could be designed. Expert systems only reveal expertise through a question answer dialogue. This if far from ideal for users who simply want to reference a particular topic. Information systems enable information to be retrieved both by referencing and by browsing because of their passive nature.

(iii) Information systems are less controversial because they cannot use their knowledge to act 'intelligently' like expert systems.

It was decided that the development plan for the information system would be similar to that of the expert system. It would be carried out in four stages:

preparation; development; implementation; and evaluation (see section 1.4.5). As before these stages are inter-related and were not necessarily carried out in a sequential manner.

1.5.2 The Preparation Period

The diagnostic expert system described in the previous section (1.4), was written in Props-2. In the early stages this had proved to be a very useful tool in developing a system rapidly, mainly due to the ease of use of the software. However, it became apparent that a faster, more flexible and less memory intensive programming tool was required. This would be especially true as the development team at the ESDSU was taking an Information System Approach for its next prototype system, and an expert system shell would be extremely unsuitable.

After exploring a number of other expert system shells and programming languages, it was decided that the Arity Prolog programming language would be the best choice. This would provide the required flexibility and speed for the next development stage. Another important factor was that the system could run on IBM (International Business Machines) compatible personal computers, which are very popular among computer users.

It was decided that two prototype modules would be developed - one aimed at health professionals and the other at the general public. The health professionals module was chosen because control of infection guidelines are vital for the effective management of a condition like AIDS. These guidelines would provide doctors, nurses, occupational health workers, and other support staff with practical advice on how to act in particular circumstances with respect to caring for the patient and preventing the spread of AIDS.

The general public module was chosen because it would address the largest audience and because of the importance placed on education by many of the main governing bodies involved in AIDS. The inaugural London Declaration on Programmes for AIDS Prevention concluded that the single most important components of any nation's AIDS programme was information and education (Mann 1988).

The experts that would be needed for the elicitation of expertise and for refining the information system were also identified and approached during this preparation period. These were:

1) Dr Susan Drake - a clinician based at North Warwickshire Health Authority (NWHA);

2) Dr Charles Farthing - a research registrar in AIDS at St. Stephen's Hospital in Fulham, London;

3) Dr Anthony Pinching - a consultant in sexually transmitted diseases at St. Mary's Hospital in Paddington, London;

4) Professor Michael Adler - a consultant in sexually transmitted diseases at Middlesex Hospital in London;

5) Healthline - a partly Department of Health sponsored charitable organisation which operated a telephone answering service for health problems.

The first four of these had been used in the development of the expert system and they again agreed to collaborate with the development team. They were particularly pleased that we were listening to their requests for an alternative computerised solution that would address a wider audience.

The fifth of these, Healthline, had actually approached the ESDSU because they needed a decision support system for AIDS. They had experience running a public information system, covering a wide range of diseases from cancer to meningitis, and they had recently added AIDS to their list.

Before the development of the information system began, it was decided to identify the user groups that would be used for the evaluation study. The users that were identified and approached had to be a representative sample of the final groups which would use the system on an operational basis. The selected groups were:

1) Clinicians
2) Welcome Tropical Institute
3) University students
4) School students

The first two of these had also been chosen for evaluation of the expert system (see section 1.4.6). The last two groups were chosen to test the usefulness of the general public module as an educational aid. The general public module would be implemented at Warwick University on the internal computer network. The

Alderman Smith School in Nuneaton was chosen because it was local and it would provide a good cross-section of young people. The North Westminster School was a community school which was also open after school hours. It would therefore be possible for parents as well as children to have access to the system.

1.5.3 The Development Period

For the first phase of development only published materials were used to build the two modules that had been identified. The most important areas of each module were discussed with Dr Brittain and Dr Drake on a regular basis. The details of these two modules are outlined later in this chapter. A large amount of published information was available for both the health professionals module as well as the general public module.

For reasons discussed in the preparation period above, Prolog, an expert system programming language, was used as the programming environment for the development of the AIDS Information System. The information was represented as a network of elements and reports, all connected by links. The elements corresponded to topics; the reports corresponded to information required on particular topics; and the links corresponded to relationships between elements and reports.

A user interrogating the system would see the elements as menu options and the reports as screens of text. Selection of a topic from the first menu would give a more detailed breakdown, and this would continue until a report was presented on the screen. Keywords were also defined and these were programmed into the system to aid retrieval in this format. The user was able to select a single keyword or a multiple number of them. In the latter case, the AIDS Information System always listed the most relevant items first.

1.5.3.1 Knowledge Acquisition

The knowledge acquisition techniques that have been used in the past are described in the next chapter of this thesis (section 2.3). Here, the tools that were used in the development of the AIDS Information System are described. The two knowledge engineers in the development team had by now gained quite a lot of medical background in the general area of AIDS/HIV. A further study of approximately one month had been carried out to become familiar with the terminology and concepts that would be used in the modules that would make up the AIDS Information System.

It was important to get familiar with the subject domain before experts were approached because they are under great pressure and have very little time to talk to knowledge engineers (Fox et al 1985).

Published Text

There was a great deal of textual information available on AIDS/HIV in textbooks, booklets, leaflets, and articles in medical journals. The textbooks on AIDS/HIV included Farthing's 'Colour Atlas on AIDS'; Miller's 'Living with AIDS and HIV'; Miller, Weber and Green's 'The Management of AIDS Patients'; and Daniels' 'AIDS Questions and Answers'. From these titles it can be seen that a wide range of books were available, catering for several user groups with different needs. One of the main problems with even the latest available books was that some of the information contained in them had become outdated by the time that they had been published, because new information about AIDS and HIV was being produced fairly rapidly. Nevertheless, the books still provided a rich source of useful information.

The Terrence Higgins Trust, a registered charity set up to inform, advice and help on AIDS, had produced a number of booklets and leaflets on AIDS/HIV. These and others produced by the Health Education Authority and the Department of Health were useful both in terms of the information content and the way in which the knowledge was divided into separate sections to cater for different groups.

There were articles on AIDS/HIV appearing regularly in medical journals like the Launcet, the British Medical Journal and the New England Journal of Medicine. These were very important because they contained information on the latest research findings, new terminologies and new definitions of AIDS. These were used primarily for maintaining, refining and updating the information obtained from other textual sources. For the Guidelines module, the two main sources, St. Mary's Control of Infection Pack (St. Mary's Hospital 1987) and guidelines from the Amalgamated Committee on Disease Pathogens (COHSE 1987), were used.

These materials provided a good source of information for developing quite a large knowledge base for use within the two modules that would make up the AIDS Information System.

Interviews with Experts

After an initial prototype system had been designed using text based materials, the ESDSU decided to show the system to collaborating experts and at the same time, have knowledge engineering sessions with them. The importance of having an operational system to show experts before any interviews for knowledge acquisition took place have been emphasised in the discussion following the development of the AIDS Expert System. The main experts used were Dr. Brittain and Dr. Drake from NWHA, and Dr. Farthing from St. Stephen's Hospital in London. Meetings were arranged on a regular basis with these experts, so that they could see the system developing in the light of their comments and suggestions for improvements.

Other experts were also used although on an irregular basis, because the time that they had available was very limited. These included Dr. Pinching, a consultant in sexually transmitted diseases at St. Mary's Hospital in London; Professor Adler, a consultant in sexually transmitted diseases at Middlesex Hospital in London; and experts at Healthline. The expertise derived from Dr. Pinching, Professor Adler and Dr. Farthing was invaluable because they were recognised as the leading experts in AIDS/HIV. They were also based in the three London Hospitals which had become established as centres of excellence because of their direct experience with a large number of AIDS/HIV patients.

All interviews between the expert and the knowledge engineer were recorded. This was important as it enabled the knowledge engineer to discuss points with the expert without slowing him down or distracting himself by continuously having to make notes on the conversations. The fact that the knowledge engineer had become familiar with the subject domain was of paramount importance, as experts find it frustrating to have to explain basic facts, terms and phrases unnecessarily. This would also have slowed the process of elicitation of knowledge from the expert and consequently, the development of the system as the time experts can allocate is already very limited (Fox et al 1985).

During the development of the Information System, the experts could see their input of information/knowledge more directly. The speed of development was also an important factor. They were willing to devote more of their time in the development, especially as they could see their efforts being translated quickly into a computer system. The knowledge acquisition techniques used for the development of the AIDS Expert System are described in section 1.4.

During the knowledge engineering sessions, the experts suggested the development of two further modules which they felt were very important in the area of AIDS. The first of these was suggested by Dr Farthing, who wanted a clinical module to assist in the identification, treatment and management of diseases found in AIDS/HIV patients. The second was a counselling module and this was identified by a number of experts as well as the development team, but in particular by Dr Drake. The important need for these two modules and a brief description of the contents of each is given later (see section 1.5.3.2).

These two additional modules were developed along the same lines as the General Public and Health Professionals systems. Existing published material was used in order to build a solid foundation of knowledge for the system before these were refined using formal knowledge engineering sessions with the experts. Again Dr Brittain and Dr Drake were used regularly to discuss the important topic areas on an informal basis.

Healthline operated a 24 hour 'phone-in' service which provided advice on a number of topics including AIDS. The telephone operators were not medically qualified. They would either answer the caller directly or play a short tape which was a recording of an expert talking on the specified subject.

A number of meetings were arranged with Healthline where the AIDS Information System was demonstrated during its various development stages. It was soon realised that Healthline operators could use the system as a tool to supplement their own understanding. They could also use the system to answer calls directly. Healthline's contribution to the AIDS Information System was invaluable because they were able to provide a good indication of the types of queries that were commonly asked by the general public.

During the development of the AIDS Information System, approximately forty hours of tape recording had been made. This represented a significant amount of knowledge especially as a voice activated cassette recorder was used for the majority of the interviews. The tapes were later played and with the help of any textual information which the experts may have pointed out for certain references, together with information from other sources which had already been acquired, the knowledge engineer structured and transformed this knowledge into the knowledge base of the AIDS Information System.

As with the development of the AIDS Expert System, an iterative process was used for building the Information System (see figure 1.2). This involved building a prototype followed by a cyclic process of extending, refining and modifying.

Two of the main problems that were encountered during the development of the AIDS Expert System were also prominent during the construction of the knowledge base for the AIDS Information System.

The first of these problems was that of differing advice and procedures between different experts. This was more noticeable in the clinical module where the recommended drug therapies and investigative procedures differed among the main London AIDS hospitals. The development team attempted to resolve these by giving the user alternatives to choose from. This was preferred to presenting just the thoughts of a particular group and hiding the alternatives.

As already mentioned, although the time that the experts could devote to the development of the Information System was limited, one of the biggest problems encountered during the development process was the bottle-neck which occurred during knowledge acquisition. For example, this occurred during several three-weekly periods of stay at St Stephen's Hospital when working with Dr Charles Farthing. The stays were not longer because the developers of the system could not keep up with the knowledge that had been acquired and the changes demanded by the experts. This was frustrating for both the expert and the development team.

Feedback from users

One of the features provided by the AIDS Information System was the facility for the user to enter any comment or question, which would get stored in a text file. This 'feedback facility' could be activated by the user at any point whilst using the system. When the latest system was left with the user-groups who were evaluating the system, this facility provided a useful way of getting feedback about the system including spelling mistakes, comments on the structure, the instructions and the ease with which it could be used.

These comments would then be viewed later by the knowledge engineer and used to refine, modify and update the system depending on the person who made the comments. Some of the comments needed to be discussed with the experts. If this text file contained suggestions on the layout or design of the system, these comments were passed on to the person responsible for programming in the development team.

A Conceptual Model of the System

There were two aspects of the AIDS Information System that were most important, particularly for menu based information retrieval. These were the structure of the system in terms of menu and sub-menu headings, and the contents of the reports. One of the problems faced by the knowledge engineer was the fact that not all experts had access to a computer. Therefore, they could not use the system for evaluation let alone use the feedback facility described above.

One of the main experts being used for the development of the Information System was Dr. Charles Farthing. The knowledge engineers spent several three-weekly periods at St. Stephen's Hospital, knowledge engineering Dr. Farthing before returning to the University to refine and update the Information System.

A conceptual model for the menu structure of the general public module was made to try and overcome the problem of the expert not having access to a PC. This consisted simply of pieces of paper (pages) of different lengths, each with a different heading on it. The pages used varied in colour depending on the level at which a particular title was displayed. These pages were all spiral bound once they had been assembled in the correct order. The paper model can be compared to an address diary where one can see the letters of the alphabet upon opening the front cover. When a particular letter is chosen, the pages reveal the addresses and telephone numbers of all contacts entered under the chosen letter.

In a similar way, the conceptual model of the AIDS Information System showed the top level menu headings of the General Public system as this would appear on the computer. When one of these was chosen and the relevant page opened, a sub-menu appeared reflecting the chosen item. This process continued until the bottom of the structure was reached, i.e. no more menus appear. This meant that a report was attached to that item. To restart, all the pages were flicked back to their original positions, enabling another choice to be made.

This model was sent to Dr. Farthing together with a printout of all the relevant reports. Using this model he was able to check the structure of the General Public system and the contents of the reports which were associated with each item. He could use this model whenever he had thc opportunity and was able to carry the compact conceptual model in his pocket.

The knowledge engineers noticed the benefits of sending this model on the very first day of their next visit to see the expert. He was already familiar with the new structure of the General Public system and had also made comments and corrections to some of the printouts that were sent out to him. Therefore, invaluable time was saved and the knowledge engineers could concentrate on other modules and aspects of the system.

One of the problems with a conceptual model is that it is difficult to keep up-to-date once the structure is changed. Either it has to be re-made completely or the pages removed, updated and modified before re-binding them. Both of these methods would be very time-consuming but, fortunately, the structure of the General Public module did not need changing very much after the first major change. Therefore, the model had already served its purpose. This concept of updating also highlights one of the advantages of having a computerised system as opposed to a paper-based one.

1.5.3.2 The Four Modules

<u>**General Public Module**</u>

In the absence of a cure or vaccine for AIDS/HIV, education is recognised as the most effective way to fight this pandemic. The way HIV is transmitted means that certain behavioural changes by individuals can greatly reduce their risk of contracting the virus. Therefore, it is essential that members of the general public as well as those at higher risk, are fully informed of the precautions which they should take.

The Government, recognising the threats posed by the pandemic, ran a number of national campaigns in 1986 and 1987 to educate the public. This included extensive advertising in newspapers, posters, radio and television broadcasts and the delivery of a leaflet on AIDS to every household in the United Kingdom. These campaigns were successful at the time in that more people became aware of the problem and realised how it may affect them individually. However, the resources required for such campaigns means that they cannot be run on a regular basis, but this is precisely what is required for them to be successful in the long term.

The General Public module was built to meet the information demands of most people. It was regarded as the most important module because it addressed the greatest audience and because everyone is potentially at risk of catching the virus. It also proved helpful to experts who found that much of their valuable time was being taken up in answering general telephone calls from those worried about

AIDS/HIV. By installing the General Public system in their secretary's room, it was found that the secretary was able to use the system to answer most of these queries. This gave the expert more time to carry out vital clinical duties.

The General Public module was installed in various locations for formal and informal evaluations. The details of these and the results and findings are described later (see section 1.5.5.). The way the information was structured reflected the needs of different user groups which ranged from the experts themselves, people considering whether to take the HIV antibody test, those already infected with the virus to information for employers, teachers and school children.

It is important to appreciate that the General Public module contains quite extensive details on issues of major importance to the general public. For example, in the transmission section of the system, the user is presented with a list of ways in which the virus cannot be transmitted. Upon selection of one of these items (e.g. insects or saliva), the user sees a detailed report including evidence of the way the virus is not transmitted in this way (see Appendix A). From earlier evaluations, it was discovered that the users were not satisfied with just *"No, you cannot catch HIV from insects"*.

The General Public module contains over 220 reports and is the largest of the four modules. The top-level menu headings of this module are given below with brief details of the contents under each heading:

1) Definitions, Causes, Origins of AIDS/HIV - this provides information on the definition of AIDS, the definition of HIV, causes and origins of AIDS/HIV.

2) Medical Aspects of AIDS/HIV - describes the most important clinical manifestations of AIDS, AIDS related conditions, possible symptoms, incubation period and similar related topics.

3) AIDS/HIV Risk Groups - puts into perspective the groups of people at risk, those assumed to be at risk including health and social workers, and the risk to women.

4) Advice Related to the AIDS/HIV Test - gives advice on the HIV antibody test, the implications of a negative result or a positive result, its reliability, what to consider before taking it and the places where it can be taken. There is a section giving advice/Information for someone with AIDS/HIV. This is a section in its own right and includes sub-sections on how to take care of yourself and others around you, support agencies, housing advice, social security and other benefits.

5) Transmission of AIDS/HIV - clarifies much of the confusion over the ways AIDS/HIV can and cannot be transmitted by giving detailed reports on each route. There is also a section on how the risk of transmission can be reduced by taking certain precautions.

6) AIDS/HIV Statistics - gives the numbers of AIDS and HIV cases in the U.K., the World Health Organisation (WHO) European Region and around the world. The UK section gives the number of AIDS and HIV cases by transmission characteristics, by age and sex, by country and by region.

7) AIDS and Children at School - educating school teachers and school children about AIDS/HIV has always been an area of great importance. This section

covers health education, infection control guidelines, the responsibilities of the school, how to educate pupils about transmission and the risks of activities commonly undertaken at school.

8) AIDS and Employment - advice is provided for both the employer and his employees including the employer's responsibilities, the rights of HIV infected employees, the risk to colleagues, and his statutory rights if dismissed.

9) AIDS and First-Aid - describes the risks involved and the significance of AIDS for first-aiders. There is also a section giving guidelines for disinfecting manikins.

10) AIDS and travel - a useful section for those travelling abroad. The number of AIDS cases around the world are given by each country and the procedures they are employing to contain the pandemic.

11) Sources for Advice, Help and Further Information - this section gives the names, addresses and telephone numbers of various organisations that provide help, advice and support for those worried about AIDS/HIV, those with HIV infection, and their family, friends and relatives.

Guidelines Module

The Guidelines module is based mainly on the St. Mary's Guidelines for Control of Infection of HIV (St. Mary's Hospital 1987) and the guidelines from the Amalgamated Committee on Disease Pathogens (COHSE 1987). These were supplemented after demonstrations and interviews with experts.

Guidelines for controlling infection are vital for the effective management of any contagious disease. The absence of such guidelines can lead to unnecessary suffering, deaths and incurment of very large costs (DHSS 1976).

The Guidelines module had been designed to provide health professionals, including nurses and occupational health workers, expert advice on how to act in particular situations with respect to caring for the patient and preventing the spread of infection. It provides advice in the form of succinct reports which can be accessed quickly and easily through menus or keywords.

The Guidelines module covers the following areas:

1) Basic Nursing Care - how to care for the patient including psychological care, symptoms to look for and the precautions to take.

2) Care of Infected Bodies - an important section detailing the procedure for disposing the bodies of AIDS/HIV patients, the clothing that must be worn depending on the diseases that the patient died from, and the last offices that should be given.

3) Infection Control Pack - this is by far the largest of the three sections and covers AIDS/HIV in the hospital, community and at home. Information is provided on the care of equipment, cleaning and disposal, procedure for accidents, protective clothing, and specimen collection in wards, theatres, maternity, cardiology and radiology. The purpose of the various policies is also provided.

Counselling Module

The Counselling module was developed to act as an on-line assistant for counsellors although it can also be used as a training aid for potential counsellors. The importance of counselling led to various counselling courses for AIDS/HIV around the country. Anyone considering taking the HIV antibody test had to have compulsory 'pre-test' counselling. Then, if they decided to have the test, they would need 'post-test' counselling after they received the result of their test. If they were found positive, they required 'on-going' counselling.

Counselling was also important for many people who were still worried even though they fell into a very low risk group. There was a need for everyone to be informed, whether they were positive, negative or did not know, to consider safer sex: if they were negative to protect themselves; if they were positive to protect others and to avoid catching other diseases.

Counselling affected not only those who were positive but also their lovers, friends and relatives. The importance of communication between those involved with AIDS/HIV has been emphasised by Miller (1987) who writes,

> *"HIV is not something to fear - it is something to fight. But to fight it effectively, everyone affected - patients, (para) medical staff, and carers (lovers, spouses, families, friends, work colleagues) - must be clear about what this phenomenon means on a social, medical, practical and emotional level. And they must learn to communicate this knowledge effectively."*

The topics covered by the Counselling module are given below with brief details of the contents of each section:

1) Breaking Bad News to Patients and Relatives - the approach that the counsellor takes to do this is very important.

2) Important Facts to Get Across - this includes facts about the virus, reduction of risk, what not to worry about and what to look out for.

3) Information Which the Counsellor Should Obtain - points out the essential information required from the patient so that adequate counselling can be given.

4) Uncertainty and its Implications - gives advice on the uncertainty of the test, loss of self-esteem and quality of life afterwards including sexual, relationship, occupational, physical and social fears.

5) Anxiety - how to recognise anxiety in the patient, the somatic, behavioural and cognitive symptoms, and how to manage it.

6) Depression - the identification and treatment of depression in the patient, explaining the difference between ordinary depression and clinical depression. There is a section on symptoms which includes cognitive features, somatic symptoms, behavioural signs and suicidal thoughts or plans.

7) HIV disorders - this discusses the essential counselling which needs to be given to the patient, counselling requirements, issues arising, obsessional states and neurological effects.

8) Practicalities - this section contains information on what advice to give on second and follow-up counselling sessions with the patient including safer sex guidelines.

9) Lovers, Friends and Relatives - the reasons for inclusion of others in counselling and what counselling they should be given depending on whether it is a lover, friend or a relative.

Clinical Module

The Clinical module of the system is the most specialist and has been designed to assist clinicians in the identification, treatment and management of diseases found in AIDS/HIV patients. Therefore, this module assumes that the patient is HIV antibody positive, i.e. he is infected with HIV.

During the development of the Clinical system, the experts gave advice which had never been written down before. There were two reasons for this, the systematic way the knowledge engineers were eliciting the knowledge from the experts, and because experts were too occupied in their day-to-day clinics and other work, that they never got a chance to write about the experiences they were gaining.

The Clinical module has been divided into different diseases all with the same basic structure, which is as follow:

1) Background - this gives a brief background to the disease with particular emphasis on its relation to AIDS and whether it is included as one of the diseases listed in the definition of AIDS (WHO 1986).

2) Possible Signs and Symptoms - this gives a list of the signs and symptoms associated with the disease. If required, it also contains descriptions of the prevalence and severity of each symptom or sign.

3) Related Disorders - this provides the clinician with a list of other diseases that he should consider in the diagnosis. He may need to carry out further investigations to establish a disease or discriminate between a number of them.

4) Investigations - this details the investigations that should be performed to ascertain the disease that the clinician is considering. This is important because many diseases have similar symptoms.

5) Treatments - this provides up-to-date information on treatment regimes being used for the disease in AIDS/HIV patients. The diseases which are present in AIDS/HIV patients (e.g. meningitis) have to be treated differently than in non-AIDS/HIV patients. The treatments are ranked in importance where there are more than one. The clinician is warned where there are possible interactions between diseases and treatments.

6) Prophylaxis - this lists the prophylactic regimes for the disease being considered. Palliative measures are described when the condition (e.g. a typical mycobacteriosis) has no known treatments and no prophylactic regimes.

7) Prognosis - provides information on the prognosis of the disease and its wider implications as a marker of the degree of compromise of a person's cell

mediated immunity. The action of the HIV virus, destroying the cell-mediated response, makes generalisation extremely difficult.

1.5.3.3 The Modes of Access

Access Through Menus

Access to information contained in all four modules can be retrieved by selecting an item from menus (see Appendix A). Each menu comprises a topic heading and a list of relevant sub-headings (items). These items can themselves form topic headings with further sub-divisions or alternatively, they will lead to a report relating to that item. The user can then return to previous menus step-by-step or return to the top menu using one keystroke.

These menu structures can be compared to headings found in the contents page of a book. However, the contents of a book are designed to be read sequentially. The menus in the information system do not conform to a strict hierarchy and cross linkages have been used extensively to express relationships among topics. This presents the information more clearly and speeds up the information retrieval process.

Access using Keywords

Information retrieval using keywords (see Appendix A) is ideal if the user knows precisely what he wants to look up. Several keywords can be selected and these may refer to concepts such as "prejudice" or more specific topics like "employment rights".

The system will search the selected topics and then present an ordered list of items as a menu. This list is ordered so that the items most relevant to the search are presented at the top of the menu, and as the list descends the topics become less relevant.

The user has the option to either add or retract some of the keywords after the initial search, or he can clear all the keywords and execute another search using a new set of keywords.

<u>**Access using free text Search**</u>

The free text search (see Appendix A) allows the user to type in a word or phrase that he wants the system to search for. All relevant reports are found and their headings are displayed as a menu. This facility was developed because information can never be referenced completely using keywords unless every word in the system is included as a keyword. This would be difficult and would reduce the usefulness and practicality of the keyword search.

The main problem with this searching facility is that it is quite slow. This is not surprising given that there are over 700 reports in the system. Also, there is no guarantee that any information will be found at the end of the search.

1.5.4 The Implementation Period

The AIDS Information System was installed at various locations for evaluation by the end users. These users had been identified in the preparation period (see section 1.5.2) and consisted of clinicians, the Wellcome Tropical Institute, university students and school pupils. The feedback facility (see section 1.5.3.1) was made available to allow users to make comments about the use and contents of the system, so that these could be used to improve future versions and for evaluation purposes.

Only the General Public module of the system was installed for use by students and pupils. The two schools where the system was installed were the Alderman Smith School in Nuneaton and the North Westminster School in London. The University of Warwick's Computer Department helped to set up the Information System so that it was available on the internal computer network. This meant that a large proportion of the under-graduates, post-graduates and staff at the University had access to information and advice relating to AIDS/HIV.

1.5.5 The Evaluation Period

Trials are useful and necessary, whether involving computers or not, for proper evaluations of any system. A formal evaluation was also carried out at a school in Nuneaton, for which the results, analysis and conclusions are described in Appendix B. The AIDS Information System was evaluated informally throughout its development stages. This constant feedback was essential to maintain the action research approach. These informal evaluations included comments and suggestions made during presentations of the ESDSU's work which included demonstrations of the system, feedback received via the feedback facility, seminars, and letters from users who had access to the system.

There were a number of groups who had access to the Information System during most of its development stages. These groups provided constant feedback by using the feedback facility. They were instructed to send the relevant text file on a floppy disk through the post on a regular basis. Examples of these files are shown in Appendix B5, exactly as they were sent by the users. The first one shown was sent by one of the users at the British Computer Society. Some users preferred to write a letter which included their comments with suggestions for improving the system. One of these was sent in by users at the Environmental Services Department, Birmingham City Council. All feedback received was used to refine the system by using the iterative process shown in Fig 1.5 (see section 1.6.5).

The General Public module of the Information System was installed at the North Westminster School in London. The Education Department of IBM provided a computer for this purpose. The system was generally available to sixth form students, parents and members of staff over a period of about four months. One of the text files sent by this community school also appears in Appendix B5 and includes some useful comments.

The Social Services Select Committee was given demonstrations of the Information System as part of their formal 'Enquiry on AIDS'. They were quite impressed with the system, and this was later acknowledged in the Social Services Committee Report (House of Commons 1987):

> *".. One facility a system such as his (Dr. Brittain's) would offer is readily available information on a computer disc, which can be quickly and easily updated and displayed on a computer screen. Such a system may have potential, especially for volunteers manning around-the-clock helplines to whom it is essential to provide accurate information from which they can answer callers' questions. <u>We recommend that the DHSS examine the contribution which information technology can make in the dissemination of accurate information about HIV and AIDS</u>."*

The University of Warwick played a key role in the evaluation of the Information System. The General Public module of the system was installed on computer networks in a number of large departments. Again, the feedback facility was used extensively to provide the development team with more valuable feedback (see Appendix B5). Also, a number of seminars were organised at the university for students as well as for external groups like health and social workers.

1.5.6 Conclusions

The previous section (1.4) described the development of an AIDS Expert System and outlined the problems encountered with this approach. This section (1.5) has described the development of an AIDS Information System using published sources and the knowledge of experts in order to resolve some of these problems. The Information System provided a tool for accessing information for use by clinicians, health professionals, the general public and counsellors. The information could be retrieved using menus, keywords or free-text searches. A formal trial using young people suggested that the AIDS Information System provided a comprehensive and enjoyable way of learning about the subject. This trial also gave evidence that the system helped to engender a more rational and balanced perspective of the risks of AIDS in young people.

The information system approach did resolve many of the problems that were posed by the expert system approach. An information system was more widely accepted by the experts than a pure expert system. Consequently, the experts were more enthusiastic and some of them devoted their time in the evenings and at weekends to help the knowledge engineers construct the knowledge base.

The AIDS Information System consisted of four modules and these could be separated easily. This meant that, for example, schools and libraries could be given the Information System containing just the General Public knowledge base. A general practitioner however, would be given all four knowledge bases to reflect all the roles that he/she is required to play.

The Expert System approach only allowed information to be retrieved through a question-answer dialogue. The Information System was able to provide different levels of use by providing browsing and referencing facilities through the use of menus, keywords, and free-text searches. The Information System addressed a much wider audience and this was important with a topic such as AIDS where education was always going to play a key role in changing people's attitude and behaviour.

The use of PROLOG as the programming environment for the AIDS Information System provided the flexibility and efficiency of development that was required. Shells, such as PROPS-2 used in the AIDS Expert System, are made easy to use because they contain many pre-defined functions and libraries. This saves the programmer time but this is traded for flexibility and efficiency.

PROLOG, developed by Colmerauer at Marseille University in 1974 (Roussell 1975), is a powerful programming language founded upon symbolic logic. It is a popular tool for developing database, knowledge base, and expert systems. The basic computational mechanism is a pattern matching process called unification, which operates on general record structures called terms of logic. This facilitates clear, readable and concise programs which leads to easier and faster development. While conventional computer languages like Basic, Pascal and Fortran have procedural interpretations, PROLOG has both declarative and procedural interpretations. This has the advantage of enabling the developer to concentrate on defining the means to solve the problem and be concerned less on how the program code will be interpreted by the computer.

One of the disadvantages of an information system is that it expects the user to have a certain level of knowledge. This is needed in order to find in which area of the system the required information is located. For example, a person with no knowledge of AIDS related diseases would have difficulty finding and understanding the treatment for a particular condition.

One further disadvantage of an information system is the absence of an inference mechanism, which means that the reports are pre-constructed rather than being assembled dynamically depending on the requirement of the user. For example, the General Public module contains information on how the AIDS virus can and cannot be transmitted, including a report explaining why insects such as mosquitoes cannot transmit the AIDS virus. If the user wants to know the risk of transmission from a spider, the system cannot infer that a spider is an insect and so the query is unanswered. This is where an expert system approach would be more beneficial because the information would be constructed dynamically from data structures.

1.6 The Expert Advisory System Approach

1.6.1 Introduction

The previous section (1.5) described the development of an Information System as a decision support tool for AIDS. It was thought that this approach was the solution to the problems that had been encountered during the development of the Expert System (see section 1.4). The Information System was more widely accepted but it too had its disadvantages. For example, the reports were pre-constructed rather than being assembled dynamically depending on the requirement of the users and their level of expertise.

It was noted that most of the advantages and disadvantages of the Expert System and the Information System were complementary. For example, the disadvantages of the Expert System to cater for different types of users and with different levels of expertise, were the advantages of the information system. Conversely, the disadvantages of the Information System e.g. knowledge representation were the advantages of the Expert System. This suggested the possibility of constructing a system with an integrated approach. This new approach is outlined in this section, and it was termed an Expert Advisory System approach.

As with the development of both the Expert System and the Information System, four main stages were identified in order to construct an Expert Advisory System. These were preparation, development, implementation and evaluation, and details of these now follow.

1.6.2 The Preparation Period

The principles of an Expert Advisory System can best be illustrated by looking at and comparing the process by which information is retrieved from a non-computerised system e.g. a textbook. The Expert Advisory System would allow five levels of access:

(i) Keyword Access - this is for an expert user who wants to retrieve information on a particular subject. He knows exactly where the information on a particular subject is located, and can precisely define a term to reference it. An analogy with a manual system would be someone looking for an item in a book. The item can be specified in such a way as to locate immediately the relevant pages in the book. An example drawn from the Guidelines module would be an expert wishing to dispose of a needle after an operation. He is able to specify "CINBIN sizes" to learn what sizes of CINBIN are available in the hospital for the disposal of sharps.

(ii) Keyword access but of a more ambiguous nature than (i) - this is for the user who may know the generic term for the information he wants but not the specific term which would take him to it immediately. This would be analogous to someone looking for a particular subject in the index of a book. Several references might exist: it is up to the user to decide which is relevant. To continue with the example cited in (i), the user might specify "sharps disposal in theatre" in this type of access. A menu would then be presented where "CINBIN sizes" would be one option. Other options in this instance might include "Disposal of CINBINS", and "Use of Exotainers".

(iii) Menu Access - the user retrieves the necessary information by selecting items from menus which progressively narrow down the sections relevant. The menus are the Object-Attribute-Value (OAV) tree. The user has some idea as to what information is wanted but has to be guided through the Information Base. A manual equivalent would be the contents at the front of a book. To retrieve information on the sizes of CINBIN available, the user might look at the "AIDS in Theatres" option in a "Control of Infection" section. This would take him to a further menu containing "Accidents in Theatre", "Protective Clothing", and "Sharps Disposal in Theatres". By selecting "Sharps Disposal in Theatres", the user would reach the section which included "CINBIN sizes".

(iv) Diagnostic Module (data driven) - the user feeds the Advisory System data on the particular circumstances where guidance is required. He/she knows what criteria will define the problem but is unable to use the Information Base directly. There is no manual analogue. The non-computerised equivalent would be someone approaching an expert for advice as to how to tackle a problem. Data entry will be through a type of form filling. The user will be shown a number of possible topics where data can be declared by "ticking off" items from a menu. The system will use this data to direct the user to the relevant part of the Information Base. In the Guidelines module, the initial menu of topics might include subject, site and activity. To obtain advice as to how to dispose of sharps after an operation, the user might select "sharps" off a subject menu, "ward" off a site menu, and "disposal" off an activity menu.

(v) Diagnostic Module (data + hypothesis driven) - this is the most sophisticated form of access and is intended primarily for the least expert user. The user is unable to address the Information Base directly and does not know the subject area sufficiently to specify defining criteria for the problem. Some data is declared to the Advisory System which triggers off a consultation in which the user is asked questions in order to obtain information which allow the Advisory System to function as if a type (iv) user was using it. Interaction will again be through a kind of form filling. A user of the Guidelines module might declare "sharps" off a subject menu but not "wards" off a site menu or "disposal" off an activity menu. The user does not know which topics are relevant to his problem. The system will use the data declared but will also ask questions in order to decide upon the relevant section of the Information Base. The system will need to prompt the user to provide data on the site and the activity.

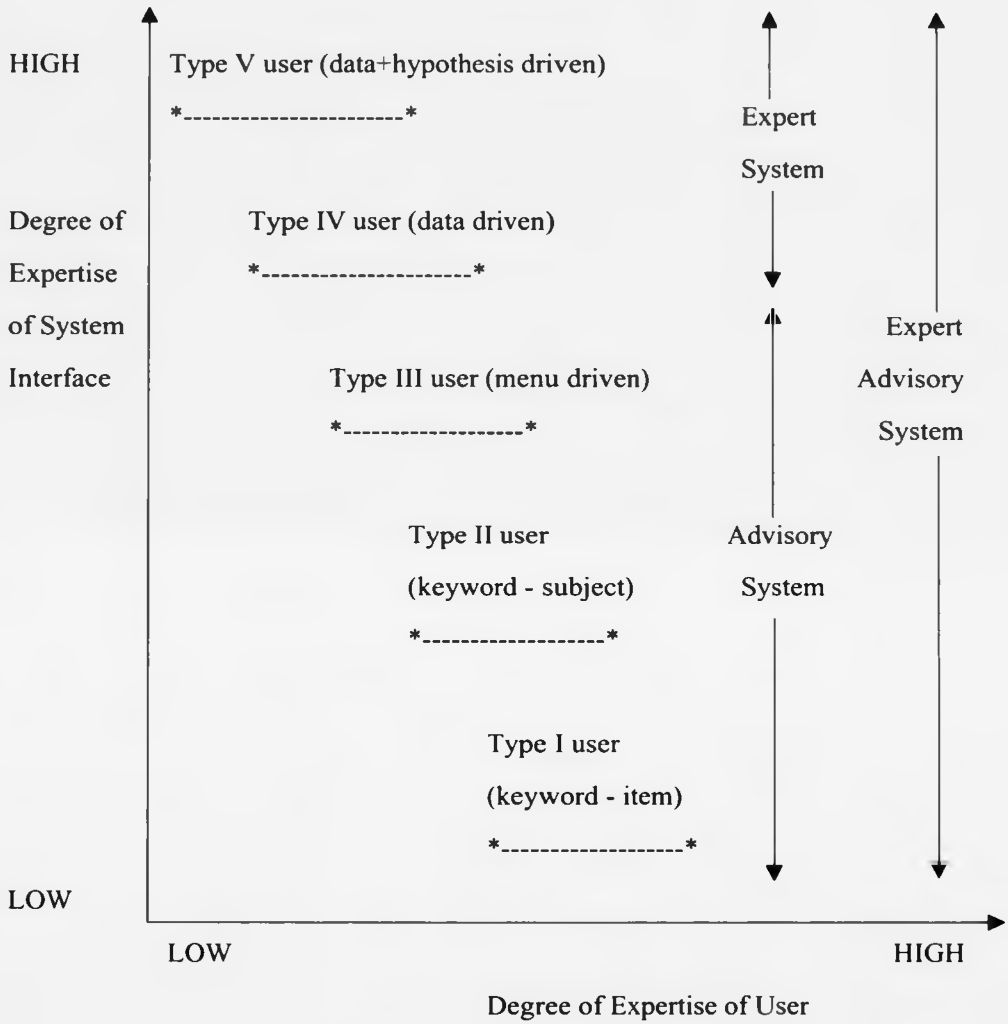


Figure 1.3

Consulting an Expert Advisory System

The different forms of access and their relationships to Expert Advisory Systems and to existing non-computerised systems are shown in Figures 1.3 and 1.4. The two models show how the various forms of access can be used by a range of users. For example, the most sophisticated interface, the data and hypothesis mode, will be used primarily by the least expert user. However, it could also be used by an expert in a critiquing role.

It was decided that the complete concept of the Expert Advisory System would only initially be developed for the clinical module. The clinical module of the information system already catered for type (i), (ii) and (iii) users seeking information about various attributes of AIDS related disorders. This would be extended to cater for type (iv) and (v) users by designing an interface which referenced the same advice but indirectly by the user describing the signs and symptoms of the patient. This interface would be based on the differential diagnosis model that was observed in clinical decision making during the development of the expert system.

It was also decided that, for the moment, no diagnostic facility would exist in the general public module. This is because it covers such a vast range of topics that it is extremely difficult to formulate rules that help decide which section of the Information Base should be addressed. A possible way of overcoming this problem is to request the user to initially express which part of the overall module he is interested in, e.g., AIDS and employment, or Transmission of AIDS, or AIDS and children at school. "True" diagnostic access could then be made available once in that section.

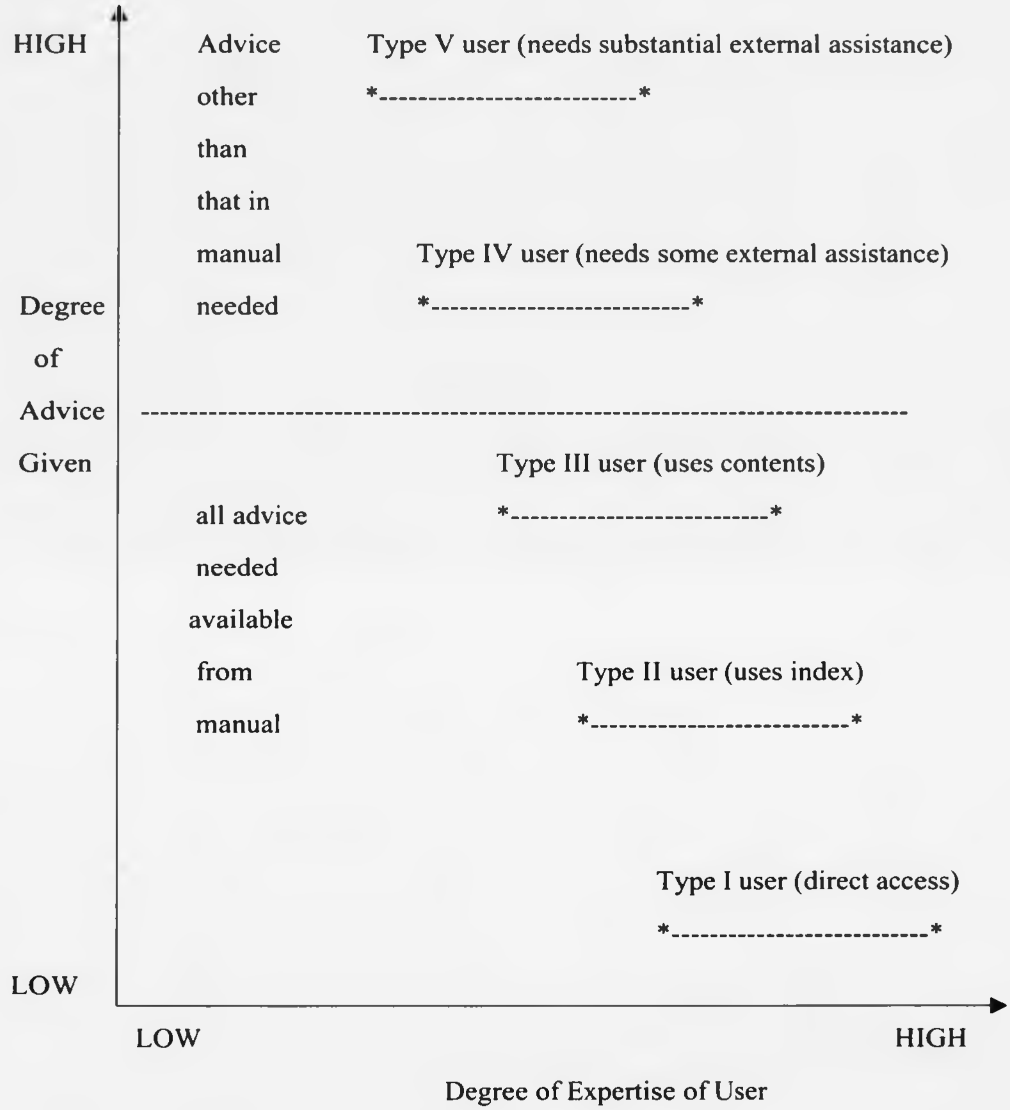


Figure 1.4

Retrieving advice from a non-computerised system

The main expert to be used for the development of the Expert Advisory System would be Dr Charles Farthing, who had made the greatest contribution to both the Expert System and the clinical module of the Information System. He had also been the most enthusiastic and co-operative expert throughout the various developments. He agreed to help the development team again when he was approached regarding the Expert Advisory System.

The user groups would consist mainly of the ones that were used for the evaluations of the Expert System and the Information System, as long as they all agreed.

1.6.3 The Development Period

During the development of the clinical module of the AIDS Information System, clinical knowledge on AIDS was structured in terms of a 'disease tree'. This described a disease in terms of its background, presenting signs and symptoms, treatment, prognosis, prophylaxis, and related diseases (see section 1.5.3). This proved to be useful in the construction of the differential diagnosis component of the Expert Advisory System.

The most useful areas were the presenting signs and symptoms of the disease and the relationship of the disease to other diseases. In the Information System, this information was presented as text files which contained a lot of detail for clarity and readability. This knowledge had to be reviewed, re-structured and represented differently for use with a differential diagnosis approach.

Other knowledge required was obtained from published sources or extracted from the mind of the human expert being used, Dr Farthing. As in the development of the Expert System and the Information System, an iterative process was used to build the latest tool (see figure 1.2). As discussed before (see section 1.5.3.1) this involved building a prototype, followed by a cyclic process of extending, refining and re-refining the system.

The knowledge that had been acquired was represented in a form that would enable the system to match a description of a patient's symptoms to a disease. This required that the system know what observations might be made of the patient and how these related to diseases within its domain.

The development team continued to use PROLOG because of the same reasons as those given for the development of the Information System (see section 1.5.3). The need to use a flexible and powerful logic based language was even greater for the development of the Expert Advisory System because of the abstract nature in which decision rules had to be represented.

The inference engine, a mechanism to control the way in which knowledge is applied, was important. This is because knowledge of diseases and their associated findings cannot by themselves form a diagnostic interface. The design of the inference engine had to satisfy one constraint, namely to allow the user to feel in control.

When using the system, the user/expert was required to enter observations of the patient through menus, which appeared as forms. This had the advantage of restricting communication to structures which could be recognised by the system, as opposed to free format entry which can cause problems. One of these problems could be if the words entered by the expert were miss-spelt, abbreviated or just input in a different format than that recognised by the system. Fortunately, experts or users preferred to make as few keystrokes as possible and were quite happy to have a list of items to choose from.

As each basic symptom exhibited by a patient is declared, the expert is required to enter the attributes of each symptom (see Appendix A). The system will then give a differential of possible diseases the patient has presented as an ordered menu of items. The expert can then activate these items and access information as in the menu mode described in section 1.5.3.3.

The expert has the facility to ask how a particular diagnosis was reached. He can also add to the list of symptoms, which might result in a different diagnosis. The diagnostic interface does not exclude the other features of the system like the menu, keyword and free-text searches. These facilities remain active and can be called as necessary.

Appendix A, which contains demonstrations of the AIDS Expert Advisory System in use, shows the layout of the menu items and instructions as they appear on the computer screen. During the development of the Expert System and the Information System it was realised that a lot of potential users were computer phobic especially those who had never used a computer before. Therefore, the Expert Advisory System was designed so that it was user-friendly. All the required instructions were always displayed at the top of each screen. In this way, there was no need for the user to have to remember or learn any commands.

Most of these instructions consisted of function keys. It was discovered that users became more confident when they were told that only a small part of the keyboard, i.e. the function keys, would be needed to use the System. However, to maintain flexibility, the keys normally associated with moving the curser or highlighter on the screen display were also available.

1.6.4 The Implementation Period

Different parts of the Expert Advisory System were installed for use by a large number of collaborating groups and individuals, many of whom had been contacted during the development of the Information System. These included the following:

- Healthline
- British Medical Association.
- Israeli National Working Party on AIDS
- World Health Organisation (European Region)
- Health Education Board of the Irish Republic in Dublin
- British Computer Society Health Specialist Care Group
- AIDS National Helpline
- West Midlands Drug Users Working Party
- Health Education Authority, U. K.
- Coventry Community Drug Team
- St. Stephen's Hospital, London
- St. Mary's Hospital, London
- Middlesex Hospital, London

For many of the users, there appeared to be little difference between the Expert Advisory System and the Information System. Only the physicians who dealt with AIDS patients were given access to the complete Expert Advisory System for evaluation purposes. The feedback facility was also made available as it had proved to be a very productive way of getting comments from users during earlier evaluations of the Expert and Information Systems.

1.6.5 The Evaluation Period

Unlike the Information System developed earlier, the AIDS Expert Advisory System was far from fully developed. Therefore, it was not possible to evaluate it to the same extent. These were limited to feedback received via the feedback facility, feedback from small user groups and from demonstrations. Any feedback received was used to refine the system by using an iterative process, which is shown in Fig 1.5 below. The feedback was very encouraging although a few users failed to appreciate that the system was intended only to demonstrate the principles of an expert advisory system and was not yet ready to be used operationally.

Dr Tim Moore, a specialist in community medicine at the East Anglian Health Authority, was appointed by the Royal Faculty of Community Physicians to conduct a study of the use of information technology in health. Dr Moore saw a demonstration of the Expert Advisory System at a conference for community physicians in Birmingham. He said that he was impressed by the system and backed this up by writing to the Faculty - suggesting that the development of the system be encouraged.

Another collaborator who was drawn into development was Mr Paul Wells, a counsellor and team leader of the Coventry Community Drug Team. He volunteered to help develop the information on drug misuse, and had adopted the present system for use by his team.

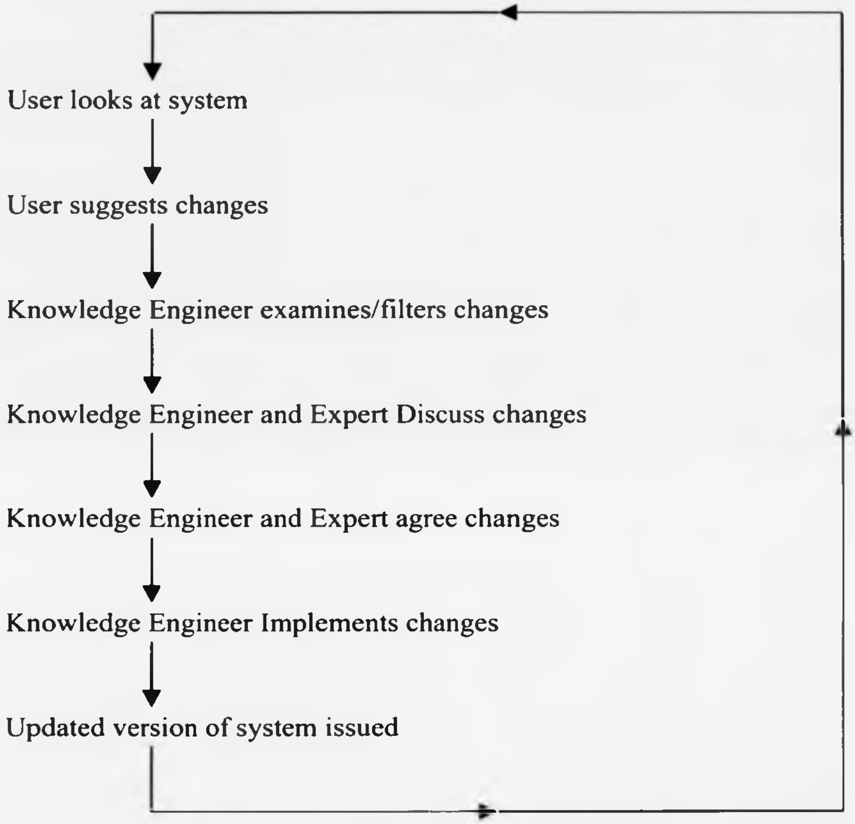


Figure 1.5

Reviewing/Implementing comments suggested by system users

1.6.6 Conclusions

The conclusions that were derived from the construction of the Expert Advisory System are not presented in detail here. This is because they are described in the next section (1.7) and reflect back on the lessons learnt and the problems encountered during the development of first the Expert System, then the Information System, and finally the Expert Advisory System.

The Expert Advisory System was built by incorporating into the Information System elements of representation and control drawn from the Expert System. This was only done in the clinical module of the complete system in the form of a differential diagnosis. This area was chosen because an enthusiastic and sympathetic expert was available, Dr Charles Farthing. The system was not developed any further than a prototype for two main reasons:

1) Models based on human reasoning are relatively time consuming.

2) Who is responsible for the information given by the system? Is it the experts who contribute their knowledge, the system designer who transcribes it, or the user who accepts the advice?

The problems of consistency and maintenance of the knowledge base identified in the Information System still remained. The diagnostic module merely added another layer to the Information System. The reports used still existed as text files and so altering a piece of information in one area was not met by a change of that information in all other areas. The knowledge base contained a large volume of information and many sections of this information needed updating regularly e.g. AIDS and HIV statistics in UK and abroad.

1.7 Conclusions

This chapter has described the development of computerised decision support systems for AIDS/HIV using an action research approach. This approach was maintained throughout the project, from its inception to its conclusions. New, updated versions of the prototype systems were sent to experts, collaborating users and organisations, and other interested groups, on a regular basis. Informal trials were carried out during the various development stages of the systems. Demonstrations were given to a wide range of audiences concerned with different aspects of AIDS/HIV.

These users, in turn, provided constant feedback which proved invaluable, determining the content and presentation of future versions of the systems. In the initial stages of this project, an Expert System approach was taken and this was later followed by an Information System approach. Finally, the concepts from both of these approaches were integrated in order to develop an Expert Advisory System for AIDS/HIV.

The Expert System approach was not successful because the diagnostic clinical system developed was very limited. Firstly, it only served a narrow user group, namely clinicians; and secondly, knowledge could only be accessed in a consultative mode. The Information System approach was received favourably and with enthusiasm by most user groups. This approach emphasised several positive features of a computerised information system:

1) It can provide a positive, interactive learning environment and thus provide a useful tool for educating children.

2) The detailed content of information and the speed of retrieval can assist telephone helplines in answering specific questions related to the information.

3) The anonymity provided by a computer is important with sensitive areas. With a personal subject like AIDS/HIV some people may not seek help and advice because they are afraid that others will not maintain confidentiality (Miller et al 1986).

4) It can accommodate different interests within a single framework.

5) It can accommodate enquirers with different levels of expertise.

6) It can provide a useful mechanism for experts to share specialist information with others.

There were also a number of deficiencies with the information system approach:

1) It cannot accommodate queries which require information that is not present explicitly because there is no capability for deduction.

2) There are problems of inconsistency and updatability because reports are pre-constructed and not produced dynamically.

3) It assumes a certain level of expertise from the user.

The Expert Advisory System was developed by using and integrating features of both the Expert System and the Information System. This new approach accommodated multiple types of user groups and multiple levels of expertise within each user group. Features derived from the Expert System helped the least experienced users; features derived from the Information System helped the most experienced users.

Some general lessons were learnt during the project about computerised decision support tools. In order for them to be accepted they need to be easy to learn and use, even for those with little or no previous experience of computers. The information content needs to be well structured and well presented.

One of the biggest problems encountered during the development of all three systems was the bottle-neck that occurred during knowledge acquisition. For example, this occurred during several three-weekly periods of stay at St Stephen's Hospital when working with Dr Charles Farthing. The stays were not longer because the developers of the system could not keep up with the knowledge that had been acquired and the changes demanded by the experts. This was frustrating for both the expert and the development team. Over 40 hours of tape recording had been made during the development of each of the Expert System and the Information System. The acquisition of knowledge is regarded as a major obstacle to success in building expert systems (Hayes-Roth et al 1983). This was confirmed during the development of all three systems for AIDS/HIV.

Although numerous trials were carried out with the computerised decision support tools, these were mostly in research and prototype environments. Before the Expert Advisory System could be used in an unsupervised and routine manner, several important issues needed to be investigated. These mainly concerned the responsibility of the knowledge contained in the system, maintenance and updates of the system and that of consensus with respect to certain advice.

The problem of consensus arises because different centres have their own procedures for certain situations and have different treatment regimes for particular diseases. An example of this is the use of different drugs by two centres for treating patients with the same condition.

It was suggested that an editorial board could be used to resolve these problems. The editorial board would ensure that the knowledge in the system was correct and be responsible for maintaining the system as well as sending regular updated versions of it to the subscribed users. This board would also tackle the problem of consensus by giving the user either one choice or a number of ranked alternatives.

The possibility of setting up an editorial board for the Expert Advisory System was investigated. The situation looked promising because the Terrence Higgins Trust and the National AIDS Helpline had agreed to form part of this editorial board. However, this never materialised and the idea was abandoned after no progress had been made for over a year. This was hardly surprising because of the enormous task involved, and the amount of finance, manpower and other resources required.

1.8 Anticipated Contribution of Thesis

The Community Drug Team (CDT) at Coventry had been using the AIDS/HIV Expert Advisory System during its development as one of the user-groups. Due to the nature of their services and the convenience of their location in relation to the ESDSU, regular contact had been established with them. The CDT had started receiving a large number of requests for information, advice and counselling related to AIDS/HIV, in particular how it affected them or their friends and relatives in relation to their drug use. Drug misusers were not regarded as being in the highest risk group with respect to contraction and transmission of AIDS/HIV.

The CDT suggested that the ESDSU should extend the current system by developing and integrating a drug misuse module. More importantly, they were willing to provide us with their expertise and also commit a significant amount of staff time to help towards the development. Most of the drug misusers in the U.K. are thought to be heterosexual and this means that infected drug misusers will provide a bridge for the transmission of the virus into the general heterosexual population via sexual activity. Therefore, vigorous preventative measures taken now will result in a better chance of stemming the spread of the virus.

Therefore, it was decided that an AIDS and Drug Misuse System should be developed. However, this system would be developed for a specific group (Coventry CDT) and would be designed for their operational use. This would have two main advantages: (a) the present system could be tested in a real-user environment in order to shed more light on its strengths and weaknesses both in general and with respect to the CDT's environment; (b) it would be easier to specify the requirements for one specific user-group.

In the past, the Expert Advisory System was not designed for any one specific user-group or organisation. Instead, to maintain flexibility, it attempted to cater for everyone, and thus the knowledge base was expanding with each request for inclusion of more topic areas. So, although it was a large system, it was of limited use to any one particular organisation because they were more likely to want extensive, detailed coverage on specific sections of the system rather than have numerous, large sections many of which they did not need at all.

Nevertheless, it was hoped that the new approach and concepts could later be generalised for other groups with similar needs and/or requiring similar information. It was also hoped that solutions could be found to some of the problems mentioned in the last section during this next stage of development.

Before any work was started on the development of the information system for drug misuse, the literature on information systems was reviewed. This was to examine the history of information systems, the different types of information systems, and the research methods which were being used for developing information systems. This is the subject of chapter 2.

By being aware of the past and current research practices as derived from the literature review, and using the experience gained during the development of the Expert Advisory System for AIDS/HIV, it was possible to clearly define the research project which would be based at the Coventry CDT. This is described in chapter 3, which emerges neatly from the first two chapters.

The contribution that this thesis makes is the concept of self knowledge elicitation as an approach to developing information systems. This concept emerged from the combination of (a) the work already described in this chapter and (b) during the early stages of the development of a drug misuse information system for Coventry CDT.

CHAPTER 2

A REVIEW OF INFORMATION SYSTEMS

"Ideas are as essential to progress

as a hub to a wheel

...for they form the centre around

which all things revolve."

2.1 Introduction

Over a century ago, the industrial revolution changed the way companies were run. The mechanisation of industry led to a reduced reliance on human strength to carry out production tasks, machines (run by humans) could do the same work with less effort. New forms of business organisation and methods of modern management were developed to take advantage of mechanisation.

We are now in an information revolution, and an organisation's success is a function of its information resources and how effectively it uses these to compete in today's dynamic environment. Management can make better and more informed decisions as they can access vast amount of data, use sophisticated models, process data in a more timely manner to control operations, communicate over world-wide networks to manage global enterprises, and even use the computer to make decisions. Given the value of information, it must be carefully acquired, managed and utilised like any other organisation asset.

We assimilate facts as an integral part of everyday life, either subconsciously or as part of a pre-planned sequence of events. **Data** can be defined as facts collected from measurements or observations about people, events or objects. Data in isolation has no real value or meaning, but by applying some form of processing, this can be achieved. The act of processing the data takes time and effort and therefore requires resources. To make this worthwhile, the data needs to be relevant and the processing needs to be *meaningful* so that value is added to the data via the act of processing to form a new product. This new product is known as **Information** (Clare and Loucopoulos 1986).

Information is the meaning or content of what we observe from the environment around us and is essentially intangible. However, for convenience and permanent storage, this information is often recorded in a tangible form such as this printed page. A system is a set of interrelated parts, and it is organised or defined for some purpose. Information systems are computer-assisted ways of dealing with information - they collect, store, process, communicate and display data as electric, magnetic or physical patterns. To the user, this data becomes information.

2.2 Evolution of Information Systems

Before the advent of the computer to process transactions, information systems consisted mainly of the manual processing of raw data into information, which was then used by managers in making decisions. Such systems included hand-written or typewritten reports, word of mouth, as well as the "grapevine". However, there did exist some mechanisation of clerical procedures during this period. Punched cards date back to the earliest years of the century.

The first commercial computer was developed in 1951 and it was later in the same year that computers started being used for processing data concerned with business and commercial functions. COBOL, a functional programming language, was developed specifically for that purpose. Initially, this technology was applied to problems that required regular, repetitive but fairly simple processing of large amounts of data. Such was the success of COBOL that it is still one of the most widely used vehicle for business information systems.

The first wave of commercial applications were the very clerical labour-intensive systems such as payroll, invoicing and stock control. All of these have the characteristic of simple processing of large amounts of data but there were also a number of other features that these and other early systems shared:

- The systems were self-contained and there was little thought for integration of various data processing systems. The users and system analysts tended to concentrate on the particular problem at hand. For example there is a natural link between invoicing and stock control via an overall order processing system. However, these not only tended to be developed entirely independent of each other, but the common data was often held in different file structures. This presented common problems of duplication and data integrity, leading to a waste of resources in such systems.

- The systems were file based and each separate system had its own file definition in its COBOL coding. If two systems needed to share the same data, the file description had to be written into the code of both systems in exactly the same way. Also, early systems used magnetic tape as the main backing storage, and were therefore restricted to sequential file organisation. In order to access a particular record in the file all preceding records had to be searched since the records had to be stored in sequence e.g. by part number, or in alphabetical order.

- The systems were restricted to batch processing of data at specific points during the working day or week, with no ability to use on-line real-time processing. This resulted in difficulties related to the currency of the information and its accessibility.

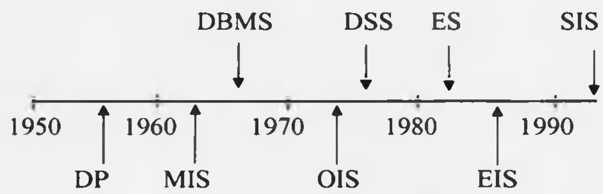
- The systems were centralised on either mainframes or minicomputers, which were normally located in the head office of the organisation. All data had to be sent to the central site for processing as today's data communication facilities were not available. The data had to be written to special forms and posted or despatched to the central site where data preparation clerks would type the data on to punched cards or directly to disk. This led to long delays between capture of data and production of information, and the extra sources of error via transcription and data preparation often proved problematic.

- The systems produced only scheduled reports - the only interface between the user and the computer was via the operations staff in the computer department. It was therefore not possible to make ad hoc requests for information from the system.

From Data Processing Systems to Information Systems

Despite the many limitations of early systems as discussed above, their use increased considerably during the 1960s, as did the power and speed of computers. Managers were able to process more operational data and use the resulting information more effectively. At this time management information systems (MIS) were developed, which produced reports that selected data relevant to decisions and summarised this information in a tabular form. The objective of data processing (also known as transaction processing) evolved into the conversion of data to information for MIS and other information systems.

Large amounts of data were stored on paper or on tape and card data files before the development of electronic databases. Database management systems (DBMS) were developed to manage data stored in a database around the same time (see figure 2.1).



DP :	Data Processing
TPS :	Transaction Processing System
MIS :	Management Information System
DBMS :	Data Base Management System
OIS :	Office Information System
DSS :	Decision Support System
ES :	Expert System
SIS :	Strategic Information System
EIS :	Executive Information System

Figure 2.1

Evolution of Information Systems

(Based on McKeown and Leitch 1993)

Clare and Stuteley (1995) have identified four major problem areas that early MISs suffered from:

- lack of appropriate technology
- inadequate underpinning DP systems
- changing needs of management
- unhelpful attitude of DP staff

Nowadays these problems have been largely addressed and MISs more closely meet users' needs, largely due to the fact that appropriate hardware, software and communications technology is now available. An MIS must be flexible enough to adapt to changes in the organisation. Also information must be relevant, accurate and timely if it is to be of any use.

Decision Support Systems (DSS) with their emphasis on supporting decisions rather than just packaging data into information, started to appear in the late 1970s. A DSS incorporates the reporting function of MIS, graphic displays, various modelling tools to further analyse the information as well as the problem-solving capabilities of management science. DSS took the concept of MIS one step further by enhancing the conceptual level at which information was presented to the end-user. It should be noted that the new emphasis on information processing did not imply a subsequent decline of data processing. Even today data processing systems form the core of most computer based systems in organisations and their importance has only increased over time.

Top-level executives found that the DSS did not always provide the information required. The development of Executive Information Systems (EIS) was possible with the proliferation of personal computers (PCs) in the middle 1980s. The PC-based EIS in linked to the company's primary computer and uses graphics extensively to display the information needed for executive decisions.

Strategic Information Systems (SIS) and Expert Systems (ES) are two more information systems that are important in organisations. An SIS enables an organisation to use information to create a competitive advantage in a number of ways: reducing costs, differentiating products, linking the customer with the company's information system, adding value to the company's product. In many cases, information that is already available to the company as a result of information processing can be used as a competitive weapon. A manager with vision will see how the information can be used most effectively. An ES provides workers at all levels with the knowledge and expertise needed to do their jobs better and these systems are discussed in more detail later in this chapter.

While DP, MIS, DSS and EIS were all developed from the original data processing function, office automation was also taking place, i.e. the jobs of clerks, typists, secretaries and other professionals were irrevocably being altered. This process started in the late 1950s with the introduction of electric typewriters and continued in the late 1970s with word processors. However it was not until the early 1980s that the most dramatic and significant changes took place. This is when the arrival of PC coincided with the rapid development of telephone and communication technology. The PC and its related systems join network software and communication devices (e.g. fax machine) to yield an Office Information System (OIS).

There are certain necessary characteristics of information that must be present if it is to be of assistance to the user or decision maker. The most important of these are that information should be:

- relevant
- accurate
- timely
- complete
- verifiable

The role of management is to plan, organise, staff, direct and control the activities of an organisation. Managers need many types and kinds of information to accomplish these tasks. As a result, information systems are extremely important to the efficient management of any organisation. It is necessary to look at an organisation's level of management in order to fully understand the various information systems within an organisation and how they meet management requirements. Table 2.1 shows a company's management levels classified as strategic, tactical and operational, and how these levels involve different types of activity and as a result require different types of information.

Activity Level	Management Level	Type of Information
Strategic	Top	Less detailed explanations and predictions based on external and historical data for strategic planning
Tactical	Middle	Summarised and timely information involving compliance with plans and policies
Operational	Lower	Very timely detailed, accurate, and internally generated information on day-to-day activities.

Table 2.1

Management Activities and Types of Information

(McKeown and Leitch 1993)

The next section gives a brief account of the functionality and scope of early computer-based information systems, in order to see the basis from which today's categories of information systems developed. The different categories of information system that are found in organisations appear under various names and some of the more important and relevant to this thesis are discussed later in this chapter.

2.3 Different categories of information systems

2.3.1 Database systems

Database systems, represent a complex and evolving discipline. They originated from computer programmers who wanted a simple way of handling their program data. Often, specialised programs were developed to manage this data. The limitations of early computers made data handling and manipulation very difficult but subsequent advances in computing technology have produced ever greater storage capabilities with the transition from punched cards to disks, magnetic tapes, and optical media.

Databases are the basic corporate information source and multi personal computer users need to be able to share a lot of the same accurate, consistent, up-to-date information efficiently and securely. Data management includes all the activities that ensure that high-quality data is available to produce valuable information and knowledge. Data management responsibilities have been discussed by Vasta (1985) and include:

- The representation, storage, and organisation of data so that it can be selectively and efficiently accessed;
- The manipulation and representation of data so that it can effectively support the user environment;
- The protection of data so that it can retain its value.

A database management system (DBMS) is a tool for implementing effective data management. In the 1980's, software for data management on PCs had been constrained by the 8088/DOS environment with its 640K bytes Random Access Memory (RAM) and 32 megabytes disk limitations, single-user and single-tasking capabilities, and relatively sluggish processing speed and disk access. However, with the advent of the 80286 processor in the late 1980's, enhancements and ways to work around their limitations were devised (Pascal 1989). It should be noted that multi-tasking and multi-user capabilities were available on workstations as well as mini and mainframe computers as early as the 1970's.

In the last seven years, there has been considerable advances in both hardware and software. On the hardware side, the launch of the 80386, the 80486, the pentium, and more recently the pentium II and Pentium III processors have changed the way data is managed in organisations. Windows based operating system software allow multi-user and multi-tasking capabilities.

The functionality of DBMS rests on a well-established technology which consists of methods for structuring and organising data. If data is to be useful it is important to ensure that it is organised. In a database, data models are used to specify how separate pieces of information are related. This information is divided into data structures, the most basic of these being records and fields. Many data models have been proposed for organising data records - the hierarchical model, the network model, the relational model, the entity-relationship data model, and the semantic data model amongst others. The relational model is by far the most popular because of its theoretical purity and its close relationship to logic.

The Relational Model

Large databases were stored mainly on mainframes and the network and hierarchical models dominated database applications until the mid-1970s, when the relational model began to gain acceptance. Mathematician E. F. Codd developed a relational theory of data which he proposed as a universal foundation for database systems (Codd 1970). His relational model was based on the set mathematics of relations and first-order predicate logic. It covered the three important aspects that any DBMS must address: structure, integrity and manipulation.

The first working version of the relational model was implemented by IBM in their System/R (Astraham et al 1976) which is a system that is still prominent today. Commercial relational DBMS began to appear in the early 1980s with the proliferation of personal computers. Examples of these include dBASE, Foxpro, Paradox and rBASE.

A relational DBMS presents databases to the user as collections of tables. These tables must have unique rows and their cells must be single-valued. Each row in a relation represents a relationship between a set of values. The relational model is based on this simple conceptual model which is the main reason for its acceptance and popularity.

The relational model has been summarised by Parsaye et al (1989) as follows:

> *"A relational database consists of tables. Each table bears the name of a relation and contains rows and columns. We can define a relation scheme as the set of attribute names for a relation. New tables can be constructed from these tables by cutting and pasting rows and columns from the existing tables. The process of constructing new tables in the relational model is governed by the operations of the relational algebra."*

The order of the columns becomes unimportant once attribute names are attached to them. Operations on this relational database consist of cutting and pasting portions of the existing tables to create new relational tables that satisfy certain criteria.

SQL

SQL (Structured Query Language) is the only concrete expression of the relational model that has gained industry acceptance. IBM developed the first version of SEQUEL (Structured English Query Language) in the mid-1970s at the company's San Jose research centre as part of a prototype relational database system, SEQUEL-XRM. A second version, SEQUEL/2, followed a couple of years later as the command language for IBM's System/R relational database prototype.

The first commercial database system, Oracle, appeared in 1979 from Relational Software (now known as Oracle Corporation) who actually beat IBM to market with SQL. However, IBM soon brought out its own products with first SQL/DS for DOS/VSE mainframes and then DB2 for MVS systems. Today, over 100 vendors offer versions of SQL and microcomputer implementations include IBM's OS/2 Extended Edition Database Manager, Oracle Corporation's Oracle, Relational Technology's INGRES, the Sybase/Microsoft/Borland International SQL Server, the SQL Component of dBASE, and Gupta Technologies' SQLBase.

These systems and others attempt to follow a SQL standard that the X3H2 Database Committee of ANSI started developing in 1982. These standards, which were very similar to IBM's DB2 dialect of SQL, were ratified in 1986 by ANSI. Subsequently, SQL has also been adopted as a standard by the International Standards Organisation, the Open Software Foundation, X/Open, and Federal Information Processing Standards.

It is important to note that SQL is a language for interacting with relational databases and is not a full application development language. This has three main advantages (Pascal 1989):

1) It keeps the well-defined, set-oriented database foundation distinct form the less precise, procedural character of existing programming languages;

2) It avoids creating yet another general-purpose language that, by trying to be everything to everybody, becomes too complex to master and invites compromises;

3) It eschews the lengthy political process that would be required to extend standard procedural languages such as COBOL and FORTRAN with relational database functions.

2.3.2 Management Information Systems

A Management Information System (MIS) has been defined by Davis and Olson (1985) as an integrated user-machine system for providing information to support operations, management and decision-making functions in an organisation. This definition emphasises support, because the purpose of MIS is to provide information that is accurate, relevant and timely in order to provide support for operational, tactical and strategic decision making.

The MIS needs to be flexible and adaptable. The MIS can be thought of as a form of model of the organisation because the decisions made all directly relate to the function of the various parts of the organisation. The organisation itself operates in the constantly changing real world of business and commerce. Therefore the organisation must adapt to this changing environment in order to remain successful in whatever its sphere of business.

The issue of relevance, timeliness and accuracy of information in the context of it supporting decision making at all levels in the organisation was discussed earlier in this chapter. The MIS must display the same characteristics in its delivery if it is to remain of use, i.e. it has to deliver the right information in the right place at the right time. The MIS should deliver information to all levels of management that need it and in all the units of the organisation.

Since all MIS's are driven by operational data processing systems, the systems that support the day-to-day operations of the organisation (e.g. order processing, payroll, financial accounting system) provide the basic data for the MIS to process. The way in which the MIS can be configured can vary. One way is to build the MIS directly onto an operational system, where it directly shares the database, competing with the operational requests for access, ensuring that the data accessed is as up to date as possible. This method is probably the most efficient arrangement as long as the operational systems are properly integrated and there are no resource constraints on the hardware, software or communications that would cause the MIS to slow down the operational system or vice versa.

Another method is to build the MIS as a physically separate system from the operational system. It would still have to be provided with access to the operational database, but this can be achieved by periodic transfer of data from the operational system to the MIS. The advantages of this method are that the MIS does not interfere with the smooth running of the operational system, and only the data specifically required by the MIS can be extracted from the operational system, leaving the irrelevant data behind. The disadvantage is that the data can become out of date if the inter-transfer periods become too long. This needs to be considered at the design stage.

Distributed MISs usually provide the most flexible solution to management information problems. The key feature of such a system is that the database is subdivided and located on machines usually at different sites in the organisation, linked via a computer network. The subdivision may be on the basis of information needs, or on geographical locations. The major advantage with distributed systems is that the data is actually processed where it is captured and where it is needed.

2.3.3 Decision Support Systems

The lack of timely information and the inability of the manager to test the effect of a decision using MIS led to the development of decision Support Systems (DSS). The objective of DSS is to allow the manager to find answers to questions and to make better decisions with quantitative and graphical models. Sprague and Carlson (1982) have defined DSS as *"computer based systems that help decision makers confront ill-structured problems through direct interaction with data and analysis models."* These problems tend to be more prevalent at the tactical and strategic levels than at the operational level in an organisation.

Figure 2.2 shows the components of a DSS - a data base, a model base and an user interface. The data base provides the data used in the models that are contained in the model base, and the user interface handles the interaction between the system and the user. The heart of the DSS is usually relational database and query language.

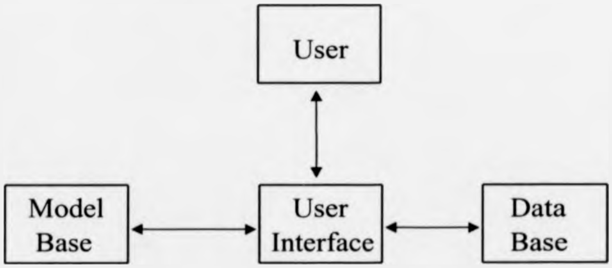


Figure 2.2

Components of a Decision Support System

A DSS can be as simple as an electronic spreadsheet on a PC or as powerful as specifically designed software on a mainframe. Most users of DSS can best be described as occasional users, in that they do not spend the majority of their working day on the DSS. It is therefore important that the DSS has an easy to use (user-friendly) user-interface. Not only are the users bound to be categorised as occasional as a result of the requirements of their job, but the unstructured nature of their tasks themselves precludes the use of rigid screen designs or complicated command sequences. Most contemporary DSS use either a menu system or a windows environment with icons and a pointing device such as a mouse.

A major requirement in the solution of unstructured problems is a ability to vary some of the parameters of the problem to see the effects on the solution, i.e. the accommodation of 'what if?' questions through sensitivity analysis. The model in the DSS must represent the physical, economic, or financial situation being studied. A model is a simplified version of reality that describes the interrelationships between important variables in a particular environment, and these include optimisation, forecasting and simulation models. Optimisation models seek to find the 'best' solution to a problem, forecasting models try to predict the future based on current data, and simulation models replicate many years' results in just a few seconds of processing.

Another important feature that the DSS must process is a fast response to requests or commands that are input to the system. It is also essential that the DSS has the ability to present the results of its processing in graphical form. DSS are often used as part of strategic or tactical planning or decision making and there is often the requirement for the user to be able to present complex information quickly and concisely. Such simple presentation of complex information is also a requirement in the production of business reports and prospectuses.

2.3.4 Executive Information Systems

The major users of the DSS tend to be middle-level managers, as they are most concerned with the specific problems involving their unit of the organisation. DSS does not always provide top-level executives with the type of information they need, and as a result, Executive Information Systems (EIS) have been developed. These are clearly aimed at the strategic level of planning and decision making, where top level executives must take a global view of the organisation.

EIS share many of the features of DSS discussed earlier : the ease of use; the fast response and the ability to generate graphical output. Executives are always short of time and therefore the ease of use feature in their EIS is very important, as well as the needed information being in a form which is easy to understand. These systems are usually built on relational database systems accessed indirectly through a query language, and they access the corporate databases. It is essential for EIS to extend the query facilities found in DSS because strategic planning involves the consideration of alternative scenarios or views of the future.

There are additional features that are desirable in an EIS. Strategic planning involves looking at corporate-wide plans and decisions in a particular future environment, and to do this the planner needs high-level information. A particular aspect of the company's activities may be affected by a change in that particular environment and the user will wish to investigate these effects in greater detail. In order to do this it is necessary to be able to look at the information relating to that aspect of the operation from a different perspective or in greater detail.

A SWOT (Strengths, Weaknesses, Opportunities, Threats) analysis is an important part of the strategic planning process. Analysis of strengths and weaknesses within the company requires an honest look at the current and likely future internal environment of the organisation, and requires exclusively internal data and information. Analysis of opportunities and threats presented by the external environment under a number of possible scenarios requires access to data and information that is outside the normal operational and planning scope of the organisation.

In order to meet these needs in an EIS, the appropriate non-company or external data has to be captured. Two main problems with this are that it can be expensive through usage and subscription charges and the way data is provided and maintained by a third party. The accuracy and integrity of the external data has to be taken on trust although many important decisions will be based on this data. Non-company data can fall into a number of categories:

- Economic information
- Competitor information
- Marketing information
- Legal and Political information
- Other information such as environmental and energy policies

All systems of quality management and control require performance measurement. Such key performance indicators need to be regularly monitored and corrective action needs to be taken if they are to be of any use. This monitoring can be built directly into the EIS by processing both internal and external data. Reporting can be either scheduled or by exception. In the event of perceived failures, the user can have the facility to take alternative information views or increase the level of detail.

It is difficult to generalise on the configuration of EIS as there are no hard or fast rules over their precise nature and function. Usually the EIS combines the power and storage capabilities of the PC. Information is usually transferred to the PC from the Mainframe or from external data bases. The user then uses some type of pointing device (e.g. a mouse) to select from a menu of results and presentation modes. Output is often in graphics form or in a combination of graphics and tables. It is important that the system presents information the way the executive thinks about the problem, otherwise he or she will be uncomfortable with the EIS and probably not use it. Today, state-of-the-art systems provide the required EIS using the Company's data base and other sources, and which support graphic as well as tabular presentations that can be made an integral part of a report.

2.3.5 Expert Systems

2.3.5.1 Introduction

There is considerable confusion in the terminology used to describe expert systems and knowledge systems because some differentiate between the two terms while others use them interchangeably. Expert systems normally refer to the kinds of systems that perform in a similar manner to human experts, while knowledge systems to those that perform simpler tasks that normally require human intelligence, though not expertise (Morris 1987). Expert systems mimic human problem solving behaviour by incorporating facts and heuristics knowledge engineered from real experts. Knowledge systems are based on facts and information collected from textual material and they usually provide electronic means to store, distribute, reason about and apply knowledge (Hayes-Roth 1984).

There are probably as many definitions of expert systems as there are researchers in this field. The Expert System Specialist Group of the British Computer Society provide a definition which is widely accepted:

> *"An expert system is regarded as the embodiment within a computer of a knowledge-based component from an expert skill in such a form that the system can offer intelligent advice or take an intelligent decision about a processing function. A desirable additional characteristic, which many would consider fundamental, is the capability of the system, on demand, to justify its own line of reasoning in a manner directly intelligible to the enquirer."*

An expert system can be regarded as the most typical application of knowledge based systems. Expert systems arose from a research program that began with the development of the Dendral system in the 1960s (Lindsay et al 1980). This dealt with the identification of chemical compounds from mass spectrometry data and this led to the acceptance that much of expertise could be generally captured in terms of highly specific domain knowledge expressed in terms of "rules of thumb" (Parsaye et al 1989).

The best known example of an expert system is MYCIN and, in fact, expert systems sprang into prominence with the success of this System and XCON (originally known as R1). The development of expert systems shells simplified the process of building the knowledge bases and inference engines required by expert systems. In the past, the embodiment of expert systems as stand-alone software environments has slowed their integration into other application environments like databases.

Parsaye et al (1989) have identified the three most prominent features of early expert systems:

1) their application to classification tasks such as medical diagnosis;

2) their embodiment as a stand-alone "pseudoexpert" that offered consultative advice; and

3) their limited availability on expensive LISP-based hardware and software platforms.

2.3.5.2 Structure of an Expert System

There are three main parts which make up an expert system - the human interface, the inference engine and the knowledge base. There are also three important roles which are involved in interacting with an expert system - the expert, the knowledge engineer and the end-user. This structure is shown in figure 2.3 (Edwards 1991).

2.3.5.3 Roles of Expert Systems

An expert system can act as assistant, second opinion, expert consultant, tutor or automaton, and these roles are outlined below.

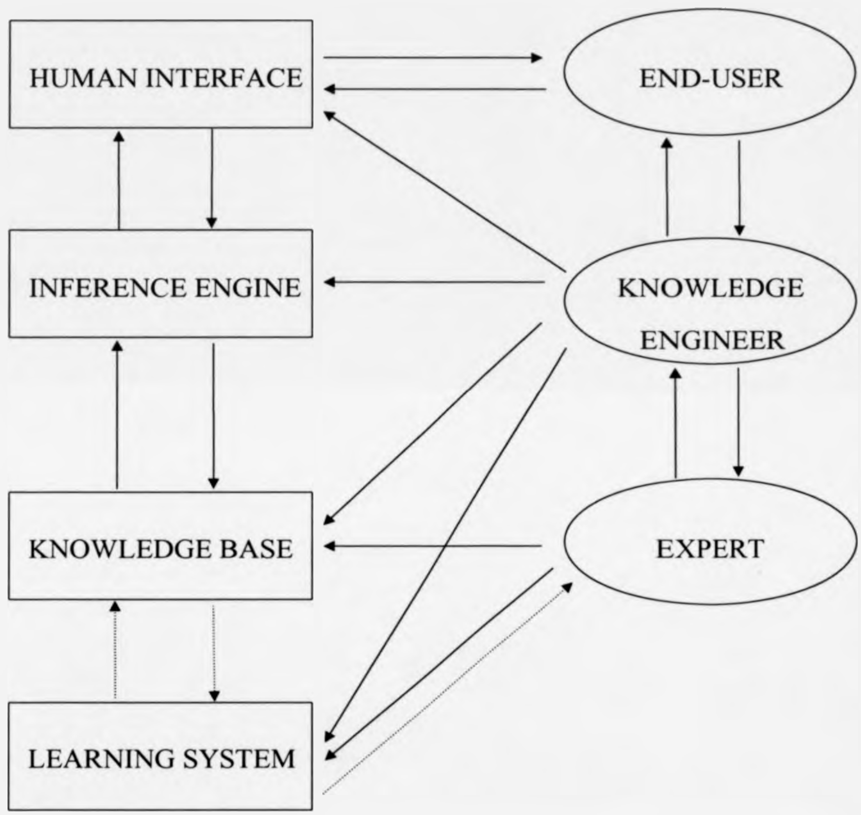


Figure 2.3

The Structure of an Expert System

Expert System as Assistant

The UK Department of Health's Performance Indicator Analyst is an assistant-style expert system, i.e. it is invoked by the user to perform a specific task as part of a wider exercise. Developed by Coopers and Lybrand using the expert system shell Crystal, it is used to look at the performance of a district health authority. This task is only part of the job of the person using it, who will usually be either an employee of the district concerned or the parent regional health authority.

Expert System as Critic

NOEMIE is an expert system which operates as critic, i.e. reviews work already completed and comments on accuracy, consistency and completeness. It is a computer configuring system and was developed by Arthur Anderson for Honeywell Bull (it's name at the time) in France. One of the options in NOEMIE is to validate configurations which were not originally generated with NOEMIE. Another feature of NOEMIE is that the user can add, delete or edit elements of any configuration produced, and then the system validates any changes automatically. An expert system in this role is the least common of the six roles described here.

Expert System as Second Opinion

In this role, the system executes task and compares its results with those of the user, sometimes critiquing the user's choice. An example of this role is the Market Training System, which carries out technical analysis of market indices and signals when the market is about to go up or down. It was developed by Criterion Software and is available in the UK and Europe from Financia Ltd. This system can track more indices than an experienced technical analyst but it does not have the same access to informal sources of information.

Expert System as Expert Consultant

This is by far the most common role, offering advice or an opinion based on information given by the user. VATIA, Stockmaster and Polapres (discussed below in section 2.3.5.7) are just a few examples of this classical model of an expert system.

Expert System as Tutor

These types of expert systems are designed to operate primarily as tutoring systems. An example of this role is the PC-based betting shop manager training system, developed jointly by Ladbroke's and Kingston College of Further Education. This system, which was written in LPA's Prolog Professional, trained betting shop managers in the calculation of the customer's winnings.

Expert System as Automaton

This is the second most common role, and is one in which the system completes tasks automatically and independently of the user. A successful example is Linkman, a knowledge-based real-time process control packag running on a DEC mini-computer or MicroVAX. It was developed originally for the control of temperature of cement kilns at Blue Circle Cement, but has been sold to several other companies both inside and outside the cement industry.

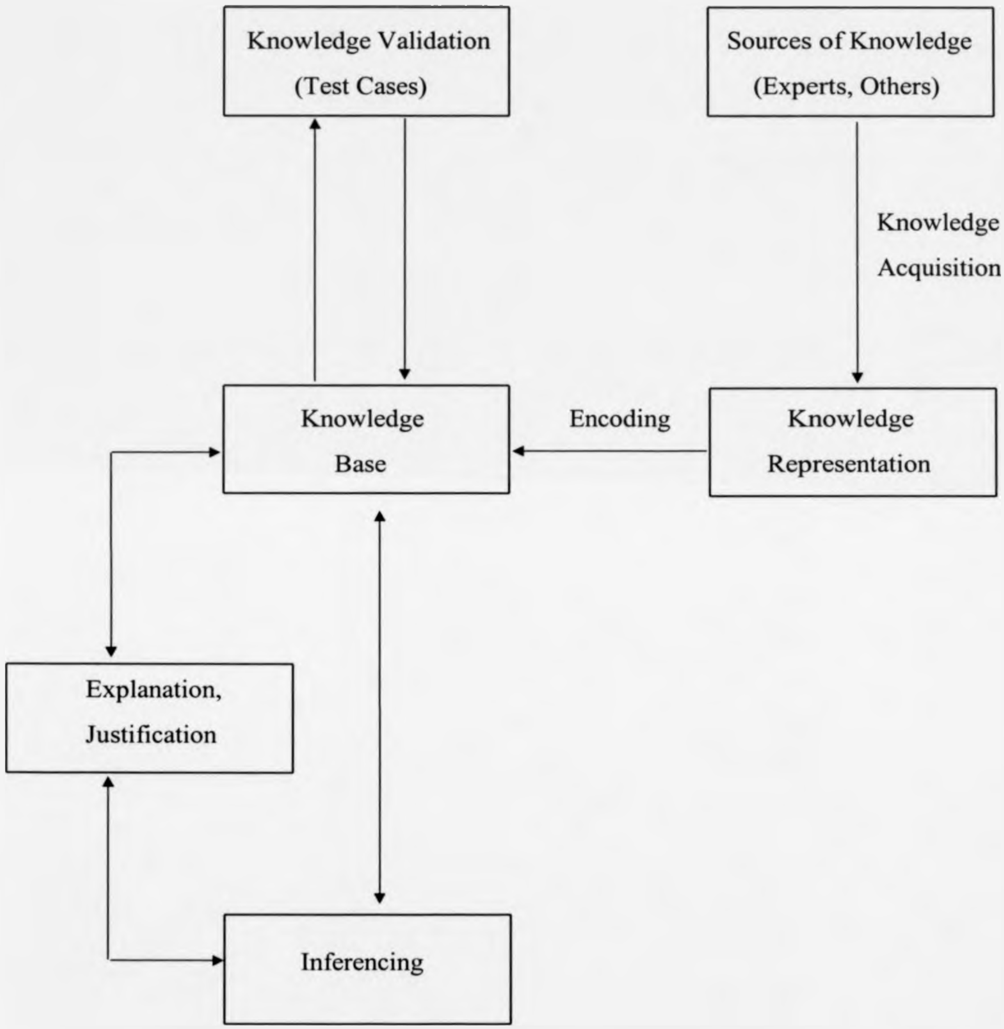


Figure 2.4

Process of Knowledge Engineering

2.3.5.4 Knowledge Engineering

The process of knowledge engineering includes five main activities: knowledge acquisition; knowledge validation; knowledge representation; inference; explanation and justification. The inter-relationship among these activities is shown in figure 2.4, and each one of these activities is described below.

Knowledge Acquisition

Before an expert system can be constructed, it is necessary to obtain a source of expert knowledge. For most applications this will mean a human expert who is willing to share his experience and expertise is required. Experts are not part of the project development team and therefore they have no prior knowledge of the techniques of expert systems. One or more members of the project team are usually appointed to perform the role which a system analyst plays in information system development. In expert systems terminology, the person who is responsible for eliciting knowledge from an expert for use with an expert system is termed a 'knowledge engineer', and the process of acquiring the knowledge is known as 'knowledge elicitation'.

The programmer could act as the knowledge engineer provided he has the required skills. Experts should not be their own knowledge engineers for three main reasons (Hart 1986):

- they will usually have insufficient knowledge about programming and expert system techniques,
- they will find it difficult to describe their knowledge adequately,

- they will have very poor perceptions of the user's needs, and sometimes little empathy for them.

The aim of knowledge acquisition is to specify a body of knowledge which is as complete, consistent and correct as possible (Fox et al 1985). Knowledge acquisition techniques have been documented in detail by Wellbank (1983). Some regard the acquisition of knowledge as the major obstacle to success in building expert systems (Hayes-Roth et al 1983), while others think that it offers few insurmountable problems (Mulsant and Servan-Schreiber 1984).

To date there have been many different approaches and techniques that have been used for knowledge acquisition. Whatever method is adopted, it is always necessary to further extend and refine the knowledge base as the development of the system progresses through different stages. The majority of knowledge acquisition techniques fall into six main groups and these are outlined below.

Informal interviews

Experts in the appropriate subject domain are interviewed by the knowledge engineer. The engineer is then responsible for reformulating the expert's statements into some sort of representation for use with the expert system being constructed.

Protocol analysis or transcription

This is a similar technique to the first one because the experts give running commentaries as they are performing their expert tasks. These are recorded and then substantive material is extracted and reformulated by the knowledge engineer as with the informal interviews method.

Computer-interactive techniques

This is the use of programs which have been developed specifically to help with knowledge acquisition directly. Examples of this include EMYCIN which evolved from MYCIN (see section 2.3.5.7), EXPERT which followed from CASNET (Weiss and Kulikowski 1979), and CSRL from MDX (Bylander et al 1983) which is another example of a system being developed from an earlier expert system. These and other programs using this technique help to maintain completeness and consistency in the knowledge base (Davis 1979).

Automatic Induction

This method relies on the principle that general rules can be derived from specific examples and case data. Programs are often written to assist in this task and this technique has been used to develop a number of diagnostic systems (Michalski 1980).

Heuristic search

Systematic patterns in the data contained in large databases can be identified by using this technique. One way of doing this is to combine statistical correlation methods with knowledge-based techniques (Fox et al 1985). The heuristic search method has been used in epidemiology by Blum (1982) in his RX project.

Consensus techniques

In this method a group of experts (usually all present at one location) are used to find the combined view on each area of knowledge or expertise. A good example of this approach is the Delphi technique (Linstone and Turoff 1975) where a situation is presented to a number of experts for their individual comments. All the responses are collated and given to each expert for further comments and feedback. This process continues until a unified view of the situation being considered emerges.

Knowledge Validation

The knowledge is validated and verified until its quality is acceptable by those involved. Using test cases is a common way of validating a system.

Knowledge Representation

There are a number of ways to represent knowledge in an expert system. The most common of these is in the form of rules, which are structured as

IF <condition> THEN <conclusion>

In a knowledge-base about AIDS/HIV (Acquired Immune Deficiency Syndrome / Human Immunodeficiency Virus) and drug misuse, one of the rules might be:

IF the client injects drugs
AND he is sharing injecting equipment
THEN the client is at a high risk of acquiring HIV infection

Other forms of knowledge representation are frames and semantic nets, both of which are in tune with the object-oriented approach to building computer systems.

Inference

This involves the design of software that will enable the system to make inferences based on the knowledge, and then provide the required advice to the user.

Explanation and Justification

This activity involves design and programming the ability to answer questions like why a specific piece of information is needed by the system or how a certain conclusion was reached.

2.3.5.5 Difficulties in Building Expert Systems

Companies can encounter several types of difficulties when trying to apply expert system technology to their problems. Scarce resources make it difficult to put together a competent development team. Another difficulty is the limitations of expert system - they are not good at:

- representing temporal knowledge
- representing spatial knowledge
- performing common sense reasoning
- recognising the limits of their ability
- handling inconsistent knowledge

Expert-system-building tools have certain limitations that affect system design and development. Some of these have been identified by Waterman (1986):

> *"Expert systems are not good at: performing knowledge acquisition; refining knowledge bases; or handling mixed representation schemes."*

2.3.5.6 Expert System Shells

An expert system shell software package or a more general-purpose programming language are the two principal alternatives for developing expert systems. Shells are empty of any specific domain knowledge and many of them have been developed out of the software used to develop specific applications. There are numerous shells on the market and these products can be differentiated by the problems that they address. Many of these concentrate on the run-time capabilities and thus address the provision of 'performance programs'; others address the problems of knowledge-base run-time capabilities.

Expert system shells enable rapid prototyping and provide good tracing, justification and other run-time support, but these need to be matched to the representational needs. The developer does not have to concern himself with providing the inference strategy or run-time support. Run-time facilities usually include the following (Black 1986):

1) Amplification of the meaning of a question. (The text for this has to have been inserted into the knowledge base by the developer);

2) Provision for the user to change previous answers to a question and have the impact of the new answer propagated through the previously derived conclusions;

3) Provision for the user to volunteer answers to questions before they are asked. Normally this is implemented by the user typing an option letter and then having a numbered list of questions presented for selection. In the future, systems with a natural language interface will enable such a 'mixed initiative' dialogue to take place more naturally;

4) Inspection of the working database, to allow the user to see the answers previously given and derived values for other goals;

5) Justification. This may be provided at any stage, where the user effectively asks, "Why am I being asked this question?" On-demand justification usually operates recursively so that the complete line of reasoning can be traced. Alternatively, some shells provide a post-consultation trace of the line of reasoning.

For many applications, an artificial programming language like Prolog or LISP has to be used instead of a shell to provide a more flexible tool. Shells do have their limitations and one of the major ones is the lack of a powerful representation formalism. Many of them are equivalent to programming languages supporting only Boolean and numeric variables.

2.3.5.7 Examples of Expert Systems

Three of the more prominent early expert systems were MYCIN, PROSPECTOR AND XCON. The more recent ones are VATIA, Stockmaster, Polapres and GATES. All seven of these are described briefly in this section.

MYCIN

MYCIN was developed by Shortliffe at Stanford University in the early 1970s. This system diagnoses bacterial blood infections and recommends appropriate drug treatment (Shortliffe 1976). It uses over four hundred "IF <condition> THEN <action>" statements known as production rules. One of its features is the ability to handle unreliable or uncertain data in a way not possible with conventional programming techniques.

A typical MYCIN consultation begins with a request for the basic patient data. Then, it asks about infections at individual sites in the body, then cultures taken from those sites, and ultimately about the shape and other observable characteristics of the individual organisms found in those cultures (Black 1986).

Initially, MYCIN was used to assist the physician but then it was found to be more useful in the training field. EMYCIN (Empty MYCIN) was developed by removing the specialised knowledge base from MYCIN, and this system has been applied to many other medical and non-medical domains.

Other developments of MYCIN include:

TEIRESIAS (Davis 1982) - an interactive interface to help in knowledge acquisition;

NEOMYCIN (Clancey 1981) - a tutorial version of MYCIN;

GUIDON (Bramer 1982) - another tutorial type version of MYCIN;

PUFF (Aikins et al 1983) - an aid to diagnose pulmonary diseases.

PROSPECTOR

PROSPECTOR's expertise lies in exploration geology - it is used as an aid to geologists in assessing the feasibility of a given region for exploration of various types of oil deposits (Gaschnig 1982). The system asks the user to give details of the rocks and minerals present in the region being considered and then it enters into an interactive dialogue to obtain further information. The original system can only be used by a geologist because the input required by PROSPECTOR includes details of the visible landforms, the exposed rocks and their appearance and texture. However, many shells are being marketed successfully based on the features of this system.

XCON (R1)

XCON, originally called R1, is the best publicised, most commercially successful, operational knowledge-based system. It used by Digital Equipment Corporation (DEC). XCON's application is the configuration of VAX computers, which are not delivered as a standard package. These computers are typically sold with a specific configuration of input, output and storage devices, processor power, main memory and software depending on the customer's requirements (Black 1986). The system will supply the user with a detailed list, floor plan, cable layout and cabinet arrangement which best fit the order (Morris 1987). XCON is very accurate and it can handle more than four times the number of orders than would be possible without it.

XCON does not operate as an interactive dialogue but requires all the data beforehand, and this is now handled by 'XSEL - expert selling consultant'. The rules in the knowledge base of XCON are processed in a data-driven strategy.

In 1980, R1 had a database of 420 components and a knowledge-base of 772 rules. By 1986 XCON had grown to a database of 10,000 components and a knowledge base of 4,000 rules. DEC's executive responsible for the original R1 project, Dennis O'Connor, was quoted in 1987 as claiming that XCON had saved his company $40 million in that year. Much of this is accounted for by the belief that it would have been impossible for DEC to have continued its policy of tailoring systems to customer requirements without the existence of XCON (Edwards 1991).

VATIA

VATIA is a system to help general auditors to assess the adequacy and compliance with legislation of client's Value Added Tax (VAT) systems and procedures. It was developed in the UK by Ernst and Whinney (now part of Ernst and Young) using the expert system shell Crystal. Although the auditors have some knowledge of VAT, they are not experts in the field; the expertise was provided by Ernst and Whinney's VAT specialists. VATIA was installed on all portable micro-computers used on audit assignments and approximately 600 copies had been installed by May 1988.

STOCKMASTER

Stockmaster was developed using a rule induction shell SuperExpert by two Swedish companies Novacast Expert Systems AB and Traversum AB, the latter specialises in the stock market. This expert system evaluates an individual stock or future with a view to a recommendation to buy, hold or sell. It has been in daily use by Traversum AB since January 1987.

POLAPRES

Polapres is a PC-based expert system developed using Texas Instruments' expert system shell Personal Consultant Plus. It was developed in Luxembourg by a steel-making company, Metallurgique et Miniere de Rodange-Athus (MMRA). The system diagnoses faults in the process of rolling, in which heated ignots of steel are passed through cylindrical presses. It was originally developed to preserve the expertise of the principal rolling expert at MMRA (who was due to retire), and to reduce the number of calls on the experts during the night shift. It has more than repaid the development cost of $235000 as it has been in use since June 1987 by the manufacturing foreman. This high figure for a PC-based system includes the considerable amount of work needed to produce the original non-expert system record of all the defects which might arise during steel rolling.

GATES

Gates is another PC-based system, developed for the US airline TWA to help in gate management at John F. Kennedy airport in New York. It was written in Turbo Prolog and it is used by airport ground controllers. Although it was originally used to produce quarterly gate schedules, a daily scheduling version followed later.

2.3.6 Intelligent Databases

Intelligent databases can be defined as databases that manage information in a natural way, making that information easy to store, access and use. By using intelligent databases users can perform tasks involving large amounts of information that would otherwise not be possible.

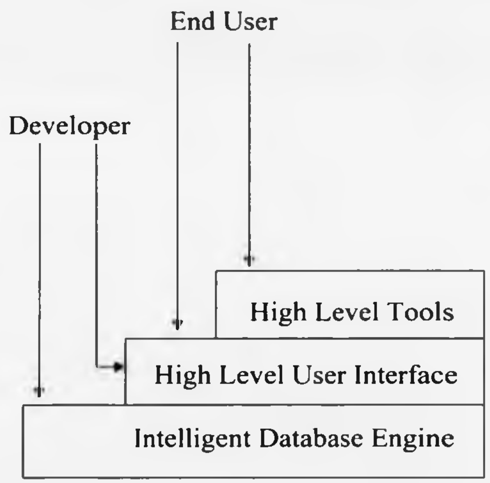


Figure 2.5
Three levels of database intelligence.

Parsaye et al (1989) have defined three levels of database intelligence and these are also illustrated in figure 2.5:

i) **Intelligence of the high-level tools provided by the database** - these tools provide the user with a number of facilities such as intelligent search, data quality and integrity control, and automated discovery;

ii) **Intelligence at the user-interface level** - this is the level that users directly interact with and is therefore very important;

iii) **Intelligence of the underlying database engine** - this is the base level of the system and it incorporates a model that allows for a deductive representation of information that can be expressed and operated on in a variety of ways.

Intelligent databases have evolved from the integration of traditional databases with more recent fields like expert systems. Intelligent databases, therefore, represent a new technology for information management, catering to the needs of the user for information that is relevant, easy to obtain and helpful in making decisions.

To achieve these objectives, intelligent databases should :

- Provide high-level intelligent tools that provide new insights into the contents of a database by extracting knowledge from data;
- Make information available to larger numbers of people because more people can utilise the system due to its ease of use;
- Improve the decision-making process involved in using information after it has been retrieved by using high-level information models (from this perspective, intelligent databases serve as decision support systems);

- Interrelate information from different sources using different media (e.g. images, text, numbers) so that the information is more easily absorbed and utilised by the user;

- Use knowledge and inference, making it easier to retrieve, view and make decisions with information.

There is a problem of information glut and the solution lies in the development of intelligent databases (Parsaye et al (1989):

> *"...the essential characteristics of an intelligent database are that it is easy and natural to use, can handle large amounts of information in a seamless and transparent fashion, and that it allows people to carry out their tasks using an appropriate set of information management tools. Such information management tools are essential in a world of information glut where the capability to store massive amounts of information exceeds our capability to effectively retrieve that information."*

It was not until the late 1980's that the construction of intelligent databases became possible with advances in information technology e.g. the removal of memory limitations in mass storage and the ability to create networks of computers. Knowledge based systems enhance the dynamism of databases because they provide the capability to reason and infer new information. Intelligent databases are more easily linked to human intelligence due to the intelligent processes that they embody.

2.4 Research Approaches in Information Systems

Information systems is a field which spans a range of disciplines including philosophy, organisational and behavioural sciences, mathematics, business, management and the natural sciences. It is therefore not surprising that different research approaches have been found to suit different problems. Galliers (1992) expresses his concerns about many faculties who utilise only one particular house style or approach instead of reviewing the range of approaches available and selecting the most appropriate, given the object of their research.

Scientific	**Interpretivist**
Laboratory experiments	Subjective/argumentative
Field experiments	Reviews
Surveys	Action Research
Case Studies	Descriptive/interpretative
Theorem Proof	
Forecasting	Futures research
Simulation	Role/game playing

Table 2.2

Information Systems Research Approaches (Galliers 1991)

Table 2.2 gives a comprehensive list of the approaches that have been used in information systems research in the past, divided into the scientific and interpretivist philosophies. It is important to distinguish between approaches and methods. Approaches are a way of going about one's research (Galliers 1992); methods are simply ways to systematise observation (Weick 1984). It would also be worth distinguishing a methodology from a technique or tool. An information systems development methodology has been defined by Avison and Fitzgerald (1995) as:

> *"...collection of procedures, techniques, tools, and documentation aids which will help the systems developers in their efforts to implement a new information system. A methodology will consist of phases, themselves consisting of sub-phases, which will guide the system developers in their choice of the techniques that might be appropriate at each stage of the project and also help them to plan, manage, control and evaluate information systems projects."*

A methodology represents a way to develop information systems systematically - techniques and tools feature in each methodology. A technique is a way of doing a particular activity in the information systems development process. Each technique may involve the use of one or more tools which represent some of the artefacts used in information systems development.

Hamilton and Ives (1982) reviewed the research approaches (MIS research strategies as they refer to it) used by researchers in the seventies. They analysed 532 MIS articles published in 15 journals over the ten year period from 1970 through 1979. The 15 journals were taken from five discipline areas : MIS, accounting, computer science, management and management science. Each article was classified as utilising an empirical approach (namely case studies, field studies, field tests and laboratory studies) or a non-empirical approach (namely conceptual and tutorial/review/other). Table 2.3 and figure 2.6 show these results and it can be seen that a high percentage (70.1%) of non-empirical research approaches were employed. Case studies (11.8%) and field studies (7.9%) were most favoured by the empirical researchers. The authors argue that it is important to establish a balance between alternative approaches. However, they go on to make a further point,

> *" The key to good research, though, is not just choosing the right research strategy, but in asking the right questions and picking the most powerful method(s), for answering the questions given the objectives, research setting and other salient factors."*

Research Strategy	**Count**	**%**
Empirical		
Case studies	63	11.8
Field studies	42	7.9
Field tests	26	4.9
Laboratory studies	28	5.3
Subtotal	159	29.9
Non-Empirical		
Conceptual	326	61.3
Tutorial, review, other	47	8.8
Subtotal	372	70.1
Total	532	100.0

Table 2.3

Research Strategies employed 1970-79 (Hamilton &Ives 1982)

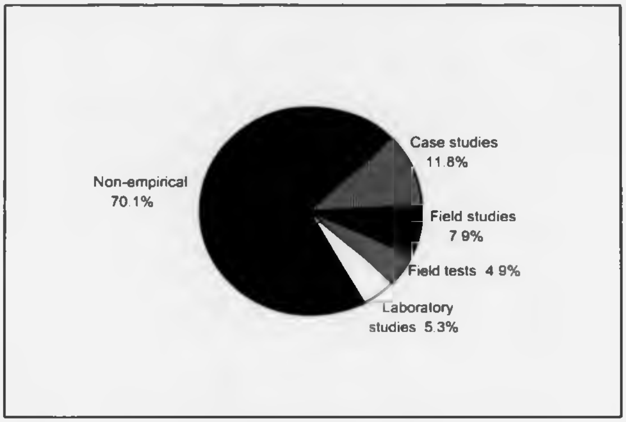


Figure 2.6

Research Strategies 1970-79 (Hamilton and Ives 1982)

A similar study was carried out by Farhoomand (1987) for the nine-year period from 1977 through 1985. 536 published articles were examined from six journals (MIS Quarterly; Information and management; Systems, Objectives and Solutions; Management Science; Communications of the ACM; and Harvard Business Review). The selection criteria was the observation of data processing, management information systems, information systems, and decision support systems (or their corresponding acronyms) in the abstract or title of the articles. The results are shown in Figure 2.7 using the research taxonomy used by Hamilton and Ives (1982) discussed above.

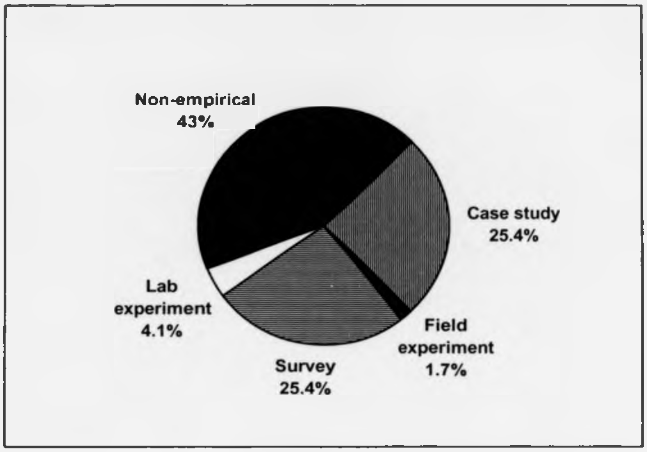


Figure 2.7

Research Strategies 1977-85 (Farhoomand 1987)

It can be seen that the non-empirical research methods adopted by researchers have decreased from 70.1% to 43.5%. It should be noted that although this is probably a true change, it may have been caused by different journal samples being used by the two studies. Case studies (25.4%) and surveys (25.4%) accounted for the majority of empirical research methods. The main features of the information systems research approaches listed in table 2.2 together with their strengths and weaknesses are shown in table 2.4.

Table 2.4 A summary of alternative information systems research approaches (Galliers 1992)

Approach	Key features	Strengths	Weaknesses
Laboratory experiments	Identification of precise relationships between chosen variables via a	The solution and control of a small number of variables which may then be	The limited extend to which identified relationships exist in the real world due to

	designed laboratory situation, using quantitative analytical techniques, with a view to making generalisable statements applicable to real-life situations.	studied intensively.	oversimplification of the experimental situation and the isolation of such situations from most of the variables that are found in the real world
Field experiments	Extension of laboratory experiments into the real-life situations of organisations and/or society	Greater realism; less artificial/sanitised than the laboratory situation	Finding organisations prepared to be experimented on. Achieving sufficient control to enable replication, with only the study variables being altered.
Surveys	Obtaining snap-shots of practices, situations or views at a particular point in time (via questionnaires or interviews) from which inferences are made (using quantitative analytical techniques)	Greater number of variables may be studied than in the case of experimental approaches. Description of real world situations. More easy/appropriate generalisations	Likely that little insight obtained re. the causes/processes behind the phenomena being studied. Possible bias in respondents (cf. Self-selecting nature of questionnaire respondents); the researcher, and the moment in time which the research is undertaken.
Theorem proof	That subset of information systems research approaches concerned with development and testing of theorems at the technical end of the socio-technical spectrum.	Similar to the scientific method generally.	Limited applicability of this style of research as one moves towards the social pole of the socio-technical spectrum.
Case studies	An attempt at describing the relationships which exist in reality, usually within a single organisational grouping.	Capturing 'reality' in greater detail and analysing more variables than is possible using any of the above approaches.	Restriction to a single event/organisation. Difficulty in generalising, given problems of acquiring similar data from a statistically meaningful

			number of cases. Lack of control of variables. Different interpretations of events by individual researchers/stakeholders
Forecasting, futures research	Use of such techniques as regression analysis and time series analysis, or the delphi method and change analysis, to extrapolate/deduce likely/future possible events or impacts.	Provision of insights into likely future occurrences in situations where existing relationships may not hold true in the future. Attempts to deal with the rapid changes taking place in IT and their impacts on individuals, organisations and society in general.	Complexity and changing relationship of variables under study. Lack of real knowledge of future events. Scenarios are not 'true' pictures of the future but enable decisions re. reactions in different 'futures'. Dependent on precision/ relevance of past data and expertise of scenario builders. Possibility of self-fulfilling prophecies.
Simulation, game/role playing	An attempt at copying the behaviour of a system which would otherwise be difficult/ impossible to solve analytically, by the generation/introduction of random variables.	Provision of an opportunity to study situations that might otherwise be impossible to analyse.	Similar to experimental research in regard to the difficulties associated with devising a simulation that accurately reflects the real world situations.
Subjective, argumentative (cf. phenomenology, hermeneutics)	Creative research based more on opinion/speculation than observation, thereby placing greater emphasis on the role/ perspective of the researcher. Can be applied to existing body of knowledge (reviews) as well as actual/past events/situations.	Useful in building theory that can subsequently be tested. Creation of new ideas and insights. Recognition that the researcher will interpret what is being studied in a particular way. Contributes to cumulative knowledge.	Unstructured, subjective nature of research process. Despite making the prejudice of the researcher known, there is still the likelihood of biased interpretations, a problem which is compounded by the time at which the research is undertaken.
Action Research	Applied research where there is an attempt to obtain results of practical	Practical as well as theoretical outcomes most often aimed at emancipatory	Similar to case study research, but additionally places a considerable responsibility on the

	value to groups with whom the researcher is allied, while at the same time adding to theoretical knowledge.	outcomes. Biases of researcher made known.	researcher when objectives are at odds with other groupings. The ethics of the particular research are a key issue.
Descriptive/ interpretive	Can be equated with the phenonemonological school of thought. Phenomena are the essence of our experience. Essences are grasped intuitively, since the proof of an essence is its self-evidence.	The ability to represent reality following an in-depth self-validating process in which presuppositions are continually questioned and our understanding of the phenomena under study is refined.	The skills of the phenomenologist and their ability to identify their biases and unheralded assumptions. Despite the fact that the researcher's biases are identified, these could still cloud the interpretation of the phenomena under study.

By analysing the various research approaches, Galliers (1992) develops a revised taxanomy which reflects the likely suitability of each approach in the context of the particular research topic under study, and its applicability in the process of theory development and extension. Using this taxonomy, he shows that the survey, descriptive/interpretive and action research approaches have the widest applicability in information systems research.

Action Research

The project reported in this thesis has been carried out using the action research approach. I am convinced that if this approach had not been adopted and used in the way it was, the whole process of going through developing an Expert System, followed by an Information System and then an Expert Advisory System (see chapter 1) followed by the various tools and systems used by the client organisation (the Coventry Community Drug Team) would have stopped at the

Expert System stage. The failure of classical expert systems has been described earlier in this chapter, and it is likely that the AIDS/HIV system would have added to this list of failures.

Developed at the Tavistock Institute of Human Relations on the basis of Lewin's (1947) work, action research is an approach which attempts to characterise a possible way of undertaking research in a social context. It is based on the premise that (a) it is not possible to confine research in the social sciences to laboratory conditions and (b) real problems can hardly benefit from theory because of the difficulty of the people involved in the actual social arena acquiring the relevant language and getting a sufficiently distant perspective of their own organisation.

Galliers (1991) states the objectives and scope of action research,

> *"It aims to contribute both to the practical concerns of people in an immediate problematic situation and to the goals of social science by joint collaboration within a mutually acceptable ethical framework."*

Da Silva (1982) has described the methodology of undertaking a research project within a real organisation and then using the action research approach as a vehicle for generalisation and conceptualisation. His work consists of the design, development and implementation of a Decision Support System Generator for the production planning function of a sponsoring organisation, from which basis he was able to generalise and isolate the components that formed the generator with which other specific applications could be built more effectively. However, this does not mean that an action research project will always produce positive results both in action and research terms. Also, it is not easy to overcome the different types of difficulties that are bound to appear. It must, therefore, be emphasised that action research has its weaknesses as well as its strengths (see table 2.4).

Rapport (1970) discusses the difficulties further and refers to them as the three dilemmas of action research: ethics, goals and initiatives. He goes on to state about these dilemmas that their,

> *"..resolution in one direction leads away from science (ie. towards the sort of action which is not theoretically informed and does not have a cumulative scientific character) while resolution in the other direction leads away from action (i.e. the sort of research that is 'purist'/ 'ivory tower' in character and lacks relevance to the important current problems of mankind. ...'good' action research selectively combines elements of both the resolutions".*

2.5 Evaluation of Information Systems

The information systems literature appears to be in widespread agreement regarding the need to evaluate the product and process of systems development. However, the focus attention has predominantly been on traditional cost-benefit analysis with the emphasis being given to cost estimation. A great deal of attention has not been paid to the estimation of benefits, especially the softer or intangible benefits. Methods of evaluation based only on accounting techniques (such as return on investment) do not, in themselves, involve a process which will bring out these softer benefits, let alone the impact which an information system may have in human and organisational terms (Farbey et al 1993).

A number of potentially high-benefit systems have not been computerised in the past due to the difficulties in quantifying the intangible benefits of improved quality or timeliness of information. In the drive to provide a rigorous interpretation and vehicle for evaluation, the social dimension of evaluation has largely been ignored.

Evaluation is not something that should be carried out just at the beginning or just at the end of the development process of an information system. The evaluation process should progress from conception to operation by means of a number of stages in each of which defined activities take place. In the earlier stages evaluation is concerned with setting targets and predicting outcomes in terms of benefits, costs, risks and obstacles. During the development phase, evaluation should aid the project manager to manage and control the project. Once a system has been implemented and comes into operational use, an ex-post evaluation needs to be carried out.

The importance of evaluation cannot be over-stated. Since it serves many purposes and is undertaken in a variety of organisational, technical and financial circumstances, it is difficult to find a single universal method. It is important that appropriate evaluation methods are applied to the information system being developed. Evaluation is the subject of chapter 4, and is discussed in more detail there.

2.6 Discussion

Computers have undeniably had a tremendous impact on both business and industry within the short period of about four decades. Over the years, the emphasis of business computing has evolved from the storage and retrieval of data to the processing of information and knowledge. This era promises to fundamentally alter the manner in which business is structured and conducted.

An organisation's information is an extremely important resource or asset, similar to its capital and personnel assets. Most companies would cease to exist very quickly without this information resource. However, information must be managed effectively to yield the maximum benefit. Managing information is handled by the organisation's information system, defined as the combination of computers and human users that manage data collection, storage and the transformation of this data into useful information.

The different categories of information system that are found in organisations appear under various names and these have been outlined in this chapter. In the same way that conventional categorisation of hardware into mainframe, mini and microcomputer has become increasingly blurred, so is the subdivision of the different types of information system. There is a strong case against categorisation and today's users require that their information needs are satisfied exactly. This usually warrants the incorporation of features from all the system types, together with other tools such as word processors and spreadsheets.

Many of the features listed under one category of information system are shared by many of the other categories. The key success factor for all such systems is that the designer works closely with the user to ensure that the system produces the right information in the right place at the right time.

CHAPTER 3

DEVELOPING SYSTEMS USING SELF KNOWLEDGE ELICITATION

"Experience is never limited and it is never complete, it is an immense sensibility, a kind of huge spider-web of the finest silken threads suspended in the chamber of consciousness, and catching every airborne particle in its tissue."

Henry James, Partial Portraits:
The Art of Fiction, 1888.

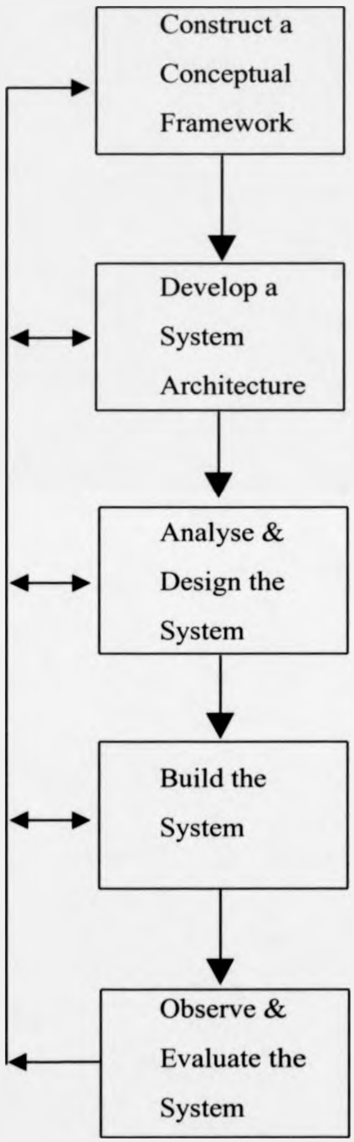
3.1 Introduction

Chapter one described the development of an Expert Advisory System for AIDS/HIV by the research team and established the need for the development of a drug misuse information system. This next stage of development became the responsibility of one member of the team (myself). A lot of experience had been gained during the first project and this would provide a useful background for any future developments. As a first step the information systems literature was reviewed to look at the types of systems which were being developed and used, together with the research approaches that were being adopted. This has been covered in chapter two.

The first two chapters lead into this chapter which describes the development of a drug misuse information system using the concept of Self Knowledge Elicitation. This idea emerged from the work described in chapter one and was developed using methods and techniques from the literature review as well as the experience gained from the Expert Advisory System for AIDS/HIV.

Systems development research is typically constructed as follows (Chen 1988): Construct a conceptual framework; develop a system architecture; analyse and design the system; build the system; observe and evaluate the system. This is illustrated in Figure 3.1 which also lists the research issues at each of these stages.

System Development Research Process



Research Issues

- State a meaningful research question
- Investigate the system functionalities and requirements
- Understand the processes/procedures of the system building
- Study relevant disciplines for new approaches and ideas

- Develop a unique architecture design for extendibility, modularity, etc.
- Define functionalities of system components and how they interact with each other

- Design data structures and processes to carry out the system functions
- Develop alternative solutions to design problems and choose one

- Learn about the concepts, framework, and design through the system building process
- gain insight about the problems and complexity of the system

- Observe the use of the system by case study and field study
- Evaluate the system by laboratory and field experiment
- Develop new theories/models based on the study of the system built
- Consolidate experiences

Figure 3.1

System Development Research Process (Chen 1988)

Table 2.4 in chapter two provided a summary of the key features, strengths and weaknesses of alternative information systems research approaches. Galliers (1992) provides a revised taxonomy of information systems research approaches which can be used as a useful guide to the suitability of each approach in the context of the proposed drug misuse information system development. The taxonomy can also be used to identify the most likely approaches in the context of building, extending and testing theory. The survey, descriptive /interpretive and action research approaches have the widest applicability in information systems research based on this taxonomy.

Figure 3.2

The use of alternative information systems research approaches in the process of theory building, testing and extension (Galliers 1992)

This process of theory building is shown in figure 3.2 and I found this a useful and appropriate model for the research that I carried out. I decided to use the action research approach for the research which is described in the rest of this chapter.

This seemed the most appropriate choice based on the objectives and nature of the research project.

The research project would be based at the community Drug Team (CDT) in Coventry as they had already agreed to collaborate and commit some resources towards it. The project would involve the development of a drug misuse information system that could be used as an operational system by CDT. However, during the development, the possibility of resolving some of the problems encountered during the Expert Advisory System development would be investigated (see end of chapter one and section 3.3 later in this chapter). Once it was developed it would also be important to install the system at other similar units so that its usefulness and applicability in different settings could be evaluated.

The evaluation of the project would be an important phase. Ideally, a project should be evaluated at each stage of its development. Initially (before the project commences), an *ex ante* evaluation is carried out to determine whether the project should proceed by studying the costs and benefits. This was not a difficult decision to make because just the known benefits outweighed the expected costs. It was also anticipated that there would be some unexpected benefits but these were not discussed in any detail.

Since two organisations were involved, CDT and the Expert Systems/Decisions Support Unit (ESDSU), the costs and benefits were evaluated for both. The costs to CDT would be staff time in developing and liasing with the developer (myself) and some computing resources. The computing resources were already available to the CDT and staff time would not incur any extra salary payments to the organisation as staff had agreed to fit the extra work into their existing schedule and do voluntary (unpaid) overtime if necessary. The benefits to CDT would be an information system which all staff could use to support the work that they did, especially as up-to-date information on drug misuse and AIDS/HIV was difficult to obtain from elsewhere.

The costs to ESDSU was one research fellow working full-time for approximately one year with CDT. However, this was also seen as a benefit because this project was the sort of research that the unit specialised in, and the availability of an organisation willing to liaise in some research work was an opportunity not to be missed. Another benefit was that the work already carried out and the experience gained on the Expert Advisory System in AIDS/HIV could be taken one step further, having already spent a lot of resources on it.

As can be seen the decision to proceed with the project was easily justified. The next main evaluation would be carried out once the system was complete and had been used for some time, i.e. an ex post evaluation (post implementation review). This would be carried out at CDT. If time permitted, the system would be set up in a number of other similar units and evaluated. Chapter four describes the methods and techniques used for evaluating information systems as reported in the literature. Chapter five details the study that was carried out to evaluate the research project reported in this chapter. The rest of this chapter describes AIDS/HIV and drug misuse; the services required by drug misusers; the role of drug services; the concept of self knowledge elicitation in the development of a drug misuse information system; and the wider use of the information system within CDT by integration with other systems.

3.2 Drug Misusers and Drug Services

3.2.1 AIDS/HIV and Drug Misuse

"HIV is a greater threat to public and individual health than drug misuse", concluded the Advisory Council on the Misuse of Drugs (ACMD) in part I of their 'AIDS and Drug Misuse' report (DHSS 1988). The ACMD was established under the 1971 Misuse of Drugs Act to keep under review, and advise the Government in, matters relating to the misuse of drugs. The Working Group on AIDS and Drug Misuse was established in July 1987 to examine the implications of AIDS for services for drug users and to report on measures which could be taken by services to help combat the spread of HIV infection.

The priority goals for drug workers are therefore to prevent drug misusers from acquiring or transmitting the virus. If this is not achieved through abstinence, then efforts have to focus on risk-reduction by: preventing or reducing injecting drug misuse; preventing or reducing sharing of injecting equipment; preventing or reducing unprotected sexual intercourse; advising infected women to avoid pregnancy and providing help where needed to reduce the number of births to these women.

HIV can spread rapidly amongst injecting drug misusers via sharing 'dirty' (blood-contaminated, non-sterile) needles or syringes, because this is a major route of transmission of the virus. This is illustrated by the tragedy of Edinburgh where the prevalence of HIV amongst this group is exceptionally high. In some European countries the majority of cases of AIDS (e.g. in Italy and Spain) or HIV infection (e.g. in Scotland) have occurred through the use of contaminated injecting equipment. Therefore, urgent and preventive action needs to be taken to contain the spread of HIV via this route.

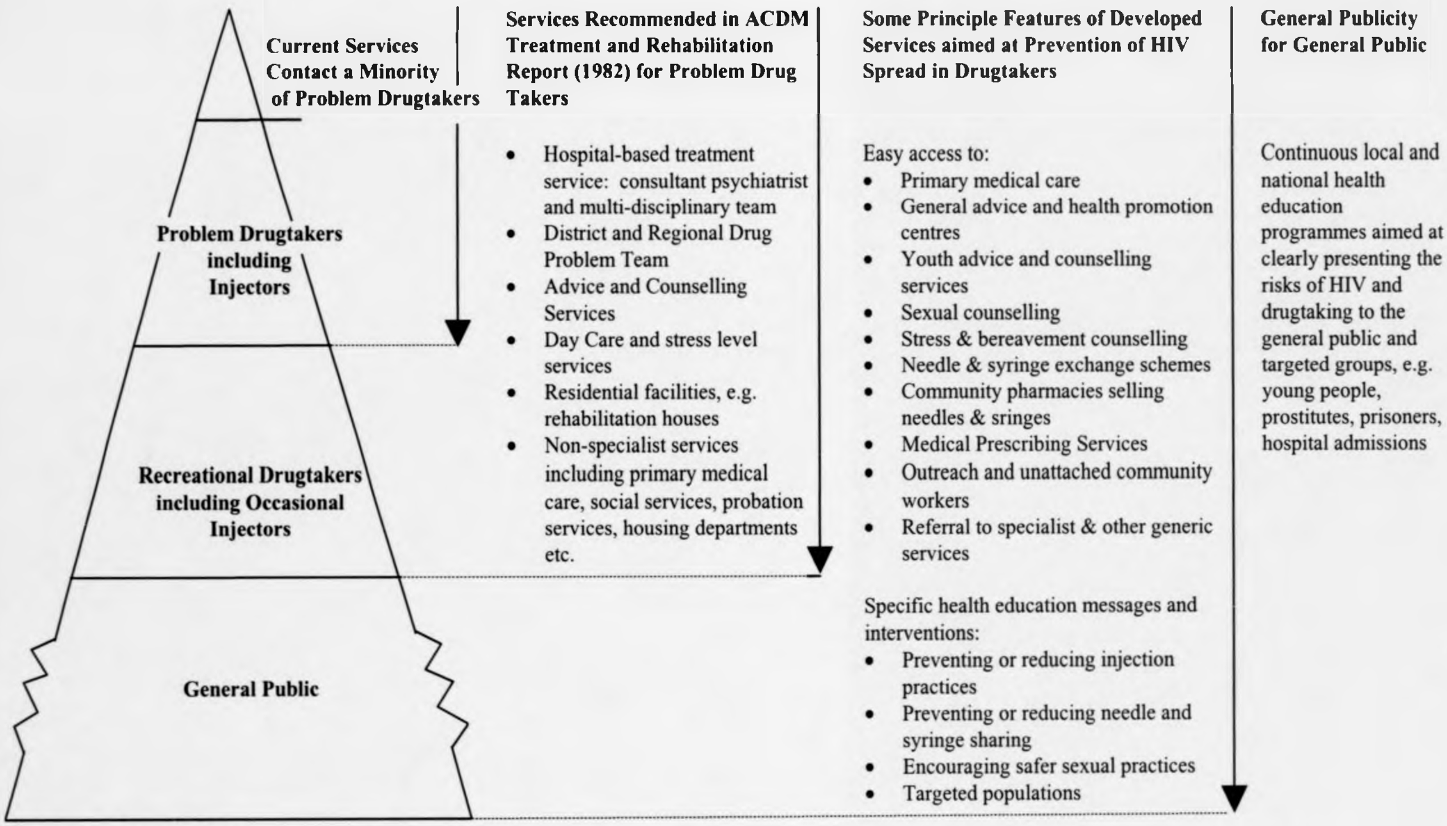
Since the HIV virus is also transmitted sexually, infected drug misusers can transmit the infection in this way as well as by sharing injecting equipment. This represents a disturbing problem because the vast majority of drug misusers in the U.K. are thought to be heterosexual. Therefore, sexual transmission will be the major route from infected drug misusers into the general heterosexual population.

In order to educate drug misusers about HIV, drug services need to make contact with as many of the hidden population of drug misusers as possible. The services can then work with this high-risk group to change their behaviour so as to minimise the risks. Although this is the most effective method of education, the majority of drug misusers will remain hidden. Therefore, there is a continuous need for local and national education, publicity and campaigns about HIV, specifically targeted at this group. Figure 3.3 shows 'The Drugtaking Pyramid' (DHSS 1988) which illustrates the pattern of community-based services that should be available in each health district, as recommended by the ACMD.

3.2.2 The Decision to Seek Help

Introduction

This section describes the main findings of a study, funded by the Department of Health, to investigate why drug users appear reluctant to approach drug agencies (drug services) even when they are experiencing difficulties. The key question was "why do some drug users seek help while others, with similar patterns of drug use, stay away from these services?" The study was carried out between November 1985 and January 1988, by in-depth interviews with 240 drug users in Inner North and Central London.



The Drugtaking Pyramid

A problem drugtaker is defined in the T & Rehab Report as any person who experiences social, psychological, physical or legal problems related to intoxication and/or regular excessive consumption and/or dependence as a consequence of his own use of drugs or other chemical substances (excluding alcohol and tobacco).

Figure 3.3

The changing nature of drug services and prevention work in the light of HIV and drug misuse.

This sample was split into two halves - the 'agency' group (AG) and the 'non-agency' group (NAG). The AG was currently seeking help while the NAG had not sought any help in the past year (and most never). Apart form this, the two groups were similar in age, ratio of males to females, patterns of drug use in the past, and background. All the participants had been using illicit drugs (opiates and/or stimulants) regularly for at least two years, although most had been doing so for much longer. All were currently using illicit drugs on a daily/almost daily basis, and included opiates (particularly heroin), amphetamines, cocaine and other sedatives, and cannabis. For most, drugs accounted for over half their total expenditure.

The AG, who were easier to contact than the NAG, were contacted while they were seeking help from a range of local drug services, e.g. a street agency, General Practitioners and an outpatient drug dependency unit. The NAG were contacted through various contact points in the community or by 'snowballing' from the help-seeking clients (AG). Over a third of both groups were women. Half of both the AG and the NAG were reinterviewed three months later.

Reasons for Seeking/not Seeking Help

Although the NAG had not sought help for at least a year, a quarter of them expressed an urgent need for help. The rest of this group had drug-related problems of varying severity. The AG sought help only after experiencing a marked increase in drug-related problems. They saw the process leading up to their seeking help as one of increasing drug use, loss of control, accumulating drug-related difficulties, growing social conflict, and increasing anxiety. It can be concluded from this that the decision to seek help is not simply a function of the severity of an individual's drug problem or the length of their drug using careers, though both of these are factors.

It was found that the AG had a better knowledge and understanding of services, with many of the NAG not knowing where and how to find help. The most important factor that both groups had taken (or would take) into account when seeking help was what services were offered by the agency concerned. Both groups indicated that these services should include: help with housing, health, skills training, legal problems, childcare; counselling on an individual basis; and facilities aimed at women (indicated by the women in the study). It is clear that knowledge of services, as well as what they have to offer, are also important factors.

Accessibility of these services (e.g. location, opening times) was found to be another factor on the decision to seek help. The NAG indicated that confidentiality was a significant barrier to seeking help, but the AG did not.

On re-interviewing the two groups, the AG reported a much greater change in the three months after they came for help, compared to the NAG. There was a significant decrease in illicit drug use and injecting, resulting in less drug expenditure and less involvement with other drug users. It was apparent that these changes would, in the long term, be beneficial both to clients and to society: lower risk of HIV infection; reduced demand on the illicit marker; lower level of criminal activity.

The AG clients also reported improvements and reduced anxiety in most areas of their life. However, despite these improvements, they showed a need for continued help and support in their drug use, health and psychological state. Two thirds of the clients were generally satisfied with the services they had received; and less than a fifth were actively dissatisfied. Nevertheless, most clients felt that they had been helped in the areas which concerned them most.

Implications for Drug Services

The findings from the above study have a number of implications for drug services, and these can be summarised as follows:

(1) Services need to contact a wider range of drug users earlier in their drug taking careers so that any future harm to them is minimised, if not avoided altogether.

(2) Services need to build on the existing informal self-help support structures and control strategies among drug users who do not seek help. Outreach work, (where workers are 'reaching out' to invite potential customers to attend and/or avail themselves of the services available from the agency base), could go some way in helping to achieve this.

(3) Services need to be more accessible, and imaginative tactics are needed to advertise and disseminate information about their existence, location, opening hours, confidentiality and services. Outreach workers, education of generic professionals, the comic-style literature, as well as many more other ideas and schemes, can all play a part.

(4) Services need to be equally accessible and attractive to different client groups like women, parents of young children, ethnic minorities and adolescents.

3.2.3 Motivating Change

Introduction

The study described in the previous section was concerned about why most of Britain's drug users were not looking for help, and suggested ways that drug services could attract this 'hidden' population of drug users. Also important is the method by which clients are approached and interviewed, once they decide to walk through the door, by the drug services.

This is especially important for clients who are assessed as being 'poorly motivated' or 'unmotivated'. These may be clients who have been rejected from treatment possibilities in the past. Motivated clients, on the other hand, normally have little or no need of treatment clinics, rehabilitation centres or counselling. Therefore, the important challenge is to meet the needs of the unmotivated client.

Motivational Interviewing

The motivational interviewing method presented in this section was developed by Miller (1983) and by Van Bilson (1986a), a method which was initially used in America with problem drinkers and then in Holland with heroin users. More recently, the Northern Road clinic in Portsmouth have incorporated motivational interviewing into their assessment procedure as well as into individual and group therapy settings with a variety of drug users.

MOTIVATIONAL INTERVIEWING	TRADITIONAL APPROACH
Individual Responsibility	
Emphasis on personal choice regarding future use of heroin.	Emphasis on the disease of addiction which reduces personal choice.
Goal of treatment is negotiated based on data and preferences.	The treatment goal is always total and life long abstinence.
Controlled heroin use is a possible goal though not optimal for all.	Controlled heroin use is dismissed as impossible.
Internal Attribution	
The individual is seen as able to control and choose.	The individual is seen as helpless towards heroin and unable to control his/her own heroin use.
The interviewer focuses on eliciting the client's own statement of concern regarding the heroin use.	The interviewer presents perceived evidence to convince the client of his or her problem.
Denial/Telling Lies	
Denial and telling lies are seen as an interpersonal behaviour pattern (communication) influenced by the interviewer's behaviour.	Denial and telling lies are seen as a personal trait of the heroin addict/ junkie, requiring heavy confrontation by the interviewer.
Lies and denial are met with reflections.	Lies and denial are met with argument and correction.
Labelling	
There is a general de emphasis on labels. Confessions of being a junkie or being an irresponsible heroin addict are seen as irrelevant.	There is a heavy emphasis on acceptance of the person as a junkie or an addict.
Objective data of impairment are presented in a low-key fashion, not imposing any conclusion on the client.	Objective data of impairment are presented in a confrontational fashion as proof of a progressive disease and the necessity of complete abstinence.

Figure 3.4

The Characteristics of Motivational Interviewing

Figure 3.4 shows how Van Bilson has contrasted the key principles of this approach with traditional approaches (Van Bilson 1986b). From this it can be seen that the basic principles are that the client: needs to be accepted in a complete and unconditioned way; is a responsible person; must be ready for change and not forced into it. If these principles are not followed, it often leads to a breakdown of relationships with clients who, as a consequence, may not return for fear of disapproval from staff.

The Process of Change

A client's motivation can be assessed by using the model documented by Prochaska and DiClemente (1984), who identified six stages of change (see figure 3.5) which are described below:

Precontemplation - this is the stage where the client often arrives at a drug unit having been sent by the court, probation office, family or lover. The client himself does not perceive that he has a problem.

Contemplation - the client may have drug related problems such as financial hardship and deteriorating health, but will also see his/her drug use as a means of coping with these and other stresses posed by life.

Decision - the client stays in this stage for a short time to decide what to do based on the pros and cons of the previous contemplation stage. He/she will either decide to continue using drugs as before (i.e. return to the precontemplation stage), or decide to make a positive change.

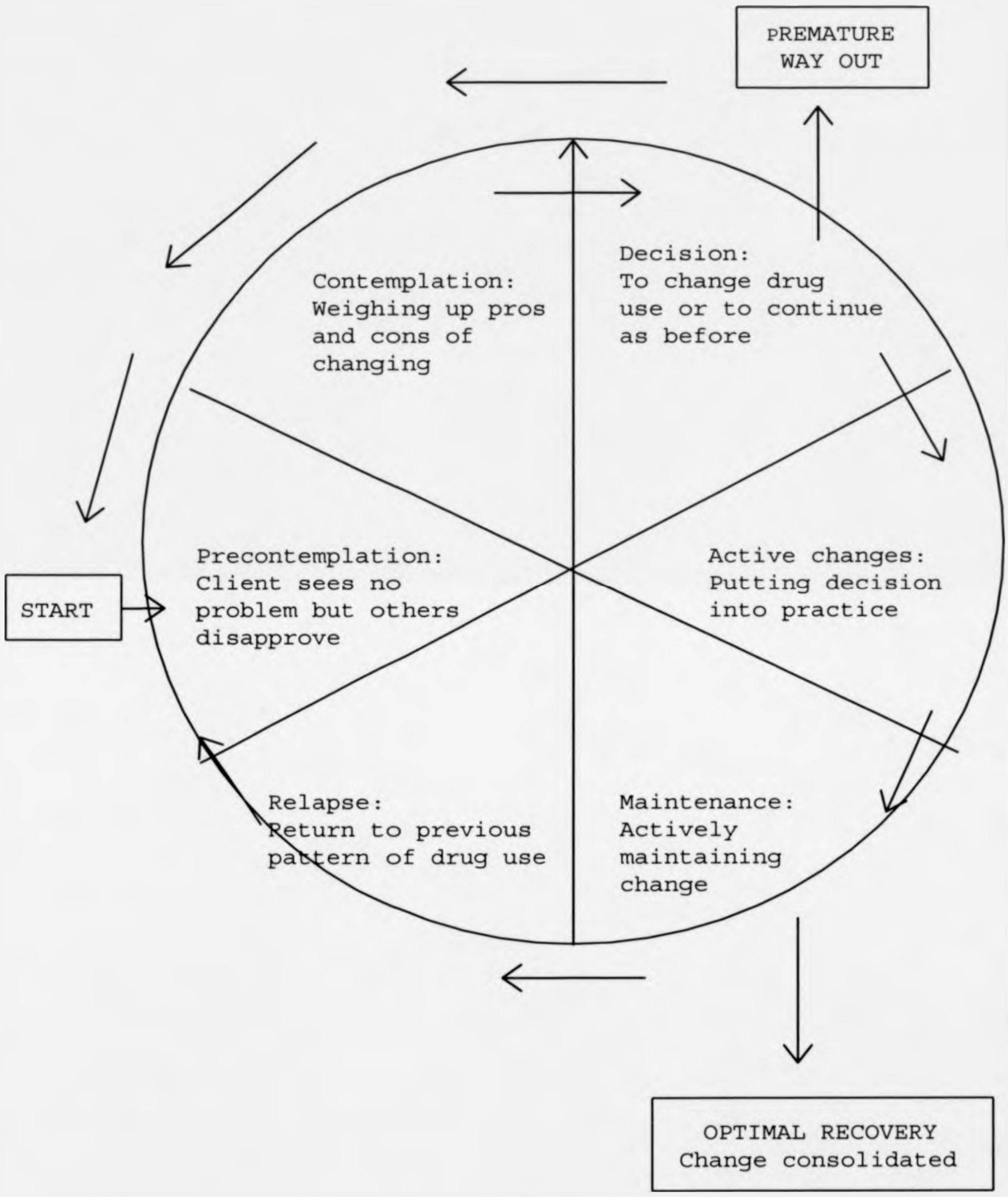


Figure 3.5

Phases in the process of change

Active Change - the client takes steps to put his decision into effect. This will be negotiated with the staff e.g. obtaining clean needles and syringes instead of sharing.

Maintenance - this is important for both the client and the drug worker, who needs to introduce and encourage conscious coping strategies to maintain the change already made. These include problem solving skills and relapse prevention techniques such as those described by Marlatt and Gordon (1985). The client may move out of this stage to 'relapse' and then back to pre-contemplation. However, the other route out of this stage is to optimal recovery. This is when change can be maintained with little or no effort, with less need for conscious preoccupation with avoiding relapse.

Relapse - this is the return to previous patterns of drug use. However, this should not be seen as a failure but a positive learning experience for the next revolution through the process of change.

3.2.4 The Coventry Community Drug Team

The Community Drug Team (CDT) at Coventry is a confidential service funded by the Health Authority and Social Services Department, which offers support to anyone who is using or concerned about drugs. Referral to CDT can be made from various sources, e.g. general practitioner, solicitor or probation officer.

Originally known as the 'Drug Problem Team', they were set-up in September 1984 with the appointment of three workers. Their initial task was to investigate the problems of drug misuse in Coventry with a view to developing and co-ordinating plans for future services. This was their important research phase and one year later in November 1985, the Team opened as a counselling and advice service to clients, staffed by a Social Worker, Community Psychiatric Nurse and Clerk. In 1986, their name changed from Drug Problem Team to Community Drug Team.

CDT was established under the auspices of the Coventry District Drugs Advisory Committee (CDDAC), from which were drawn members of the Management Committee.

The CDDAC is chaired by the Venerable Alan Morgan and has a wide representation from local statutory services, voluntary sector and local committees i.e. Family Practitioner Committee, Local Medical Committee. The Drugs Advisory Committee meets quarterly.

The Management Committee consisted of members of the Drugs Advisory Committee, who were senior officers in the Social Services Department and Coventry Health Authority; a representative from the Education Department; line managers of the two staff and officers in attendance. The Management Committee had the delegated task of developing the Community Drug Team into a service. The Committee was dissolved in April 1987 following the appointment of the Team Leader.

Since April 1987, the Community Drug Team has been managed by the Team Leader who reports to line managers in both Social Services and the Health Authority, and to the Coventry District Drugs Advisory Committee on a quarterly basis.

Within the Community Drug Team individual staff are regularly supervised by the Team Leader. On professional issues, for those not employed by Social Services, there is access to line managers if necessary. Team meetings are held weekly where business issues are discussed, clients are allocated and information is shared.

Confidentiality is a very important issue and clients need to be assured that their personal details and records will be kept totally confidential. This fact is clearly publicised by CDT when advertising its services and stressed during client interviews.

An Outline of the Present Role

The Coventry Community Drug Team advertise themselves as "a friendly team of drug-workers offering support to anyone who is either using, or concerned about, drugs". In brief, they will: listen in confidence to drug misusers who need to talk to someone; help them to make decisions about giving up drugs, or look at less risky ways of taking them; support them in building up self-confidence, coping with stress, and learning alternative ways to deal with problems; offer advice on HIV/AIDS and other related infections; and support family and friends concerned about their drug use.

If clients are using illegal drugs on a regular basis, they are more likely to get into trouble with the law. CDT can help them by preparing court reports as well as going to court with them. CDT can also give information on detoxification and rehabilitation centres, where spaces are usually limited, to help clients choose the most suitable option.

3.3 An Editable Expert Advisory System

3.3.1 Preparation

The Coventry Community Drug Team (CDT) had been using the Expert Advisory System (EAS) in AIDS/HIV as one of the collaborating user-groups. They found that the General Public and Counselling modules of the system were of most use and relevance for their particular needs. The General Public module did contain some advice and information related to drug misuse, especially information relevant to intravenous drug misusers.

However, the CDT found that this information was often inadequate for the specific queries that they had to deal with as well as for the detailed advice and information which needed to be given to their clients during personal interviews. It was clear that they needed a large, detailed section on 'AIDS and Drug Users'. They had been using the AIDS/HIV EAS for over a year and the staff had become familiar with the operation and contents of the system.

The Team Leader was prepared to share his experience and expertise in the design and development of a new module aimed at drug misusers. Obviously, the CDT also had to deal with queries from clients and the general public on drugs and drug misuse in general, i.e. not necessarily bearing any relation to AIDS/HIV. Therefore, this new module needed to include issues that were of most importance to drug users and drug services. The previous section discussed some of these and provided indicators on the types of advice and information that would be required.

Chapter one described the development of computerised decision support tools for the AIDS pandemic. It was found that the most useful of these tools was the AIDS Expert Advisory System which was developed by integrating the features of both the AIDS Expert System and the AIDS Information System developed in the earlier stages. However, as discussed in the conclusions to chapter one, there were a number of problems which needed to be resolved and issues to be considered before such a tool could be used in a real, practical situation. These are summarised below:

1) A lot of time had to be spent by the knowledge engineer in order to get familiar with the subject domain. Developing a drug misuse section would involve a further period of study which would be time-consuming.

2) A bottle-neck occurred during knowledge acquisition because the system development could not keep up with the knowledge that had been acquired from the experts.

3) Who carried the responsibility for the knowledge contained in the system; and the problem of consensus when advice and information differs between two centres. An editorial board was suggested as a possible solution to both of these problems. The editorial board would tackle the problem of consensus by giving the user either one choice or a number of ranked alternatives.

4) Updates and maintenance of the system. Again, an editorial board could provide the solution by being responsible for maintaining the system as well as sending regular updated versions of it to the subscribed users.

Problems one, two and four all involved the time-factor. Time would be limited during this phase of the project because only one knowledge engineer (myself) would be involved in knowledge elicitation and he would also be responsible for all the design, development and programming work involved. During the development of the AIDS computerised decision support tools, these were major problems. Not a great deal of thought had gone into finding solutions to the first two points mentioned above because the development team were aware that systems of this nature were time-consuming to build.

The problem mentioned in point four was realised during and following the development of the AIDS Expert Advisory System. Whenever some advice or information on AIDS changed or some new information was discovered, some of the reports in the knowledge base needed updating. Even if no new information needed changing, updates were still necessary to keep some sections of the system up-to-date. For example, statistics on HIV and AIDS cases in various countries around the world were published every month by the World Health Organisation. The development team saw their role as system developers and not touch-typists trying to keep a system updated by researching the latest AIDS literature.

During this preparation period, I investigated the possibility of designing a computerised tool to help solve these time-factor related problems. From earlier experiences, another important consideration was that any tool which was developed needed to be easy to learn and use in order for it to be accepted by the user.

I decided that any new developments would continue to be programmed in PROLOG. This language had been used as the programming environment for the development of both the AIDS Information System and the AIDS Expert Advisory System. The flexibility and efficiency that it had provided then would be needed in any new developments. Another important consideration was that I had become familiar with the use of PROLOG and it would save time compared to using a new environment.

The Team Leader of the CDT, Mr Paul Wells, was familiar with the AIDS/HIV Expert Advisory System, and he indicated that the retrieval of information using menus, keywords and free-text searches was attractive and these modes of access would be the most useful for a Drug Misuse system. He liked the concept of differential diagnosis and wanted to investigate using this mode of access for the drug misuse system at a later stage. The Expert Advisory System comprised of four main modules and the Drug Misuse system would form the fifth module, and would be called 'AIDS and Drug Users'.

Although the expert was very enthusiastic in developing the drug misuse module, his time was very limited because of his role as Counsellor and Team Leader. He would, therefore, find it difficult to set aside too much time to talk to the Knowledge Engineer on a regular basis. Nevertheless, the expert was prepared to allow time for a meeting with the knowledge engineer at least once every fortnight.

3.3.2 Development

An idea that I had about a new development was the result of feedback received from users. During a demonstration that had been given to a small user group, someone in the group asked whether it was possible for the user (of the system) to modify the reports himself. Another user, using the feedback facility provided in the AIDS Expert Advisory System to give his comment, had asked the same question. He had found a spelling mistake in one of the reports and wondered if it was possible for him to correct it himself.

My idea, as the knowledge engineer, was to modify the programming of the AIDS Expert Advisory System to make it possible for the user to be able to edit the reports. I spent some time developing this new tool which made the Expert Advisory System even more flexible. This new tool was termed the 'Editable Expert Advisory System'. The new features in this were designed thoughtfully in order to make them easy to learn and use. This is important as learnt from earlier experiences and discussed in the previous section.

A meeting was arranged between the Knowledge Engineer (myself) and Mr Paul Wells, an expert and counsellor in AIDS/HIV and drug misuse. The Knowledge Engineer had not spent any time getting familiar with the subject domain as in the development of earlier systems. For example, during the development of the AIDS/HIV Expert Advisory System a two month period of study was undertaken before arranging any knowledge engineering sessions with the experts.

The expert was asked to structure his knowledge and expertise into a hierarchical form consisting of a top-level menu which covered the main subject areas in drug misuse. Each entry in this top-level menu would then need to be divided into sub-menus consisting of the relevant topic areas. Each entry in these sub-menus could be divided into further sub-menus or it could activate the relevant information in the form of a short report. All entries would eventually lead to a report after going through a set of menu selections.

The expert was familiar with this approach as he had been using the AIDS/HIV Expert Advisory System, which was based along the same principles, for over a year. Also, he was given the Conceptual Model which was made during the development of the General Public module of the Expert Advisory System. This compact model illustrated the major areas covered by the General Public module and provided the expert with a good, clear guide on the way that his knowledge needed to be structured and the wide range of topics that needed to be addressed.

The principles of the Editable Expert Advisory System were discussed with the Expert at the same meeting. Once he had structured the drug misuse knowledge, the knowledge engineer would implement this structure into the Editable Expert Advisory System. The system would then be installed for the Expert to use and he would then be able to modify any of the reports whenever he wished. The Expert agreed to do this and send the structure within the next few weeks.

About a fortnight after the first meeting with Mr Wells, a typed copy of the Drug Misuse tree-structure was received through the post. The Knowledge Engineer examined this structure and saw that it had been divided into menus and sub-menus by the Expert precisely as it was required. This structure is shown in its original form in Appendix C. The numbers to the left of the topic titles (or items) indicate the level at which those particular items should appear in the hierarchical structure.

The Knowledge Engineer used these numbers and the tree-structure, and transformed them into a diagrammatical representation, and a small part of this is shown in figure 3.6. It can be seen that each item is a node which is either linked to a number of other nodes or (if it does not have any further sub-divisions) to a report. This can be compared to a tree where the branches represent the links and the leaves at the end of the branches represent the reports. The expert had only written some of the reports that would form the leaves of the tree-structure, but said that he was working on the others but expected them to take much longer.

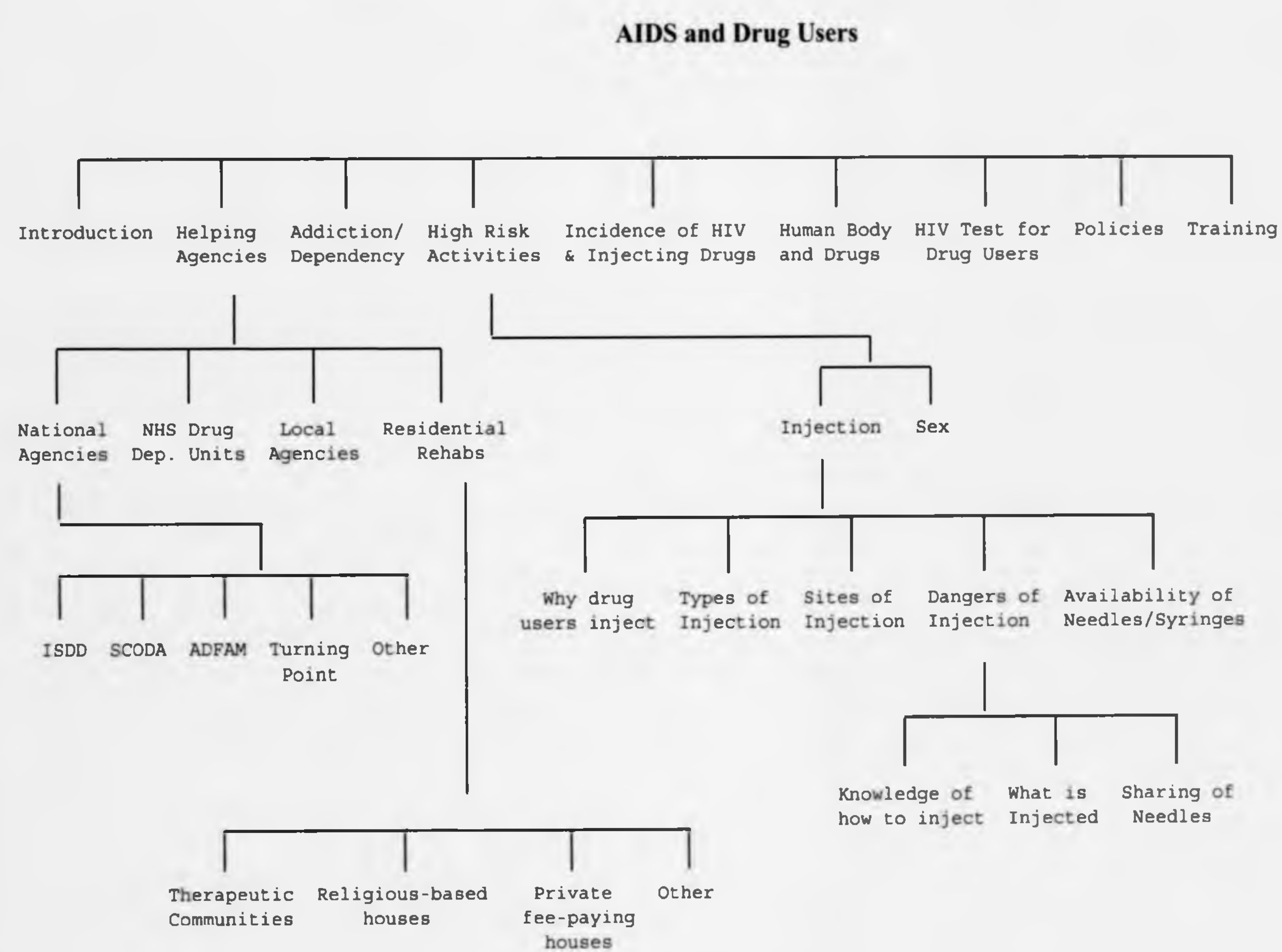


Figure 3.6

A Diagrammatical Representation of the Drug Misuse Tree-structure.

This structure was programmed into the AIDS Expert Advisory System so that the user now had access to five modules, the last one being the Drug Misuse module. On selecting the Drug Misuse option, the user was presented with a sub-menu reflecting the tree-structure (see Figure 3.6). This new, updated version of the Expert Advisory System appeared and worked exactly like the previous version of the system. However, there was one very important difference - when the report page was reached on accessing via the menu mode, the user had the ability to edit the report, i.e. he could add, modify or delete either the whole report or parts of it. This seemed to be an important concept in the development process and represented a useful technique for knowledge acquisition.

The Expert at the CDT was given the Editable Expert Advisory System with this tree-structure for the Drug Misuse module programmed into it. He was given a demonstration of how to use the new system in order to add the reports which he was preparing. The nature of the system meant that he could add reports in any order and could also modify them at a later date if this became necessary. He would not need to consult the Knowledge Engineer each time a report needed modifying.

Apart from using the AIDS Expert Advisory System, Mr Wells had no previous experience with computers. It was important that any tool he was given was easy to learn and use. This had been taken into account and it had always been the philosophy of the development team to make systems user-friendly. The commands for editing the reports could be displayed on the screen so that the user did not need to remember them. These commands and other features were kept simple (see Appendix C).

The expert found this approach appealing and judging from the log in his diary of the time spent on the system, it showed he was spending a significant amount of time on it. He had indicated that he would prepare the relevant reports either at home in the evenings and at the week-ends or in his office whenever he had the opportunity. He could then use the system to type the prepared reports or on most of the occasions he would ask his secretary to do this for him. He had a lot of books and other published material on AIDS/HIV and drug misuse which he could call upon to supplement his own knowledge. Appendix C demonstrates the use of the AIDS/HIV Editable Expert Advisory System.

3.3.3 Evaluation

Advantages of this Approach

When the Editable Expert Advisory System was set up on a PC at the Coventry Community Drug Team for the Expert to use, I thought this new approach would prove quite important. There were a number of reasons for this:

(1) Chapter one discussed the problems of responsibility, updates and maintenance for the information content of the AIDS/HIV Expert Advisory System and suggested a solution in the form of an editorial board. If such a board was established, they would find the Editable version of the Expert Advisory System a very useful tool for updating and refining the knowledge base. Once this knowledge was finalised for a particular version of the software, the knowledge in the Editable version could be transported into the knowledge base of the non-editable version. By doing this, the end-user would not have the facility to change the information content, which would be a guarantee for other users that the information had not been altered and was thus correct, as established and censored by the editorial board.

(2) The Editable version is also a useful tool for the Knowledge Engineer in a number of respects:

(i) Primarily, it saves him a considerable amount of time which would normally be used for interviewing the expert to elicit his knowledge and expertise. For example, forty hours of tape recording was made whilst interviewing various experts during the development of the AIDS/HIV Information system.

(ii) The Knowledge Engineer needs to know very little about the subject domain and this also saves him time. Before the development of the knowledge base of the AIDS Information System, a two month study period was undertaken by the Knowledge Engineer in order to become familiar with the subject area of AIDS/HIV.

(iii) The Editable version of the system can be used to add, modify and update other reports in the system in a more direct way. This avoids having to always check the names of reports and the nodes to which they are linked because the Editable version will always automatically select the correct report during retrieval.

(iv) There is no bottle-neck during knowledge acquisition because the Expert is transferring his knowledge straight to the computer.

(3) The Expert feels part of the development team and can see the system develop as he puts more work towards it. Seeing the fruits of his labour keeps him motivated.

(4) The knowledge engineering sessions were quite different to the ones that took place during the development of the three tools described in chapter one. The knowledge that the Expert had structured was discussed at a general level. Therefore, more time was spent discussing the system design, user-interface, other features and how it could best serve their needs. Only one meeting every fortnight was arranged with the Expert.

Sophisticated word processors in the Windows environment are now commonplace in most organisations, and particular ones are usually used as a standard package throughout the whole organisation. It would be possible to link the Editable Expert Advisory System to whichever word processing package the user required, as opposed to the standard editor which is presently built into the system. That way, the user would not only feel more comfortable, but would be able to use the advanced features of their packages when editing reports.

Problems with this Approach

On the third meeting between the Knowledge Engineer and the Expert , the latter said that he had found a problem with the Editable Expert Advisory System. During the preparation of the reports for the Drug Misuse module, he realised that the tree-structure which he had constructed a few weeks earlier needed some modifications. He found, as he began to search around the initial structure, that there were items which he had omitted from some of the menus; he wanted to reposition some of the entries into other parts of the structure; he wanted to delete some of them; and he also wanted to cross-reference some items to items elsewhere in the tree-structure, usually at different levels in the hierarchy.

The Editable Expert Advisory System allowed him to modify only the reports and so he would request the Knowledge Engineer to do this each time a modification was required. This process was extremely slow and frustrating for both the expert and the Knowledge Engineer. When one change was requested by the Expert, this change usually needed further modifications once the Expert saw it in operation on his PC.

Although the Editable Expert Advisory System could still be used by the Knowledge Engineer and at a later date by an editorial board (if one was set up in the future), a new approach was required for the development of the Drug Misuse module. This approach needed to be quicker and more convenient, without the need for the Knowledge Engineer and the expert to have to communicate too often especially if the only purpose was to modify and implement part of the Drug Misuse structure.

Another potential problem would occur if the CDT had the Editable Expert Advisory System on two different PCs for use by more than one person. The two systems would be at different stages of development and this would lead to confusion. One solution to this problem is to only have the system installed on one PC, but then only one person at a time can develop or use the system. Another solution to this problem is to network all the PCs that have the system installed on them. Passwords could also be implemented into the system so that only authorised users would be able to modify the Knowledge, whilst the others would only be able to retrieve information that was already there.

Mr Wells also suggested that it would be simpler to have just the Drug Misuse module available during its development as opposed to the whole AIDS/HIV Expert Advisory System. He also expressed concern about not having access to a computer when he was at home, which stopped him from developing the system further and utilise the spare time which he had available outside office hours. This showed his enthusiasm and commitment in helping to develop the Drug Misuse system.

The Knowledge Engineer gave a lot of thought to these problems. He had a lot of time available, as this was saved in the development process using the Editable Expert Advisory System. However, he was now also responsible for the design and programming of any new systems which needed developing. The solution to the Expert's problems seemed obvious - modify the Editable version of the system and allow the user to have the facility to change the menu items.

Mr Paul Wells, the Expert, was told that the Knowledge Engineer was working on a new improved tool for him. The Expert was told to persevere with the construction of the Drug Misuse module in the meantime.

3.4 Self Knowledge Elicitation Tool

The problems that the expert and the Knowledge Engineer were faced with in using the Editable Expert Advisory System for developing the Drug Misuse module led to the ideas and development of another important tool. This tool was given the name 'Webofax' (or 'Web-o-Fax') because of the way it allowed the user to create a 'web' of information. The main purpose of this tool was to give the expert the flexibility to add, modify and delete the structure of the menus as well as the contents of the reports during further development of the Drug Misuse system.

When it is first used for a new system, Webofax is in fact an empty shell, i.e. it contains no information at all either in the form of menu titles or reports. Going along with the past philosophy, it was designed so that it would be quick to learn, easy to use and did not require the user to have any experience with or knowledge about computers. Simple, clear instructions were displayed at the top of each screen of the computer so that the user did not have to remember the commands needed to build or maintain a system. The process of constructing a system in Webofax is demonstrated in Appendix D.

The Knowledge Engineering sessions had continued every fortnight to (i) discuss the progress made on the Drug Misuse system (ii) to discuss and demonstrate prototype versions of Webofax whilst it was being developed - its features, user-interface and usability.

When the development of the new tool Webofax had been completed, the Expert was shown how to use it by the Knowledge Engineer demonstrating the construction of an example system. The original, empty Webofax software was then installed on his computer, ready for him to use. Although the ESDSU had a limited number of computers, they decided that the expert should be given one of these for a three month period so that he could develop the Drug Misuse system at home as well as at work. This proved to be a good decision as it maintained his enthusiasm and strengthened his relationship with the Unit. He was shown how to transfer the latest copy of his developing system between the two computers (one at home and the other at work) using floppy disks.

After a period of four weeks, the expert had built quite an extensive system and this was discussed with the Knowledge Engineer at their next scheduled meeting. The system contained over 100 nodes and links in the menu structure, and he had managed to prepare many of the reports which were needed at the end of these links. His secretary had typed most of the reports as she was a touch-typist. He said that he had not encountered any problems whilst using the new tool and was pleased with its speed and ease of use. He also found it helpful to have just the tool, as opposed to having all of the AIDS/HIV Expert Advisory System Knowledge base as this tended to confuse the issues and thus slowed the development process.

Webofax represented an important tool for knowledge elicitation as it helped to build a prototype system in a much shorter time period compared to using conventional knowledge acquisition techniques. It could also be used by other experts who were interested in building knowledge bases in other related areas. All these knowledge banks could then be pooled together to form one large, complete system. For example, the AIDS Expert Advisory System consisted of a large range of topic areas. Each expert or group could have been given the responsibility for one topic.

However, the self knowledge elicitation concept was more than just a knowledge elicitation tool - it could be used as a system in its own right. In theory, it could be used to develop a prototype system in any field and then be used by the developer to access the information entered in the knowledge base during development. A prototype system could potentially be developed by any user who had some experience or knowledge on a specific area, without the need for any technical skills. The ability to do this was shown to a number of interested groups during demonstrations of the system. These groups indicated that they would select an area of knowledge that they were familiar with and attempt to translate this into a structured knowledge base using the concept of self knowledge elicitation.

The Self Knowledge Elicitation Tool was also given to a number of other small groups for the development of prototype systems in which they wanted the knowledge to be retrievable via a menu mode. Some users, because of its speed, indicated that they would be interested in using this tool to develop prototype systems and then would program them (by themselves or with technical assistance) into other languages.

After about six months, the CDT Expert, Mr Paul Wells, had developed a large Drug Misuse system using his experience and expertise, complemented with textual information which was obtained from various sources. Most of the development work involving the construction of the knowledge base had been done by the expert although regular meetings were arranged between him and the Knowledge Engineer to discuss the structure and contents of the Information.

The meetings with the Expert every fortnight were also used to discuss the tool which the Expert was using - its usefulness, speed, problems etc. Although Webofax appeared to be a useful tool for development, the expert expressed concern about a number of problems which he had encountered during the development, e.g. some of the menu instructions were not displayed on the screen. He found that if he had not used the system for some time, he would forget which keys performed these tasks.

Another problem was that the instructions for editing the reports were not displayed on the screen. The most important omission from this list was the command to exit from a report once it had been added, modified or deleted. Although some commands were generally obvious (e.g. the arrow keys to move the cursor around the screen), this exit command was the least obvious because it involved pressing one of the function keys. The expert found that this was the most frustrating problem because he would sometimes have to press a number of incorrect function keys before he found the required key.

Initially, the full set of instructions and commands were provided on an instruction sheet but, not surprisingly, this was often misplaced. Also, new users who were not familiar with Webofax would find some of these problems frustrating, especially if they had not been given a proper demonstration on its use. The fact that the CDT expert could forget a command for Webofax even after many months of use should not be surprising. This is because, like many other users, he was now using a number of other software packages where function keys were used quite frequently, and these keys activated different commands depending on the package being used.

The problems mentioned above were some of the issues discussed during the knowledge engineering sessions. The Knowledge Engineer would attempt to resolve these problems and issues before the next meeting with the Expert. For example:

(i) The missing instructions were added and displayed on the screen so that trial and error became unnecessary;

(ii) Instructions were displayed on the screen so that there was no need to refer to an instruction sheet;

(iii) Two sets of commands were displayed - one for the menus and the other for the reports.

Once an acceptable level of development of the Drug Misuse Knowledge Base had been achieved (as judged by the expert), it was possible to transfer this to form part of the AIDS/HIV Expert Advisory System. However, the Expert decided that this would not be the best step forward. Instead, the knowledge bases of the General Public and Counselling modules were detached from the original AIDS/HIV Expert Advisory System and these were integrated with the Drug Misuse system to form a new system - this was termed the 'AIDS/HIV and Drug Misuse Knowledge Base' (ADMKBase).

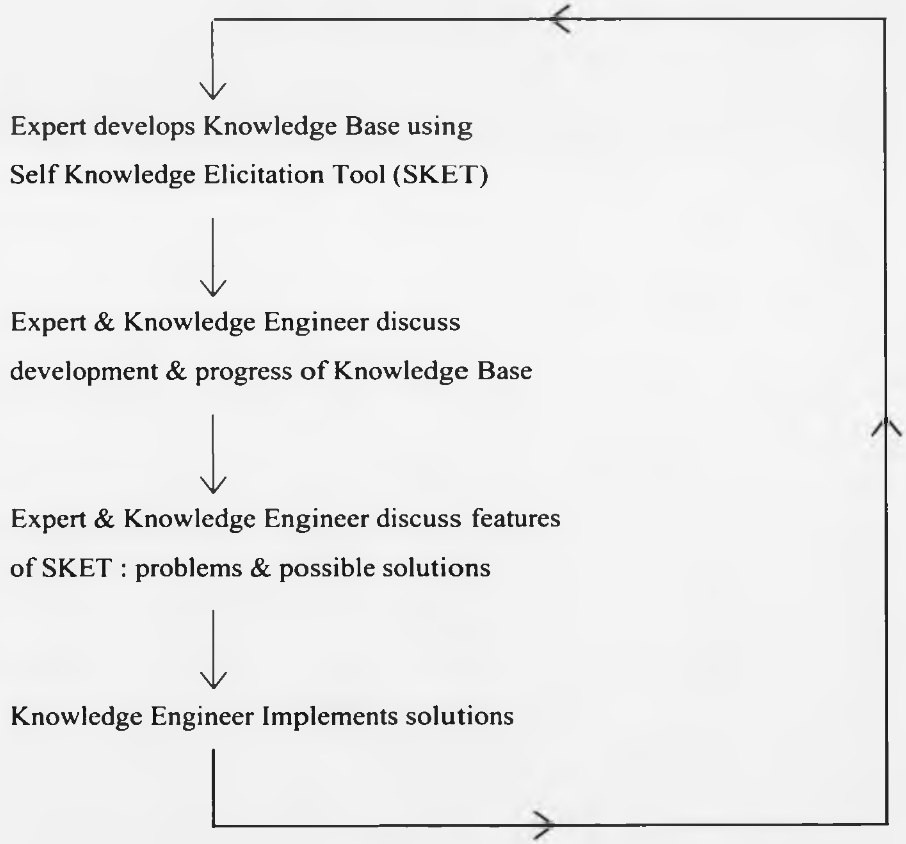


Figure 3.7

The Interaction between the Expert and the Knowledge Engineer

The top-level menu consisted of the three main modules mentioned above. These were all re-programmed to make them compatible with one another, so that they could be integrated to form one system. At this stage, the Knowledge Engineer (also responsible for programming) became familiar with the Drug Misuse knowledge contained in the ADMKBase. The contents of the Drug Misuse section are outlined in the following section.

Figure 3.7 is a diagrammatical representation of the iterative process that was used to develop the AIDS/HIV and Drug Misuse Knowledge Base. The interviews with the Expert, which are normally concerned with knowledge acquisition were now quite different. The contents of the Knowledge Base which the Expert had developed were discussed at a more general level. Generally, the Expert's opinion on the structure and content of the Knowledge Base was accepted. However, the Expert was sometimes questioned on his reasonings for the way he had structured certain areas of the knowledge.

The interaction between the Knowledge Engineer and the Expert during the development of the AIDS Expert System and the AIDS Information System was illustrated in figure 1.2. This can be compared to figure 3.7 which represents knowledge acquisition using the Self Knowledge Elicitation tool. This process concentrated more on the tool: its features, problems and possible ways to resolve them. When a solution was found and discussed with the Expert, it was programmed and then implemented. The new version of the tool was then made available to the Expert. Examples of these changes have already been discussed.

The large Knowledge Base containing a rich source of practical advice and information had been built up over the last six to nine months. So, the Community

Drug Team now had a system which appeared to be useful for operational use. The Drug Misuse section of the AIDS/HIV and Drug Misuse Knowledge Base (ADMKBase) contained detailed advice and information on a wide range of topics including drugs, the drug laws, drug terms, drug-taking, the risks involved, medical issues and rehabilitation hostels. The ADMKBase worked like the Self Knowledge Elicitation Tool (Webofax), so the expert and other staff members at the CDT had the facility to develop the system further. The system could be easily maintained and updated as often as they wished, without the need for a programmer to be consulted. It was also a useful tool for training new staff on getting them familiar with the wide range of information on drugs and drug misuse in general, as well as to teach them counselling skills and techniques.

It was important that any new features added to the Self Knowledge Elicitation tool were developed so that it was easy to learn and use. The idea was to let the Expert concentrate on the structure and content of the Knowledge Base rather than worry about learning how to use a sophisticated package. Otherwise, the Expert may as well use an expert system shell (see chapter two, section 2.3) in which case there would be no need for a knowledge engineer or programmer. The Expert would be performing all three roles - that of the Expert, the Knowledge Engineer and the System Developer. The Self Knowledge Elicitation concept can also be used for fast and easy prototyping of Knowledge Based Systems.

It was also important to have regular meetings between the Expert and the Knowledge Engineer. The Knowledge Engineer has less control over the development because he has to rely on the Expert to build the Knowledge Base. This can cause delays because the time that Experts have is already limited. In these situations, the time saved by using the Self Knowledge Elicitation tool can be lost. Ideally, an enthusiastic expert is needed so that the pace of development is kept constant.

3.5 The Contents of the Drug Misuse Section

The Drug Misuse section of the ADMKBase contains ten top-level menu items. The contents of these sub-menu items are outlined below.

Druglist - this section contains a sub-menu of the main family of drugs that are misused including opiates, barbiturates, cocaine, cannabis, amphetamines, MDMA, hallucinogens and benzodiazepines. Each group contains detailed information and has been structured into five areas to provide information on the background to the drug, the legal status, the penalties associated with it, and the effects of short-term and long-term misuse of the drug.

Drug Laws - provides general information on the Misuse of Drugs Act, the Medicines Act, the Drug Trafficking Offences Act, and the Intoxicating Substances Supply Act. There is detailed information on the Misuse of Drugs Act with explanations on the class and schedule of Drugs and gives guidelines on the maximum penalties associated with Class A, Class B and Class C drugs.

Drug Terms - this is a small but important section because it clarifies the meaning of terms which are used commonly when talking about the misuse of drugs e.g. tolerance, withdrawal effects, dependence, addiction, drug abuse and drug misuse.

Drug-Taking and Risk-Taking - describes the risks involved in misusing drugs, with particular emphasis on the dangers of overdose; misusing drugs bought from the illicit market because they may contain impurities and adulterants; taking more than one drug at a time; and injecting drugs.

Medical Issues - there are three main sections under this heading. The first section deals with the notification of drugs, gives details of the notifiable drugs and the rules about prescribing to addicts. The second section is concerned about specific complications and other problems that can occur if drugs are injected (e.g. collapsed veins, injecting into an artery). The third section provides advice and information on the treatment options available from local general practitioners, the Sub-Regional Consultant and the Regional Addiction Unit. There is a list of general practitioners who provide detoxification and other medical treatments for drug misusers in each Local Authority ward district in Coventry. This information is very important and it is requested frequently. Therefore, the list includes details of the name and surgery address of each doctor, the telephone number, the surgery opening hours, as well as other relevant information like whether an appointment is required.

Accommodation - rehabilitation hostels and housing are the two main items on which information is provided. The housing section contains a list of the names, addresses and telephone numbers of places which act as Emergency Accommodation. There is a large list of rehabilitation hostels which have been divided into separate lists: national; mixed sex; male only; female only; and those that accept children. Again the details of each hostel is given including the prices and conditions of acceptance.

Child Care - this section contains information on the NSPCC (National Society for the Prevention of Cruelty to Children). The Social Services District (SSD) Area Team's number is given under each SSD Area in Coventry.

Women and Drugs - this section is aimed specifically at women who misuse drugs. The topics discussed include heroin and other opiates, stimulants, tranquillisers, smoking, drinking, AIDS/HIV and childbirth.

Statistics - this is not a very large section at present because not many statistics are available on drug misuse. However, there is a large section on statistics under the 'AIDS/HIV Information' section of the ADMKBase.

Further Information and Help - this section is useful for those who want further help and information. There is a list of services who provide literature on drug misuse and related issues. These are listed with the relevant information, together with details of other organisations like the Standing Conference on Drug Abuse (SCODA), Families Anonymous, Aid for Addicts and Families (ADFAM), and the National AIDS Helpline.

3.6 Integration with other systems

Coventry CDT have been keeping statistical data on a PC since their services began in 1985. They need to collect, store and retrieve data in order to help them to monitor the demands made upon their services. This is essential for monitoring the effectiveness of its present services so that future services can be planned. A good example of this is the adoption of a Needle and Syringe Exchange Scheme because there seemed to be an alarming large number of drug misusers who were using drugs intravenously.

In December 1988 the CDT decided to have a new database management system developed. This needed to be designed so that it was fast, user-friendly, easy to learn and use, and contained features to produce various reports. The CDT experts (Mr Paul Wells and his colleagues) and the Knowledge Engineer discussed the contents of the forms which were presently being used and how they could be re-designed to capture important information which was previously hidden.

The layout and contents of the new re-designed forms were agreed and work was started on the development of a database management system in January 1989 by the Knowledge Engineer. This system was termed the Community Drug Team Database (CDTDBase) and was developed and programmed in the dBase IV language. It contained a large number of new features and seemed to be the most suitable database package on the market at the time. It was also cheaper for the CDT to get an upgrade using their existing dBase III software, rather than spend money on a completely new package. The CDTDBase went through a number of prototypes until May 1989, when the CDT started to use it to record information on clients as well as on the use of other services which they were offering.

In November 1989 a similar system for the Needle and Syringe Exchange Scheme was developed and integrated with the CDTDBase. This was followed by the development of a prescribing system in 1996.

The Department of Health had instructed Regional Health Authorities to establish drug misuse databases. In November 1989, the Health Secretary described this as *"a very important step forward. If we are to tackle the problem of drug misuse successfully it is essential that we have better information about the pattern of drug misuse and the impact of services."* A circular was issued on the same day requiring each region to implement a drug misuse database by 31 March 1990 (Department of Health 1989).

The CDT provide an extensive range of confidential services and these are used by a wide audience including drug users; their relatives, friends and lovers; health professionals; and members of the general public. The demands made on its services are always recorded on a number of different forms. The CDTDBase consists of five databases which reflect the main areas of the CDT's work and these have been integrated to form one system. This system replaced the previous one which the CDT staff found difficult and frustrating to use because it required the user to have detailed knowledge about dBASE III and its commands, and it was also extremely slow. It was not possible to produce useful reports and this was often done manually or by using a separate program.

The CDTDBase, which was programmed using the dBASE IV command language, solved many of these problems as it contained many advanced features which were not available with dBASE III. The CDT staff found that they were able to use the system without any demonstrations *because "the system always made it obvious what to do next"*. The forms which were being used for recording data were completely re-designed as the first step towards the development of this database management system.

It is important for the CDT to monitor the demands made upon its services so that they can plan future services by highlighting major problems. This task is simplified by the CDTDBase because it allows the user to produce lists of individual records as well as produce more detailed reports. The reports can be requested with a number of different parameters so that different time periods, drugs and areas can be considered when analysing the data. The user could be sure that the information in the reports was consistent because the system checked for the validity, integrity and consistency of the data as it was entered.

A Needle and Syringe Exchange Scheme was launched in June 1990 and this was being organised by the CDT who used their base and three pharmacies to operate it. In order to monitor its level of success, a Needle and Syringe Exchange Scheme Database was developed and integrated with the CDTDBase. The integration provided an easier way of obtaining more detailed information on certain clients who used the Scheme.

Now, the CDT had two systems - the AIDS/HIV and Drug Misuse Knowledge Base (ADMKBase) which has been described earlier in this Chapter and the Database Management System (CDTDBase). The CDTDBase provides a simple way of storing, managing and retrieving data on clients and the services used by many other people. The ADMKBase could be accessed independently or via the CDTDBase, and this provided the user with assistance in the form of information and advice, which could be used when providing a service to clients.

The rest of this section describes how these two systems were integrated to give the overall database system some "*intelligence*". This concept could be compared to the differential mode of access during the development of the AIDS/HIV Expert System and the Expert Advisory System.

Knowledge Acquisition

Each time their services are used, the CDT capture this use and other information on the different forms which they use depending on the type of client and service offered. This information is then input into the CDTDBase. It is possible to input the required details and information into the CDTDBase directly, during the period of contact with the client. The ADMKBase can be used to provide the expert with assistance when dealing with the needs of clients. This system has a large

Knowledge Base containing a rich source of information which can be accessed quickly.

The speed of information retrieval is very important, but this can sometimes be slow because the required information has to be searched from deep within the tree-structure of the Knowledge Base. Usually, more than one piece of information is required and this slows the process down further. However, the CDT have still found the system adequate for assisting them in providing a service to their clients. Nevertheless, they had expressed a concern about one problem when using the ADMKBase - it was not always obvious which part of the tree-structure contained the information they required. This was one of the problems highlighted during the development of the AIDS/HIV Information System (see chapter one).

When thinking about a solution to this problem, the Knowledge Engineer (also the Programmer) examined the concepts of the two systems, the services the CDT were providing and the way the two systems were being used. After some time experimenting, the Knowledge Engineer thought that it would be possible to generate the required advice and information automatically for a specific client. The client's personal details, characteristics and presenting needs as entered in the CDTDBase could be used by the ADMKBase to generate a mini tree-structure consisting of information which would be specific to the client being considered. This would be a positive step towards giving the CDTDBase some Intelligence. This was a similar idea to the one developed earlier in the construction of the AIDS/HIV Expert Advisory System. Retrieving information by differential diagnosis was one of the four modes of access, the others being menus, keywords and free-text searches.

The first and most important phase in the development of the proposed system was the intense interviews with the experts at the CDT. The main expert used was the CDT's Team Leader, Mr Paul Wells, but other members of the CDT staff contributed because they all had experience and expertise in dealing with clients. Each expert was interviewed separately to discuss the contents of the four forms they were using to collect data. They were knowledge engineered about the advice, information and counselling which they provided for each service, and the way this changed with the drug use, details and other characteristics of individual clients.

Development

The knowledge acquisition techniques used for the development of the AIDS/HIV Expert System, Information System and Expert Advisory System have been described in chapter 2. One of these techniques involved interviewing the experts in order to elicit their expertise. In these interviews traditional approaches for knowledge elicitation were used but these proved to be very time-consuming. The main technique used was using published sources but this too was time consuming. The knowledge engineer had to spend a long time getting familiar with the subject domain.

The knowledge acquisition techniques used during the development of the AIDS/HIV and Drug Misuse Knowledge Base were quite different. These involved using a self knowledge elicitation concept in the form of a computerised tool. This saved time (at least 3 months) because the knowledge engineer did not need to get familiar with the subject domain except at a very general level. Also, meetings between the knowledge engineer and the expert were focused more on the features of the self knowledge elicitation tool and so did not involve a great deal of time extracting expertise from the expert. After the meetings the expert played the role of the knowledge engineer, the knowledge engineer played the role of the programmer and implemented changes to the tool supplied to the expert.

During this latest period of development a combination of the two approaches discussed above were used. Each expert at the Coventry Community Drug Team was interviewed separately but with the AIDS/HIV and Drug Misuse Knowledge Base system installed and running on a computer besides them (see Figure 3.8). For all the services which they offered (and which the expert being interviewed dealt with) different scenarios were used. This was to establish what action they would take or what advice or information they would give in order to satisfy the client or enquirer. The Knowledge Base was then checked to see if it contained all this advice or information, and whether it was up-to-date and accurate.

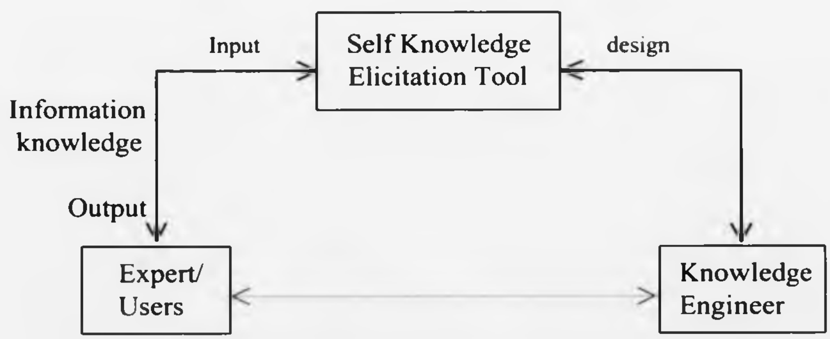


Figure 3.8
Interactions between the Expert, Knowledge Engineer and the Self Knowledge Elicitation Tool

The Knowledge Engineer made a note of all the relationships between the data supplied by a client and the advice or information supplied or other action taken by the Expert. The Expert made a note of all the information in the knowledge Base that needed adding, correcting or updating. After the interview the Knowledge Engineer would concentrate on the development of the system whilst the Expert and his colleagues would be responsible for developing the Knowledge Base using the Self Knowledge Elicitation Tool.

Although most of the interviews were recorded, the Expert and the Knowledge Engineer both made notes and the tapes were never played back. An iterative process similar to that used for the development of the AIDS/HIV Expert Advisory System (see figure 1.2) was used to refine and re-refine the knowledge and expertise which had been acquired.

The acquired expertise was programmed to produce a system which was formed by integrating the Database Management System and the AIDS/HIV and Drug Misuse Knowledge Base. During the later stages of development, it became apparent that there were still important omissions and deficiencies in the Knowledge Base. This was noticed because of the way the different situations had been considered and structured systematically. The deficiencies were discussed with the experts and these were removed by the Knowledge Engineer, who further added and refined some of the information in the Knowledge Base. Therefore, as a result of developing the Intelligent Database, the AIDS/HIV and Drug Misuse Knowledge Base also became a much more practical tool. It could be used operationally for training staff, especially new recruits and staff employed on a temporary basis. Some of the omissions found in the Knowledge Base existed because it had not yet been fully developed.

The CDT experimented with the AIDS/HIV & Drug Misuse Intelligent Database by using details of previous clients to observe and test the advice and information that was being offered. They would then make a note of any inconsistencies and omissions in the system. These would then be discussed with the Knowledge Engineer who would make the relevant changes and produce a new updated version of the system. This process continued a number of times until the system was well developed. Examples of the system being used with specific clients is demonstrated in Appendix E, with a discussion on how the information presented by the System relates to each client being considered.

Discussion - Integration with other systems

This section has described the development of an AIDS/HIV and Drug Misuse Intelligent Database. This was constructed by acquiring the knowledge of Experts at the Coventry CDT. The Database Management System (CDTBase) and the AIDS/HIV and Drug Misuse Knowledge Base (ADMKBase) which had been developed earlier, were integrated. This integration, combined with the Expertise which had been acquired by using a Self Knowledge Elicitation Tool, produced the Intelligent Database.

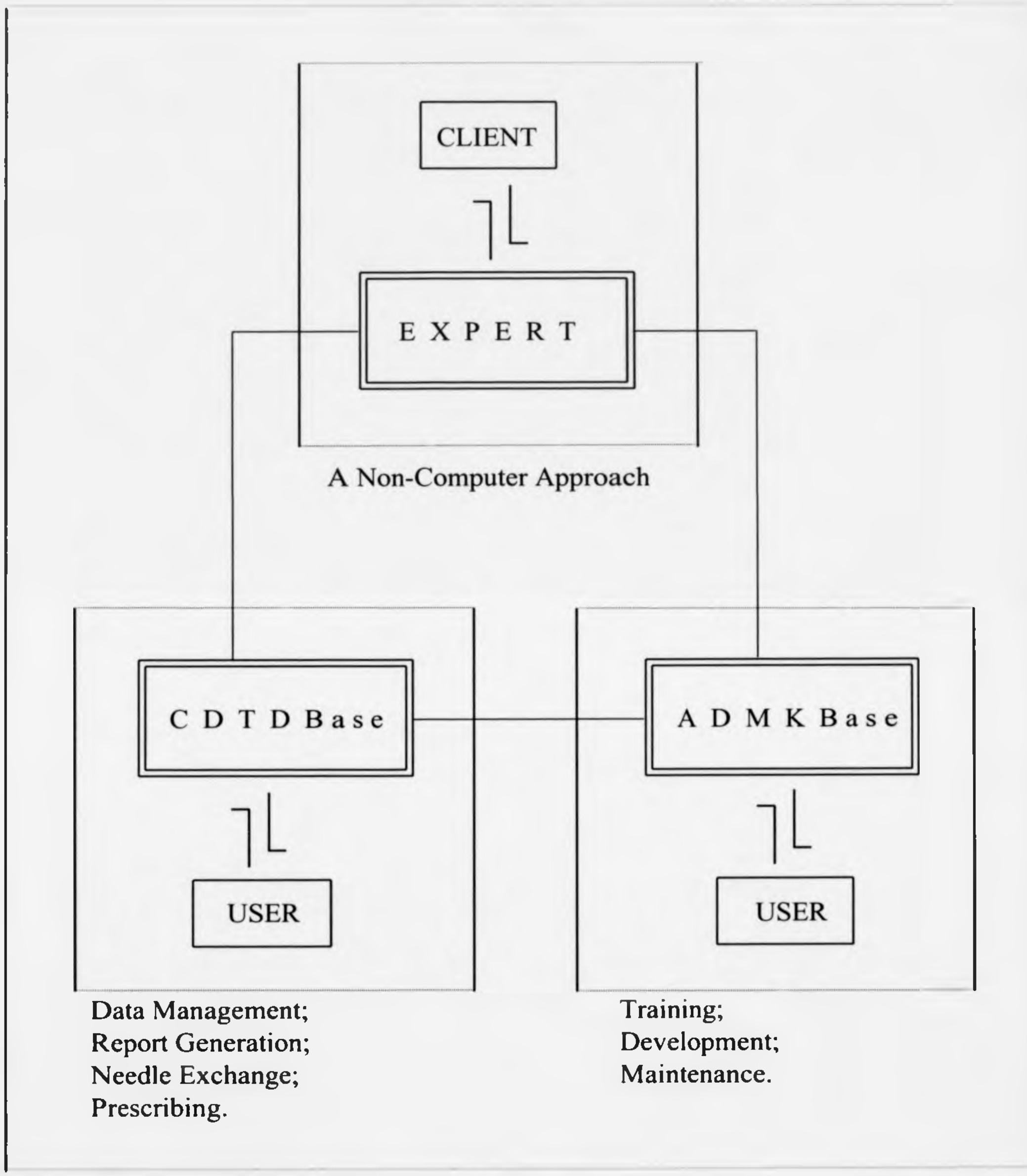
Chapter two discussed intelligent databases and how they have evolved from the integration of traditional databases with more recent fields like expert systems. Intelligent databases were defined as databases that manage information in a natural way, making that information easy to store, access and use. By using intelligent databases users can perform tasks that would otherwise not be possible.

The experts at the CDT were interviewed and their experience and expertise was knowledge engineered to find the advice, information, counselling and practical help which they provided to clients depending on their individual needs, situation and personal characteristics. This stage of the development process was essential for the development of the Intelligent Database but it also improved the consistency, structure and content of the ADMKBase.

The experts at the CDT indicated that the knowledge engineering process also helped them to check and manage their manual files and information resources, and they became better organised as a consequence. The concept of Self Knowledge Elicitation was used during the development of the system as discussed above.

The Intelligent Database uses the information on the selected client as stored in the CDTDBase and then displays the relevant advice in the ADMKBase as a tree-structure which is client-specific. This advice is then available to the expert responsible for dealing with the client. In fact, any information contained in the ADMKBase can be accessed because this is also available in three modules which are the same as those obtained when using the ADMKBase without a specific client. This provides the expert (or any other user) with greater flexibility.

It was still possible to use the CDTDBase or the ADMKBase as stand-alone systems. Figure 3.9 shows how these two systems together with the non-computerised approach can all exist independently, or as one integrated system. This system is referred to as the AIDS/HIV and Drug Misuse Intelligent Database System.



The Intelligent Database

Figure 3.9
The three systems which integrate to create an Intelligent Database

This Intelligent Database system can be compared to the diagnostic module of the AIDS Expert Advisory System. The diagnostic module of the Expert Advisory System was the most sophisticated form of access and was intended primarily for the least experienced users (see Figure 1.3 and Figure 1.4). Similarly, the Intelligent Database would be most useful to the least experienced workers dealing with clients. The system can be used to answer queries over the telephone or during personal consultations with the client. The Intelligent Database system would also be useful for even the most expert users. It will remind them of all the topics that need discussing and have readily available practical information. For example, it is possible to access the names, addresses and telephone numbers of rehabilitation hostels and give a printout to the client.

The system could also be used as a training tool. Trainees could do case studies by looking at the details of a hypothetical client (drug misuser) and deciding what advice they would give in their situation. Then, by using the Intelligent Database system, client data can be input into the database management component of the system and the knowledge base component activated (see Appendix E). The system will then present all the information on the screen which is relevant to that particular client, taking the client's personal details and circumstances into account. This will allow the trainee to compare his advice to that of the system and try to reason out the differences.

One of the problems with the differential diagnosis mode of retrieval in the AIDS Expert Advisory System was that of storage of patient data (see Chapter 1). Patient data in the form of presenting signs and symptoms together with their characteristics, had to be entered before a consultation could be carried out. If another consultation involving the same patient was carried out, all the data needed to be re-entered even if only one of the variables had changed.

The concept of the Intelligent Database system resolves this problem as it contains a database management component for storing such data. Once the data has been entered for each patient then any future consultations only requires the user to modify the data which has changed. Additional personal details would have to be stored in the system to identify each patient, e.g. reference number, name and date of birth. Details of all patients would be stored in the same system. In this way, analysis and research could be carried out on the data to establish any patterns or trends.

3.7 Discussion

This chapter has described the development of the concept of self knowledge elicitation during a research project based in Coventry at the Community Drug Team (CDT). It has explained how this concept initiated from research carried out during the development of the Expert Advisory System in AIDS/HIV; how an information system on drug misuse was developed using this concept; and how the ideas were extended so that the emerging information system would have wider use. This concept now needed to be evaluated by carrying out a post implementation review. This evaluation is described in chapter five which follows chapter four, which itself presents a review of methods and techniques used in evaluating information systems as reported in the literature.

A key feature of the self knowledge elicitation concept is the high degree of user involvement in the design and development process. Alter (1996) has emphasised the importance of users and developers working together because they each bring knowledge and understanding essential for system success:

- Developers have experience of different types of system applications and may be able to suggest approaches users would not imagine. They know what is easy, what is difficult and what it takes to make the system maintainable over time.

- Users have the most direct experience with the business problem but may not have much experience articulating the problem systematically.

Even more than twenty years ago, Lucas (1976) strongly recommended that "*users should design their own systems*", instead of viewing the analyst as the designer of the system. What he meant was that the user should actually do some of the tasks normally carried out by the analyst and that the user was capable of doing so. A number of beneficial results from user involvement have been summarised by Lucas (1976):

- It is ego-enhancing and builds user self-esteem.
- Involvement can be challenging and intrinsically satisfying.
- Involvement usually results in more commitment to change.
- As a part of the planning process, participation means the user becomes more knowledgeable about change and is better trained in the use of the system.
- We can obtain a better solution to the problem because participants know more about the present system than analysts.
- Involvement means the user has retained much of the control over operations.

CHAPTER 4

A REVIEW OF EVALUATION METHODS

"...the system, as seen by users, is the interface. They are - and should be - uninterested in the clever coding, hierarchical structuring, relational data bases, table driven software, ...that carry out their requests. They are very sensitive to the quality of the interface."

Keen and Scott Morton, *Decision Support Systems: An Organisational Perspective,* 1978.

4.1 The Role and Importance of Evaluation

Chapter two provided a review of information systems and how the changing role of information technology (IT) has had an impact on management methods and the types of information systems developed and used in organisations The substantial reduction in the cost of IT combined with increased power and communication facilities, has led to IT being at the core of business processes rather than just supporting functional processes. The use of IT and information systems does not imply that organisations will become successful. In fact, there have been many failures reported in the literature. There is a lot of uncertainty and unpredictability with investments in IT and this is why evaluation is so important. If no formal evaluation process takes place, managers will make judgements based on their own perceptions.

The problem of evaluation of retrieval systems is associated with the difficulties in defining the term *relevance*. Buckland (1991) has distinguished three different processes: the representation of an enquiry in the terms of the system; the retrieval process itself, which depends more or less on representations of what is retrievable; and the use made of what has been retrieved. This leads to two different bases for evaluation: evaluation of the retrieval system itself and evaluation of the combination of retrieval system and its users. The latter is concerned with human values from which alone utility and beneficial effects derive.

The problems of determining costs and benefits has been well documented in the information systems literature (Hirschheim and Smithson 1987, Domsch 1979, Farbey et al 1993). Many of these problems stem from the uncertainty of the life of a new system, the proportion of total IT costs which are attributable to the system, influence of a project champion or even a counter-champion, managerial competence in terms of how information retrieval from a system is utilised, and the shortage of good methods of evaluation.

Where evaluations have been carried out they have concentrated much more on the cost side of the traditional cost-benefit analysis equation, whilst not much thought has gone into the estimation of benefits, especially those related to the non-technical or social dimension. In fact, there are reports of a number of potentially high-benefit systems that were given low priority because of the difficulties associated with classifying the 'intangible' benefits (Couger 1987). Unfortunately, where information systems evaluation concentrates on the technical rather than the human or social aspects of the system, a true or meaningful evaluation picture is unlikely.

The life-cycle model of an information system consists of a number of stages which overlap or proceed in parallel, and the whole process contains a number of iterations. Evaluation should ideally be an on-going process during and following the design, programming, testing, installation and usage of the system. Unfortunately, a final evaluation or post-implementation review rarely occurs (Buckland 1991), even though it would benefit the process of future systems development, as well as personnel performance measurement and system maintenance.

The first stages of evaluation are concerned with justifying the decision to go ahead (or not as the case may be) with the development of an information system. Then, evaluation should turn to setting targets and predicting outcomes in terms of costs, benefits, risks and obstacles. The evaluation process will also aid the project manager to control and manage the project during its development stages. Once a system has been implemented and is in operational use, a post implementation review (*ex post* evaluation) should be carried out. An objective appraisal of results versus plans is the goal, e.g. are the information requirements being provided? Are information quality and system performance specifications being met?

A post implementation review can identify unforeseen or unexpected benefits or costs. It can provide a valuable learning experience about the effectiveness of the cost assessment methods used to estimate project development costs. Also, it will tell you the way people in the organisation respond to technology-based systems which should help with estimating the impacts of future systems.

Farbey et al (1993) have identified three ways of carrying out post implementation reviews:

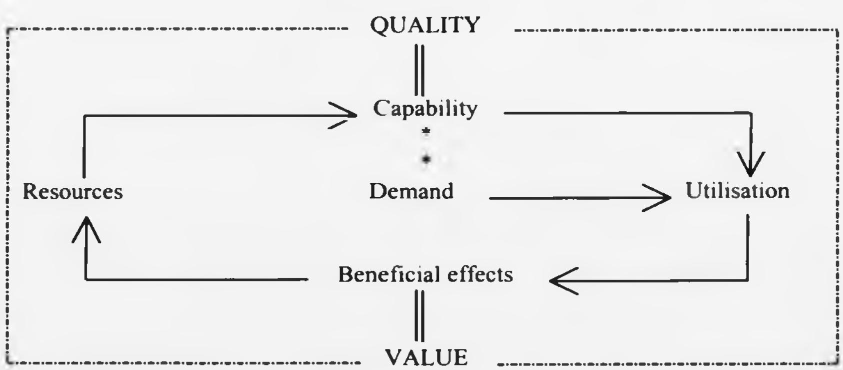
- By establishing the degree of user satisfaction with the new system
- By measuring the usage of the system
- By measuring actual performance in terms of the performance benchmarks established at the specification stage of the project

Although there is a direct relationship in the first two methods between user satisfaction and the quality and quantity of use of the system, other factors also need to be taken into account. The extent to which user satisfaction is transformed into organisational benefits is one factor. Another factor depends on whether the use of the system is mandatory or discretionary.

4.2 Evaluation Methods and Techniques

Information systems typically have good and less good features. Orr (1973) introduced the idea of information system *goodness* and questions whether it can be measured. His approach points out that there is a fundamental ambiguity in discussion of goodness of service because there are two quite different sorts of goodness: how good is it? - a measure of quality - and, what good does it do? - a measure of value.

Quality and value are both difficult to measure operationally and one tends to fall back on indirect, surrogate measures in practice. If the resources allocated to the service are large, then the service is expected to be good; if the service is heavily utilised, there is an implication both that the service is good and that it is beneficial. One would expect the value of a service to be reflected in the resources allocated to it (Buckland 1991). The dashed lines in figure 4.1 are an attempt to show these relationships.



══ denotes the practical interpretations that qualify means capability and value means beneficial effects.
── denotes assumed casual relationship.
* * signifies the need for capability to be related to demand.
-·-·-· denotes surrogate measures. The allocation of resources implies a perception quality and value; utilisation also implies a perception of quality and value.

Figure 4.1
Information System Goodness (Based on Orr (1973) and Buckland (1991))

One would expect the allocation of more resources to the service to result in better capability, i.e. better quality of service. Improved capability should lead to increased utilisation, which in turn should mean increased beneficial effects. A perception of greater beneficial effects (i.e. value) is likely to result in the allocation of increased resources.

As Orr (1973) pointed out, good management is reflected in tight connections at each point: the greater the increase in capability for any given increase in resources; the greater the increase in utilisation for any given increase in capability; and so on.

Due to the wide range of information systems that are developed and their differing circumstances, it is not possible to have one method or technique that could cope with the process of evaluation. The characteristics of a system and its organisation environment should determine which technique is best suited for that particular project. *Ex ante* evaluation is concerned with the estimate of future costs and benefits followed by decisions which justify going ahead with the project. In *ex post* evaluation the problem is to identify costs incurred and benefits achieved and to determine the extent to which these were the outcome of the changes under consideration. These will provide retrospective justification that the project had been worthwhile, and provide a valuable learning experience even if the project was not as successful as had been envisaged.

Tables 4.1 and 4.2 provide a summary of the methods and techniques that are commonly used for evaluation (Farbey et al 1993). Table 4.1 lists the more objective methods which tend to rely on conventional accounting methods to obtain the data required for evaluation. The methods in Table 4.2 are more subjective in nature where numbers are less important than a thorough understanding of the issues. These include the opportunities provided by the projected changes, the threats of failure, and the possible disadvantages which the change may bring to individuals and the organisation.

Table 4.1 Objective methods and techniques for Evaluation (Farbey et al 1993)

Method	*Level of detail required*	*Management process or method*	*Data characteristics*	*Features of method*
Cost/revenue analysis	Very detailed	Accounting and costing staff	Cost accounting and work-study methods	Concentrates on cost savings and cost displacement
Return on investment (ROI)	High	Calculation by professionals; enumerates tangible costs and benefits and aggregates these as cash flows	Tangible; direct; objective	*Ex ante* and *ex post*. Takes account of future uncertainty. Middle to high cost
Cost-benefit analysis	High	Bottom up; carried out by experts; provides money values for decision makers by incorporating surrogate measures	Enumerates cost and benefit elements and expresses them in a standard money value form; pseudo-objective	*Ex ante* or *ex post*. Selects cost-effective solutions; copes with 'external' and 'soft' costs and benefits; numbers are more important than process; provides input into return on investment calculations. High cost.
Return on management (ROM)	Low	Calculation by professionals; manipulates accounting figures to produce a residue - value added by management	Accounting totals, e.g. total revenue, total labour cost	*Ex post*. No cause and effect relations can be postulated; applies a formula. Cheap
Boundary values and spending ratios	Low; aggregate	Top-down. Involves senior stakeholders; calculation by professionals	Ratios of aggregated numbers, e.g. IT spend per employee	*Ex ante or ex post*. Good for comparisons with competitors, or others in same industry sector. Cheap
Information economics (IE)	Can be very detailed	Involves many stakeholders. Requires detailed analysis	Permits ranking and rating of objectives, both tangible and intangible	Deals comprehensively with all options. Hence rather complex

Table 4.2 **Subjective methods and techniques for Evaluation (Farbey et al 1993)**

Method	*Level of detail required*	*Management process or method*	*Data characteristics*	*Features of method*
Multi-objective, multi-criteria (MOMC)	Any level	Top-down; explores perceptions; consensus seeking; involves all stakeholders; computes best choice, helped by expert facilitator	Stakeholders revealed preferences; uses subjective evaluations of intangibles	*Ex ante*. Good for extracting softer requirements; process is more important than numbers; helps select (a) preferred set of design goals, (b) best design alternative. High cost
Value analysis	Any level; generally detailed	Iterative. Involves senior to middle management; relevant variables and their values are identified using a Delphi method	Indirect; includes subjective evaluations of intangibles; uses utility scores	*Ex ante*. Iterative. Incremental; concentrates more on value added than on costs saved; process is more important than numbers. High cost
Critical success factors	Short list of factors	Senior management define CSFs	Interview or self-expression. Quick but takes up senior management time	*Ex ante*. Highly selective
Experimental methods	Can vary from detailed to abstract	Management scientists working with stakeholders	Exploratory. Reduces uncertainty	*Ex ante*

4.3 Selecting Suitable Evaluation Methods

The previous section has described some of the more widely used methods and techniques used for evaluating information systems. Due to the wide range of objectives and the different types of applications, we need to have a wide range of evaluation methods. Some of these methods will be suitable for evaluating one type of application whilst some will be more suited for other types. The first step in selecting suitable evaluation methods is to classify the use of the information system.

Farbey et al (1993) have classified applications using a model which postulates a ladder, where each rung of the ladder represents a type of application. This model is shown in figure 4.2. As you go up the ladder the applications represent increasing potential benefits but also increasing risk of failure, and the evaluation

Rung 8	Business transformations
Rung 7	Strategic systems
Rung 6	Inter-organisational systems
Rung 5	Infrastructure
Rung 4	MIS and DSS systems
Rung 3	Direct value added
Rung 2	Automation
Rung 1	Mandatory changes

Figure 4.2

The Project Ladder

technique will change for each rung. It is possible to quantify costs and benefits more precisely nearer the bottom of the ladder; whereas experimental and judgmental processes have to be relied on as we step up towards the top of the ladder. The Self Knowledge Elicitation Tool, discussed in detail in chapter 3 and which is the focus of this thesis, would fall into rung 4 (management information and decision support systems) in this model.

The applications in this category include management information systems, decision support systems, expert advisory systems and executive information systems - all of which have been described in chapter 2. These applications allow the users or managers to make better and more informed decisions by giving them information which is more relevant, reliable, accurate, timely and presented in a more digestible form. However, it should be noted that value will only be added if the users have the opportunity and capability to use the information effectively.

The purpose and timing are two important factors that will affect the way an evaluation is carried out. *Ex ante* evaluation before a project is given the go-ahead and *ex post* evaluations following implementation and use have already been discussed. It is also important to understand the *context* in which an evaluation is taking place. The influencing factors which define this context have been classified by Farbey et al (1993) into five main groups:

- The role of the evaluation, i.e. the time and level of the organisation at which it carried out.

- The decision environment in which evaluation will take place, e.g. the culture, past experience in implementing information systems.

- The system characteristics - is it a specific application or does it provide an infrastructure? Is it a core role or a sporting one?

- The organisation characteristics - is it a leader or a follower? Is the industry that it is operating in stable or is there a lot of change, restructuring, turbulence and high levels of IT development?

- The specificity with which cause and effect between an investment and its benefits can be linked.

These five dimensions can be used as a guide to characterise the circumstances in which the Self Knowledge Elicitation Tool is to be evaluated. As already discussed in the previous chapter, the post implementation review stage of the evaluation process will be the main concern for this project. There are a number of factors that must be considered in order to determine the success of a system at this stage (Gremillion and Pyburn 1988). These are the extent to which the system:

- Has met the original projections for development and operational cost
- Reflects the technical design specification
- Reflects the functional design
- Satisfies the user's original information requirements
- Satisfies the user's information requirements, as they are now perceived.

One of the most important reasons for doing a *postaudit* is to help refine our ability to estimate project costs and benefits. By comparing the actual costs and benefits with those which were estimated at the beginning of the project, we can learn where mistakes were made and how we might avoid them in future projects. The Self Knowledge Elicitation Tool will be evaluated both at the senior level as well as the operational level. This is achieved easily because the organisation is very small and one of the key users is also the senior manager.

It is now necessary to *match* the Self Knowledge Elicitation Tool with suitable evaluation technique(s). A systematic means of performing this matching process has been developed by Farbey et al (1993) and consists of three stages:

1. Represent the circumstances of the Self Knowledge Elicitation Tool (using the five broad dimensions listed above) as points on a series of 2 x 2 matrices.

2. Use the information about evaluation techniques (see tables 4.1 and 4.2) to locate each technique at some point on a 2 x 2 matrix.

3. Overlay the matrices to match technique(s) to the Self Knowledge Elicitation Tool.

Stage 1 is summarised in figure 4.3 which consists of six 2 x 2 matrices representing the five broad dimensions listed above. Some of the variables are either/or: stage of involvement; level at which justification carried out; decision process; and directness of impact. In these cases a cross can be place in the middle of the appropriate quadrant. The rest of the variables can be scaled (e.g. from 1 to 10) to indicate the importance of those particular variables. Four out of the five dimensions have two sub-dimensions which make up the horizontal and vertical variables of the matrices; whilst one of them (the decision environment) has four sub-dimensions and these are represented by matrices (b) and (c) in figure 4.3.

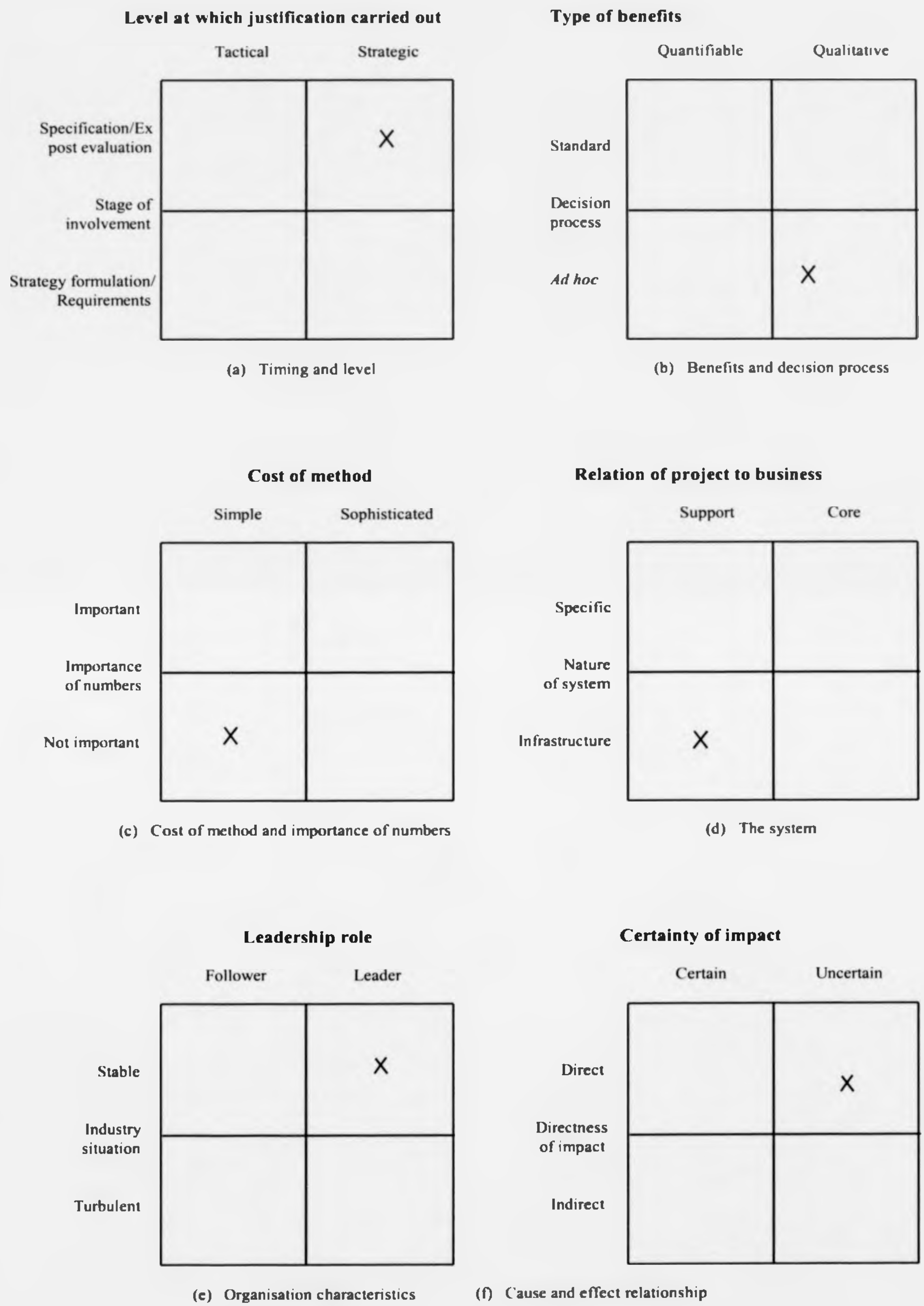


Figure 4.3
Stage 1 of the Matching Process

The six matrices shown in figure 4.3 can be overlaid to provide one overall summary matrix (see figure 4.4). Farbey et al (1993) have loosely defined the horizontal scale as the *role of IT within the organisation* and the vertical scale as *Evaluation constraints*, both of these being derived from the horizontal and vertical scales of the six matrices in figure 4.3.

Stage 2 of the matching process requires the location of the evaluation methods summarised in tables 4.1 and 4.2, and this is shown in figure 4.5.

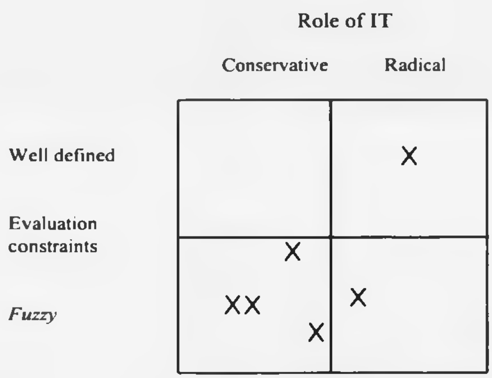


Figure 4.4
Summary matrix

From figure 4.4 it can be seen that the crosses lie mainly in the bottom-left quadrant, i.e. IT is being applied in conservative ways but in a fuzzy decision-making environment. Experimental methods and MOMC methods are exploratory in nature and they can cope with uncertainty in the decision-making process.

Although this matrix method is not very precise, its simplicity makes it a worthwhile technique to use to promote an awareness of the options available.

Evaluation constraints \ Role of IT	Conservative	Radical
Well defined	ROI	CBA
Fuzzy	EM MOMC	BV CSF IE ROM VA

Figure 4.5

The evaluation methods. (BV, boundary values; CBA, cost-benefit analysis; CSF, critical success factors; EM, experimental methods; IE, information economics; MOMC multi-objective, multi-criteria; ROI, return on investment; ROM, return on management; VA, value analysis)

4.4 Discussion

This chapter has stressed the need and importance of carrying out evaluations of information systems. The different types of applications and the wide range of objectives when developing systems means that we need a wide range of evaluation methods, and it is impossible to have one technique that can be applied to all systems. The commonly used methods and techniques have been presented, some of these will suit one application whilst others will suit another application.

For information systems evaluation to be meaningful, both technical and non-technical (i.e. social and human) criteria must be included in whatever method or technique used. The technical aspects are more objective and therefore easier to measure but the non-technical aspects are subjective and therefore difficult to deal with. In the past, the social aspects of the system have either been neglected or an attempt has been made to qualify them so that a technical or scientific technique could be applied.

Having reviewed some of the methods and techniques available for evaluation of information systems in this chapter, the next chapter describes the evaluation that was carried out for the Self Knowledge elicitation Tool.

CHAPTER 5

EVALUATING THE CONCEPT OF SELF KNOWLEDGE ELICITATION

"..Mankind has not
Woven the web of life,
We are but one thread within it
Whatever we do to the web
We do to ourselves
All things are bound together
All things connect ..."

5.1 Introduction

Chapter three described the development of an information system using the concept of self knowledge elicitation. The need to carry out a post implementation review was established. This was followed by chapter four which reviewed some of the most common methods and techniques being used for evaluating information systems. A systematic method using 2x2 matrices which was developed by Farbey et al (1993) was used to find suitable evaluation techniques for the self knowledge elicitation tool. The general conclusion was that IT was being applied in conservative ways but in a fuzzy decision-making environment. This chapter leads in from the previous two chapters and describes the evaluation of the system in question and discusses the findings.

The information system on drug misuse developed in liaison with the Community Drug Team (CDT) in Coventry was evaluated before the project began as well as on an on-going basis. As a result modifications were made to the self knowledge elicitation tool in order to improve the efficiency and effectiveness of the process of building information systems using this approach. This development period continued for approximately nine months. After this period CDT continued to use the system for several years. This indicated that it was a useful system but which still should be evaluated thoroughly. Rather than limit the evaluation to one organisation, it was decided to approach other similar organisations who would be willing to participate in the evaluation process.

Twenty-one other units were contacted and they all agreed to take part but they could not guarantee the resource commitments at this stage (in terms of staff time). Two areas would need to be evaluated:

(a) how useful was the information system on AIDS/HIV, drug misuse and counselling developed by CDT and the Expert Systems/Decision Support Unit (ESDSU); and

(b) how useful was the self knowledge elicitation concept itself.

I decided that the best way to evaluate the system was to have a number of meetings with each unit which agreed to participate, in order to get some informal feedback and ensure that there were no problems in trying to use the system. The exact nature and number of visits to each unit would be determined by the time constraints of the project as well as the number of units that were involved. This informal feedback would then be followed by a formal evaluation using a specifically designed questionnaire. It was important to attempt to capture both the tangible and intangible benefits using both the informal and formal methods of evaluation. In the past the intangible benefits have largely been ignored because they are more difficult to measure and are not always accepted by management (see chapter four).

5.2 Preparation

Twenty-two teams or units (including Coventry CDT) who provide advice, information and counselling services to alcoholics and drug misusers, their relatives and friends, professionals and students, were contacted by telephone. Most of these units also provide services like outreach work, needle exchange schemes, prescribing as well as advice, information and counselling for people concerned about AIDS/HIV. Fourteen of these units agreed immediately over the telephone to collaborate and a date for installing the system and doing some training on its use was arranged. With the other eight units, a preliminary meeting was arranged with each manager/team leader of the unit (and usually one or two workers from the unit also attended) to discuss the implications of installing and evaluating this system at their site. Agreement was achieved from all the units following these meetings, and again a date for installation and training was arranged.

There are a number of reasons why all 22 teams agreed to participate:

- Many of the units were aware of the existence of this information system at Coventry CDT from either visits to their office or from discussions at regional meetings between the drug agencies. I was told by some of these units that they had received positive feedback about the usefulness of the system from Coventry. A few of them had actually used the system briefly during their visit there.

- I had developed a tailor-made database management system for 19 out of the 22 units, similar to the one designed for Coventry CDT (see chapter three). As a result, I had worked closely with the team managers, workers and administration staff and a good working relationship had developed over recent years.

- The units knew that I was familiar with the set-up and configuration of their hardware and software, and had provided technical support to many of them over the past few years. Thus, they were relaxed about allowing me full access to their personal computers and networks.

- Apart from staff time evaluating the system (using, developing, maintaining the system and providing feedback) there were no additional costs. I would be responsible for providing technical advice and support for the system. All of the units had identified at least one existing PC on which the system could be installed, and so there would be no additional hardware or software costs.

- There could be benefits, e.g. if the system provided relevant, accurate and timely information. This would also depend on how this information was accessed and used at present and how efficient the present methods were.

- The units knew that at least 21 other teams would have the system for evaluation, and they did not want to be '*left out*'. Having knowledge that so many similar teams were participating appeared to add credibility to the whole process.

For each unit, the installation/training date which had been arranged was used to first install the system onto PCs that had been identified by the unit. This was followed by a 20 minute briefing session on the system, which included a demonstration on how to use it. The installation of the system took between two and three hours depending on whether they wanted it installed on a network, on more than one PC and on whether this included a notebook computer. They were allowed to ask as many questions as they wished during the training session. An instruction manual was left with them and this contained a detailed description of each facility available on the system (see appendix D). The system which was left with each unit consisted of three sub-systems (options):

(1) Build a system from scratch
(2) Drug Information System
(3) AIDS/HIV, Drug Misuse and Counselling Information System

Option 1 was completely empty of any information and was just an empty shell of the system. This could be used to develop a new application which would be relevant and useful to the unit developing it. Options 2 and 3 could be browsed to give users ideas for their own application when using option 1. It was possible to develop any number of new applications by defining each application as the top level menu.

Option 2 was an example of a system which had been developed by Coventry CDT by starting with an empty shell (option 1). The top level menu of this consisted of the following topics:

- Druglist
- Drug Laws
- Drug Terms
- Drug-taking and Risk taking
- Medical Issues
- Rehabilitation Hostels

Option 2 could be used not only to retrieve information, but to modify or update it or even add new information as necessary. Modifications could be made to the structure of the menus as well as to the reports. In fact, it was possible to delete everything in option 2 and end up with the same system as option 1.

Option 3 was a more detailed and extensive system with the top level menu consisting of the following topics:

- Drug Misuse Information
- AIDS/HIV Information

- Counselling Advice

The drug misuse information section was similar to Option 2 but contained more detailed information as it was developed further by Coventry CDT and ESDSU, especially following the integration of the information system with Coventry CDT's database management system. The AIDS/HIV information and the counselling information was derived initially from the Expert Advisory System for AIDS/HIV (see chapter one). However, it was developed extensively following its use at Coventry CDT particularly following the integration with their database management system just mentioned.

The AIDS/HIV Information section consisted of the following sub-sections:

- Description, Causes, Origins of AIDS/HIV
- Medical Aspects of AIDS/HIV
- AIDS/HIV Higher Risk Groups
- Transmission of AIDS/HIV
- Advice Related to the AIDS/HIV Test
- AIDS/HIV Statistics
- AIDS and Children at School
- AIDS and Employment
- AIDS and First-Aid
- AIDS and Travel
- Sources for Advice, Help and Further Information

The Counselling Advice section consisted of the following sub-sections:

- Introduction

- Breaking bad news to patients and relatives
- Important facts to get across
- Information which counsellor should obtain
- Uncertainty and its implications
- Anxiety
- Depression
- HIV disorders
- Practicalities
- Lovers, Friends and Relatives

The three systems could really be thought of as one system at different stages of development. There was no real need to have options 1 or 2 installed as anyone wishing to develop a new application could use option 3 and add an extra item at the top-level menu for each new application, identifying the name of the application and then building it from there. However, setting it up as three sub-systems would make it easier to see exactly what they had done with options 1 and 2 when evaluating it. The instructions for developing and using all the sub-systems were the same for obvious reasons. All the functions and facilities available on the system were not demonstrated to the users deliberately. This was to test if the user could learn and use these by himself either with the help of the instruction manual or by experimenting with the system.

5.3 Development: Monitoring and Feedback

One member of staff from each unit was nominated to be the contact point, and who would coordinate and monitor the use of the system in liaison with the system developer (myself). He/she would be responsible for providing feedback and for contacting the system developer if there were any queries, comments or problems.

All units were informed that they would have a minimum of three months and a maximum of six months to use the system before any *formal* evaluation was carried out, but that there would be on-going evaluations on a informal basis taking place. However, the system would be available for an unlimited period after this time and so any application they developed would not be wasted.

The installation of the system was spread over a two month period due to the large number of organisations involved and the distances between them. The 22 units where the system was installed were:

1. Coventry Community Drug Team
2. Burton Drugline
3. Stafford Drugline
4. Shropshire Drug Help Project, Telford
5. Kidderminster Community Drug Team
6. Redditch Community Drug Team
7. Alcohol Advisory Service, Coventry
8. Druglink North Staffs, Stoke-on-Trent
9. Cannock Drugline
10. Birmingham Drugline
11. Drug and Alcohol Services Herefordshire, Hereford
12. Alcohol and Drug Advisory Service, North Warwickshire
13. Alcohol and Drug Service, Solihull
14. Rugby Community Drug Team
15. Worcester Druglink
16. Alcohol Advisory Service, Rugby
17. Alcohol Advisory Service, South Warwickshire
18. Substance Misuse Unit, Shrewsbury

19. South Birmingham District Health Authority
20. HIV Network, Coventry
21. South Warwickshire Drug Advisory Service
22. St. George's Hospital, Stafford

Two or three weeks after installation, each unit was contacted by telephone to check everything with the system was satisfactory and to answer any questions that may have arisen since set-up. Approximately six weeks after installation, a visit was made to each unit to see if the system was being used, ensure they were not encountering any problems and to get some informal feedback. As a result of these visits, the system was additionally installed on a notebook computer for two of the units. This was because some of the workers did not get a chance to use the system because it was being occupied most of the time by other workers, working on a range of applications.

One unit had their premises broken into and their server for the PC network had been stolen, therefore the system had to be re-installed on their replacement server when it arrived. A request was also made for an additional copy of the system to be installed on their notebook computer and this was done. One of the units who had only one key staff member trained to use the system, had left, therefore another two workers were briefed and given the same demonstration as the other units had been. A number of units had either misplaced their instruction manuals for the system or requested additional copies, all of which were supplied.

A number of letters were received from the nominated coordinators for the units (as explained above). These have been copied with the permission of the individuals and the organisations concerned and are shown in appendix F. Nevertheless, the individual's name, the date of the letter and other references have been removed from all of these letters but the unit's name has been retained. These letters will now be discussed briefly in the order they appear in appendix F.

Letter 1 - Shropshire Mental Health NHS Trust

This is very positive feedback from a user who has a fair amount of experience with computers in terms of usage. He likes the contents of the existing system and the way it is structured, particularly the ability to edit both the structure and the reports. His only criticism is that a print facility is not available. He expressed his concern about security and suggested making parts of the system read-only, and the rest password protected. He also developed a new application on Community Mental Health Trusts and this is discussed later in this chapter, in Section 5.5.

Letter 2 - The Regional Drug Misuse Database Unit

This feedback is from an experienced user of computers at the West Midlands Regional Drug Misuse Database Project. All drug misuse units in the West Midlands Region are responsible for supplying this centralised regional unit with information on all drug misusers that they have face-to-face contact with. This is done by either completing the standard forms supplied by the Regional Database Project or by generating the information automatically using their own local database management systems.

This user thinks the reports are too long and suggested dividing them into bullet points or further sub-headings. The ability to use advance facilities like tabular and graphical information when editing reports is also required. Another problem with the system is that one of the function keys has to be used to exit and save reports (the F7 key) *even* if the information has not been edited.

Putting this system on the Internet is suggested as an easier means of distributing the information. However, concern is expressed about the cost implications. To gain access to the Internet, users would need to upgrade their PCs with a modem and would need to pay a monthly subscription to a service provider, e.g. CompuServe, Demon, Easynet (usually between £6 and £12), as well as pay telephone charges which are variable depending on usage.

Letter 3 - Rugby Community Drug Team

The system installed at this site is available and used by a large number of people. Although they are generally finding it easy to use, they did experience the same problem reported in letter 2 about the function keys for exiting and saving reports. In terms of system maintenance and updates, they feel that this should be done centrally for the core of the information but local information (including any new applications that they may have developed for their own use) would be done by their own unit. Another two suggestions were the ability to print information, and networking the computers in the agency (local area network) or externally to other organisations such as probation (wide area network). This unit has also developed their own application, details of which are in the letter, and are finding this very useful as a practical tool.

Letter 4 - North Worcestershire Community Drug Team

This unit do not see this system as a practical tool on a day-to-day basis in its current state. They would need the information supplied and updated centrally on a regular basis, although they would maintain and update their own local information. Two means of distributing this information is suggested: using a floppy disk (or CD-ROM if large volumes are involved), or using the Internet.

Although they preferred the Internet method of distribution, they felt that it would be more difficult to justify due to the costs involved.

Concern was expressed at the system being DOS based, especially as all their other applications on the PC are *Windows* based to which they are more familiar. A number of topics that they would find useful as part of the system are listed.

Letter 5 - Coventry Community Drug Team

This letter is from a unit which has been using the information system for several years. A lot of changes have taken place to their unit since they first started using and developing this system using the concept of self knowledge elicitation. Their workload has increased dramatically, the number of workers have increased, the services they provide have been expanded, they have a PC network (instead of just one or two PCs as in the past) consisting of six PCs each with a high specification.

The letter speaks for itself, providing a good summary of what would need to be done to make the system a more practical tool for use by other agencies, based on their own experience of regular use for several years. Although it appears to be a good idea to them, doubt is thrown on whether agencies would use the facility of an information system integrated to a database management system. One of the reasons that this 'extended' system would not be used practically is because information for the database management system is not collected interactively with the client present. It is first recorded on paper forms by the workers and then input into the database management system at a later stage by administration staff. Workers inputting and outputting information on a computer with the client present may be more acceptable by the clients in the future as computer technology is more common and widespread. Also, the possibility of cheaper notebook computers in the future which can be taken into counselling session rooms (where clients are normally seen) would also help in making this possible.

To date, Coventry CDT have mainly used the 'integrated' system for training purposes and the majority of the time the information system is used without the links to their database management system. However, the linkages have helped to improve and extend the information system, making it more practical and useful as a stand-alone system.

The last paragraph of the letter neatly summarised everything in this letter and many of the points made in the first four letters:

> *"Overall, I feel that by defining the target audience and the core information, improving the presentation and having the facility to configure the system locally there should be a market for Webofax."*

5.4 Data Collection for Formal Evaluation

Whilst the units were using the system a questionnaire was designed in order to carry out a formal evaluation. Although a lot of good constructive feedback had been received from regular meetings with the 22 units and from written feedback (e.g. letters as discussed above), a standard format of questions for all units would supplement and enhance the evaluation process. Since there were so many organisations involved a questionnaire seemed the most appropriate method of getting standardised feedback.

The main features of the system, its ease of use, usefulness, and the unit's experience using and developing the system were listed initially as the variables which needed to be evaluated. These were used to design the questions for the questionnaire, which was supplemented with additional requests for information on the unit's services, hardware resources and configuration, staff numbers and their experience with computers. The questionnaire went through a number of revisions using the assistance of a psychologist, two statisticians and two users of the system.

The final questionnaire is shown in appendix G. A section on the right-hand side has been included for additional comments that the user may wish to make, especially if their answer to certain questions is not covered adequately by the choices available. This can also be used if the answer that they have given needs clarification or other factors to be taken into consideration.

The questionnaire was sent out to each of the 22 units taking part in the evaluation with a covering letter asking them to return it by a specified date. In the meantime, a spreadsheet was set up (using Microsoft Excel) so that the data could be input when the completed questionnaires were returned. All units were contacted by telephone to check if they had received the questionnaire and ask if they would be able to return it by the date specified. Contact with each unit was always made through the nominated coordinators for the project, as discussed earlier.

Approximately half of the questionnaires were received by the requested date or within a few days of it. The rest of the units were contacted by telephone to ask if they were still prepared to complete and return the questionnaire. The importance of receiving enough replies to carry out a proper evaluation was stressed. The majority of the units said that they would return them and had not managed to so far because of workload, annual leave or sickness. One unit had misplaced their questionnaire and so another copy was sent out to them.

More questionnaires streamed in over the following six weeks, some only after a number of further telephone calls. At this stage, 20 questionnaires had been received in total and no further attempts were made at 'recovering' the two outstanding ones. All the information received was input into the spreadsheet which had been designed specifically for the questionnaires, which then made any analysis of the data and output into graphical form easier.

5.5 Results

The results of completed questionnaires received from the 20 units participating in the evaluation study are summarised in Appendix H. The findings are now discussed below and include additional comments and information supplied by the users.

General Information

The position in the organisation of users who completed the questionnaire was fairly evenly distributed between manager/team leader (30%), worker/counsellor (40%) and administrator (30%). No one had any programming or development experience with computers. Approximately half (55%) had a good or reasonable amount of experience which included word processing, database and spreadsheet packages; the rest (45%) had relatively less or no experience with computers. This is quite a subjective question because users define their level of experience in different ways, but the results appear to give a reasonably accurate picture based on my informal observations when visiting these units. The ones who only have limited experience tended to be the managers, who were users of the information obtained from PC systems by other staff, but did not use the systems themselves. It was interesting to note that two or three users, who had classified themselves as having a good or reasonable level of experience on the questionnaire, had indicated that they had very little or no experience with computers at the start of this evaluation project. In many cases, this was more than six months ago and they had since taken an interest in learning more about PCs through training courses and getting more involved with this type of work.

The number of full-time staff who use a computer ranged from 2 to 9 and the average for all the sites was 5. All units had a smaller number of PCs than staff, ranging from 1 to 7 with an average of 2.75. Many of the users (60%) indicated that they encountered problems gaining access to a personal computer with the information system on it. The most common reasons given for this was the shortage of PCs and the information system not being installed on their network and so it could not be accessed from any PC (these units had not requested a network version of the information system).

Half of the units (50%) only had one or two computers at their site, and so it was not surprising to find that many of them (55%) did not have a local area network, some had a part-network (15%), and the rest had all their PCs networked (30%). It was interesting to note that from the units that were fully networked no one indicated that they had problems gaining access to a PC with the information system on it. This is partly due to the fact that fully networked units generally have more PCs - their staff to PC ration is greater (0.71) than the staff to PC ratio for all units taken together (0.54). It should be noted that the units who had a part-network did not choose to have the information system installed on this, but on one or two stand-alone PCs instead.

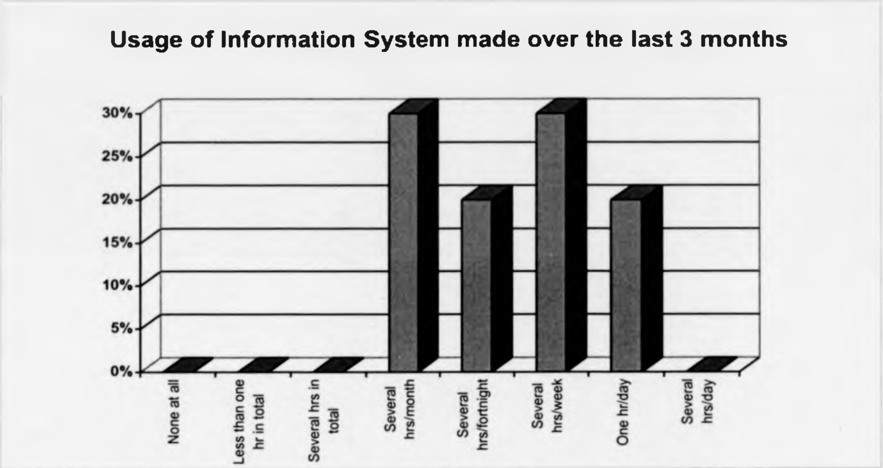
The services that the twenty units provide include counselling (95%), advice/information on drugs (85%), advice/information on alcohol (30%) and advice/information on AIDS/HIV (10%). All services providing advice/information on drugs will generally also provide advice/information on alcohol (it can be regarded as a drug) and AIDS/HIV. However, there are usually special and separate teams who can deal with these problems and provide a more specific service to clients. For example in Coventry there is a Community Drug Team, an Alcohol Advisory Service and an HIV Network. The units have therefore only ticked their main services.

Use of Information System

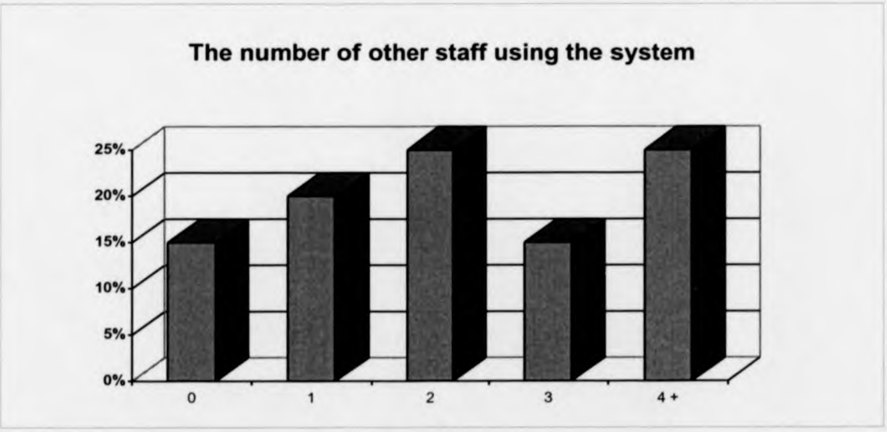
One quarter of the units (25%) only had access to one PC with the Information System on it, another quarter (25%) had access to at least four PCs, whilst the other half (50%) had access to either two or three PCs. Five units (25%) had the system on a laptop or notebook PC in order to increase mobility e.g. working from home.

All the units used the system for at least several hours every month for the three months prior to completing the questionnaire. No one used the system for several hours per day on average. The usage from the units is shown on the chart in figure 5.1(a).

The number of other staff using the Information System (apart from the user completing the questionnaire) varied from no other users (15%) to at least four other users (25%) as shown in figure 5.1(b). The question specified that the staff must have used it on more than a few occasions to be included because many staff may have used it once or twice out of curiosity only. There was no relation between the number of other staff using the system and the number of staff who normally use a PC at the site. For example, one unit had no other users accessing the system, although there were four other members of staff who normally make use of a PC. However, this may have partly been due to problems gaining access to a PC with the information system on it.



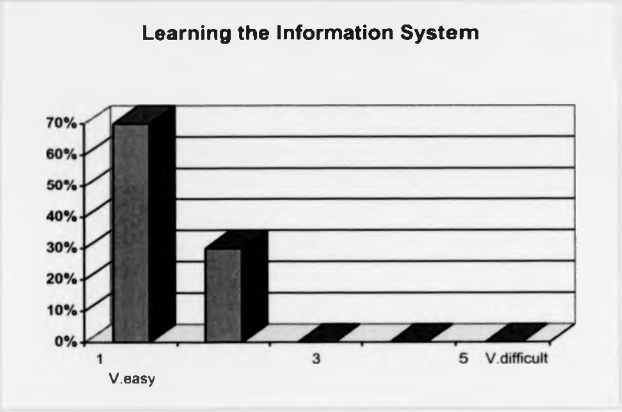
(a)



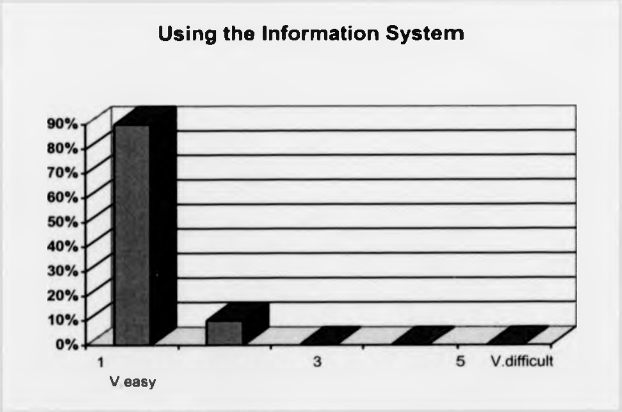
(b)

Figure 5.1
Usage of the Self Knowledge Elicitation Tool

All users found it easy to learn and use the system (see figure 5.2). Three users indicated that they had problems exiting out of the reports the first time they used it but resolved it after consulting the instruction manual. There were five users with additional comments expressing (a) their preference for a windows based environment as this was more familiar and/or (b) an improvement and increase in the editing facilities when working on reports. Two other users commented that making it too easy to use compromised on advanced functionality.



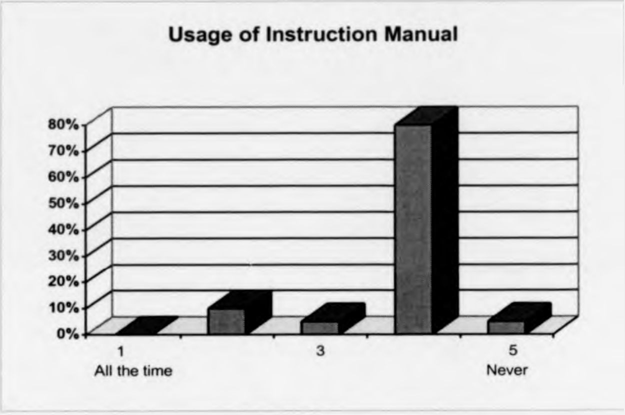
(a)



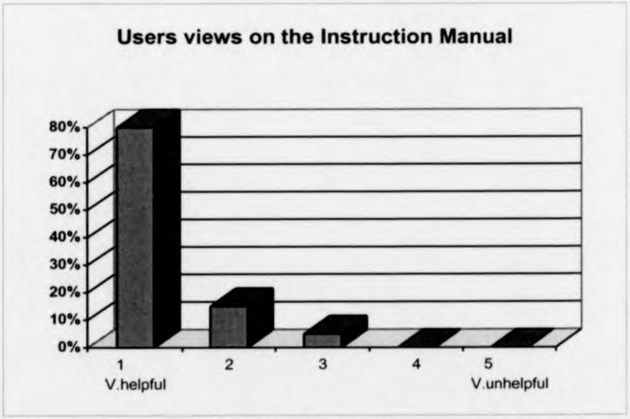
(b)

Figure 5.2
Learning and Using the Self Knowledge Elicitation Tool

The instruction manual was used very infrequently by most users (see figure 5.3). However, by studying the reasons given by users for not using it very often were that they did not need to. Most used it the first and second time and then only referred to it for the advanced or least frequently used functions (e.g. link, join). Most users found the instruction manual helpful when they did use it.



(a)



(b)

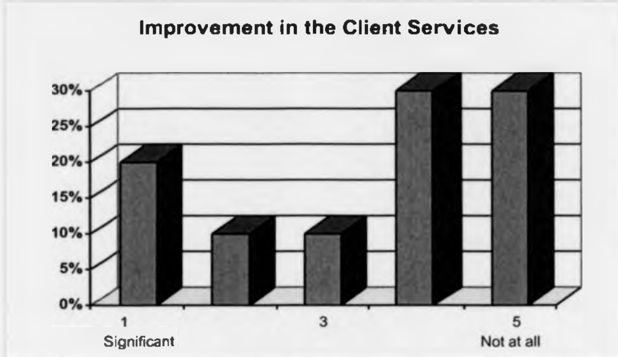
Figure 5.3
Instruction Manual for Self Knowledge Elicitation Tool

Effect of Using Information System

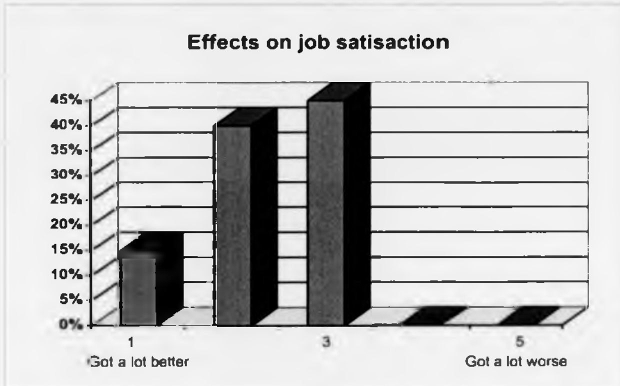
Many users (60%) did not feel that using the information system improved client services (see figure 5.4(a)). Additional information from these users indicated that they were not trying to use the system for clients at this stage as they only saw the system as a trial. Some (20%) indicated that it improved client services significantly and it was noticed that all of these had developed a small application and most of them were referring to the use of this section for the improvement.

No one's job satisfaction got worse as a result of using the information system and nearly half (45%) said that it had no effect (see figure 5.4(b)). Just over half (55%) found that the system improved their job satisfaction because it made their job more varied, it gave them the opportunity to use PCs more regularly, they were able to get information about drugs and counselling for their own understanding and awareness (especially administrative staff who were not expected to know this sort of information), and they were able to look up information they could not obtain elsewhere easily.

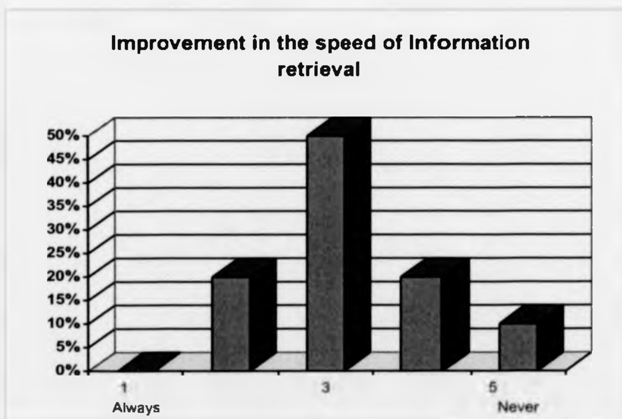
Generally, many units thought that information retrieval was only speeded up sometimes (see figure 5.4(c)). Most of the units who scored 4 or 5 for this question provided alcohol services as one of their main areas of work and there was no specific information on alcohol. Users indicated that they found it quicker once they knew what range of topics were included in the system. Some indicated once again that PCs were not always available when some information was needed, therefore it was quicker to obtain it elsewhere.



(a)



(b)



(c)

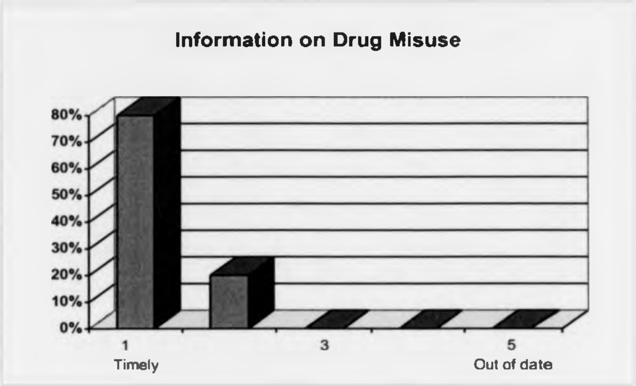
Figure 5.4

Effectiveness of Self Knowledge Elicitation Tool

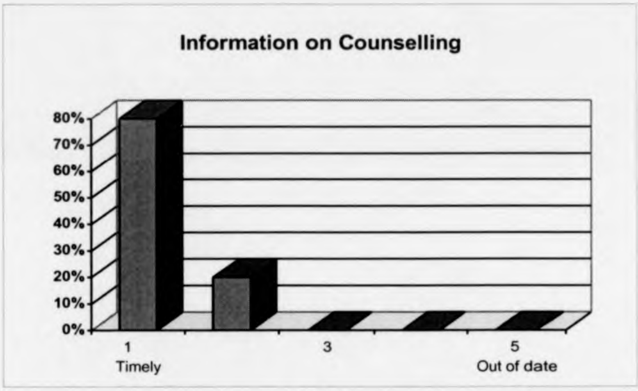
Information Content of System

All users found the information on drug misuse and counselling timely but the majority felt that the information on AIDS/HIV was out of date (see figure 5.5). Users appreciated the wide range of information on AIDS/HIV and the detail to which many of the reports went into as this was not generally available elsewhere. However, they felt that many of the sections were out of date. Some of these sections would need updating every month (e.g. the section on AIDS and Statistics which had a lot of statistical information on number of cases of HIV and AIDS both in this country and other parts of the world) as new figures were released every month. These figures were always sourced and dated with the exact period covered specified clearly. Some users said that they would update some sections of the system but would not always know where to obtain the information from in the first place.

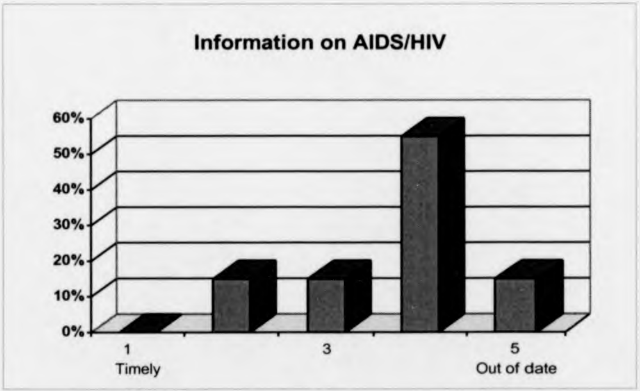
The majority of users (85%) found the information contained in the system quite accurate (see figure 5.6(a)). Some users found a number of spelling mistakes but were pleased that they could correct them easily using the facilities provided. One user thought that the language in some parts of the system could be improved. The same percentage of users (85%) found that the information was relevant (see figure 5.6(b)), although the distribution of scores 1 and 2 for relevance varied with the scores of 1 and 2 for accuracy. One user (5%) did not find the information very useful.



(a)



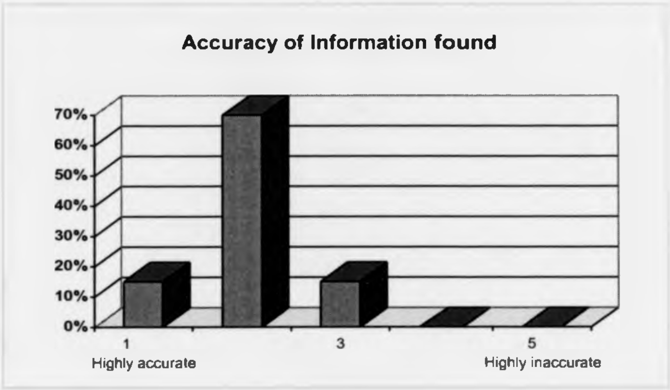
(b)



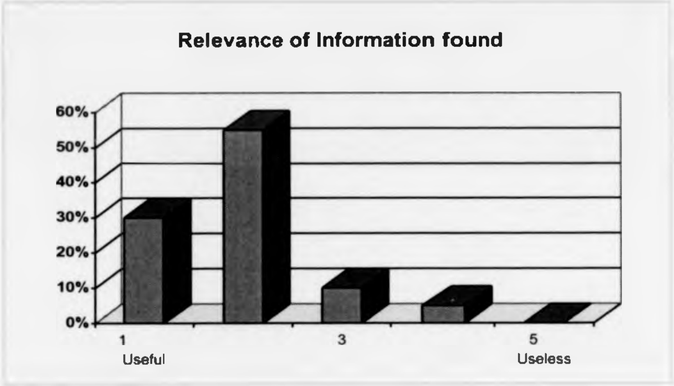
(c)

Figure 5.5

Timeliness of information contained in the Self Knowledge Elicitation Tool



(a)



(b)

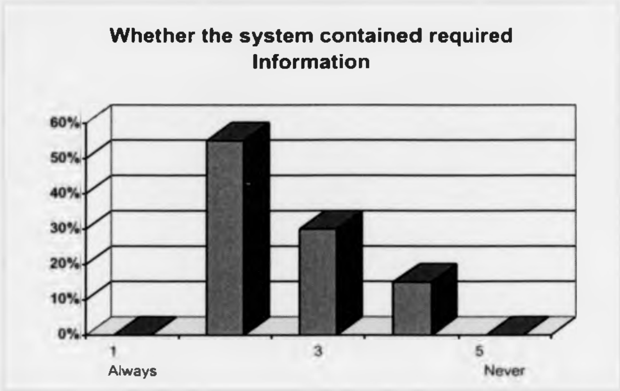
Figure 5.6
Accuracy and relevance of information in the Self Knowledge Elicitation Tool

The question on whether the system contained the information they wanted resulted in a range of answers as shown in figure 5.7(a). No one though that the answer to this question was *always* or *never*. The three users (15%) who scored 4 for their answer (which can probably be interpreted as ‘most of the time’) provided counselling and advice/information on alcohol as two of their main services and did not deal with drug misuse and AIDS/HIV as a primary service. The system was therefore limited for their purposes as it did not contain any information on alcohol. From the six users (30%) who selected 3 as their answer (which can probably be interpreted as 'sometimes'), two of them provided both drug misuse and alcohol related services. Some of the units had started developing a new application on alcohol information (this is discussed later in this section).

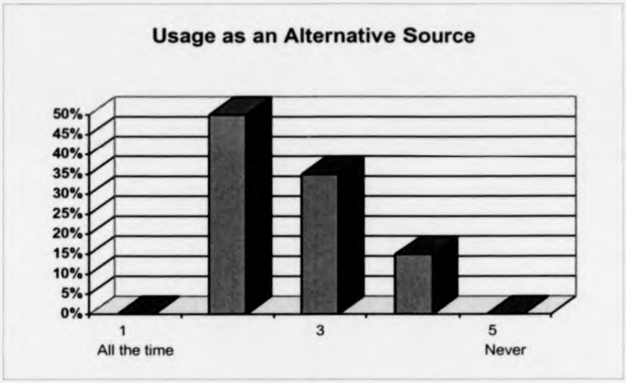
A similar distribution of the answers to this question was observed for question 26 (see appendix H for the questionnaire) which asked how often they used the system to obtain advice or information as an alternative to obtaining it from other sources. The responses are illustrated on the chart in figure 5.7(b). It is not surprising to find that generally, users will only use the system to obtain information if they know that the system caters for it. One or two users had inputted some new information into the system by obtaining it from elsewhere and then used the system to retrieve that information on a number of subsequent occasions.

Most users (80%) indicated that they modified some of the information. It was noted that the rest (20%) had developed a new application and left the existing information as it was. The extent to which the information was modified was not known but probably varied considerably. Some users commented that they only corrected a few spelling errors, whilst others changed the structure of some sections of the system quite significantly.

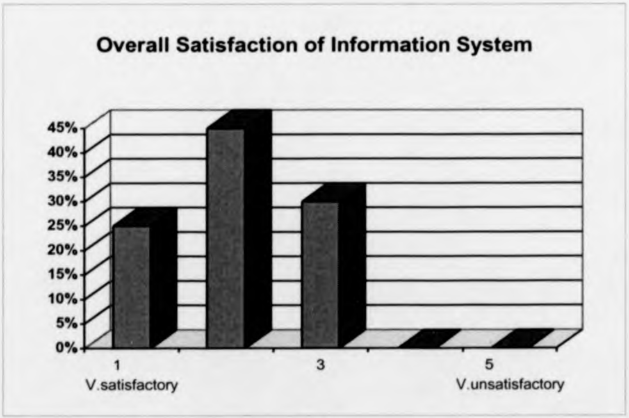
New information was added to the system by three quarters (75%) of the users but this did not include developing a new application. Many users said that they tended to add local information only (e.g. contact names and telephone numbers of rehabilitation hostels) for which they had frequent requests.



(a)



(b)



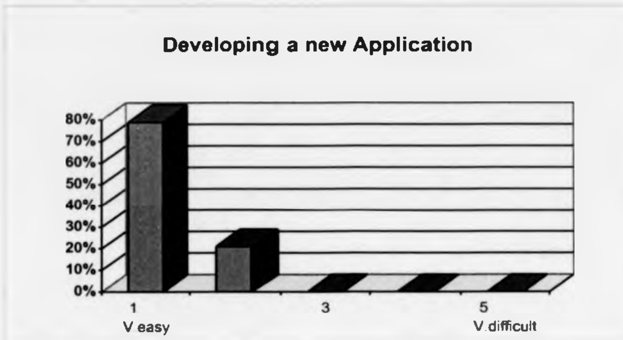
(c)

Figure 5.7

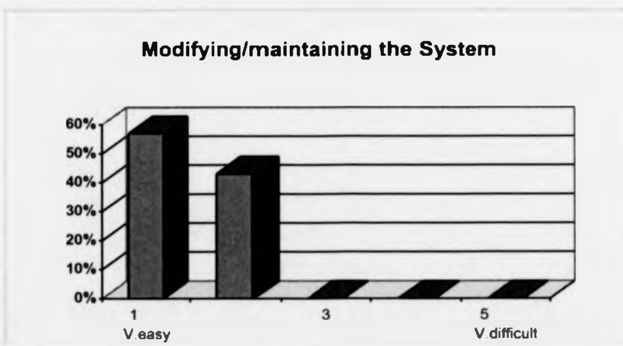
Information content and overall Satisfaction of Self Knowledge Elicitation Tool

Developing a New Application

A high proportion (70%) of users developed a new application. The others (30%) who did not develop one gave their reasons as a lack of staff resources and/or a lack of computer resources. This question may have made them feel they were expected to develop an application and so the true reason may not have been stated e.g. they may have not thought there was a need for a new application.



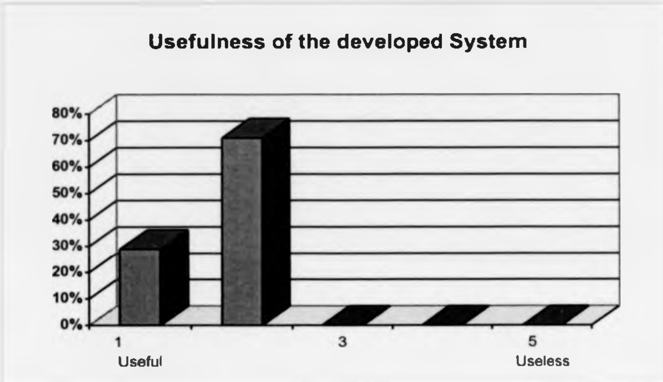
(a)



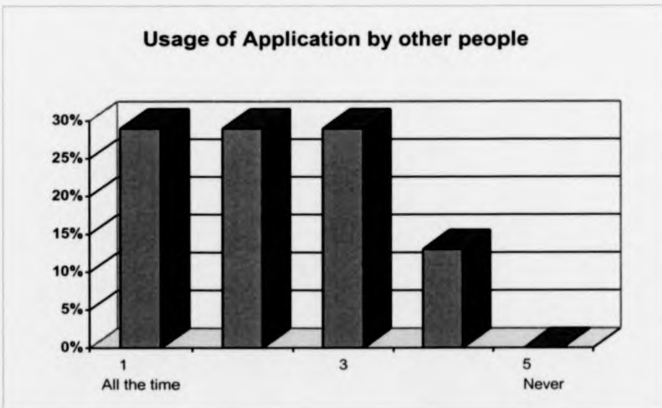
(b)

Figure 5.8
Developing and maintaining a new application using Self Knowledge Elicitation

From those who did develop a new application area, all of them found this easy to build and then easy to modify and maintain (see figure 5.8). These answers were similar to the answers obtained from the question on how easy or difficult they found the system to learn and use (see figure 5.2). All of these users found that the information system that they had developed was useful (see figure 5.9(a)) although the use of the system by other people varied from 'All the time' (29%) to quite infrequently (13%) as shown in figure 5.9(b).



(a)



(b)

Figure 5.9
Usefulness of a System developed using Self Knowledge Elicitation Tool

Additional comments by users again referred to the need for better editing facilities for reports, a 'windows style' presentation of the information, and the use of a mouse when the reports were longer than half a page. Another suggestion was the facility to see whether anyone else in their unit had modified the structure or reports since the user last used it, and possibly have the system password protected.

The Application Areas Developed

Fourteen units (70%) had built new applications using the self knowledge elicitation concept as their development tool. The size of the information systems developed varied considerably. Five out of the six units that provided advice/information on alcohol had developed an information system based (in general) on advice/information on alcohol. Some of the topics that formed these systems were:

- your body and alcohol
- alcohol at work
- drinking and driving
- sobering up
- safer drinking
- tips for cutting down
- sensible drinking for young people
- alcohol and older people
- a woman's guide to alcohol
- further information sources

Many units that provide both drug and alcohol services have drug workers as well as alcohol workers. The first criticism that most of the alcohol workers (and some of the drug workers) had was that the system contained a lot of drug information but no alcohol information. Although they all worked independently, it was interesting to note that many of the units that developed an alcohol module had produced very similar structures. The amount of work they had put into the development varied and was constrained mainly by staff resources.

Three units who were all based in South Staffordshire had a good working relationship with each other. They liaised with one another and produced an information system on prescribing which consisted of a wide range of topics including:

- prescribing clinics
- general information
- prescribing scheme and how it works
- families and drugs
- registered addict information
- notifiable drugs
- clinic protocols
- confidentiality waiver
- assessment form
- prescription contract

This information is based on a new service, the replacement prescribing scheme, which is a joint initiative between The Gateway Project, Turning Point and Staffordshire Health Authority. The scheme has been set up so that people living within the area can more easily get to see a doctor for help with drug related problems. A lot of the structure and information content was decided by regular meetings of workers from all three units working together. This was then input by the administration staff at one of the three units as they had more staff resources than the other two. The workers found this system very useful as a source of information, especially as this was a new service with which no one was very familiar with. They were also able to use this system to obtain information to pass on to clients.

One unit set up a system on statistical information and this included topics on Regional Drug Misuse Database, Home Office addicts index and agency information. This was sub-divided into Health Authority areas and then further into agencies and hospitals. Another unit developed an information system on Residential Rehabilitation Units which included location, cost, method of referral and research data as its main topic areas.

One unit had the system available on a PC in a general office area where up to 20 volunteers had used it and many of them had experimented with building a new application. The unit actually had approximately 40 part-time volunteers registered to work for them and they were all informed that an information system was available for evaluation. It was not felt that there were any serious applications resulting from this unit as many of the volunteers and full-time staff had worked on their own small systems for short periods only. Due to the large number of volunteers involved, the PC on which the system was installed was usually occupied by another worker.

Another unit developed a simple but practical system on Community Mental Health Trusts. The top-level menu is divided into different areas in Wrekin, Shropshire and Shrewsbury. Each one of these is then further divided into GPs, consultants and mental health units in that area. The team leader of the mental health unit, his telephone number and address are included in the information as well as all the GP's names and telephone numbers.

One unit used the self knowledge elicitation tool to develop an information service on Ecstasy tablets by liaising with the Government Forensic Science Laboratory. The details of this system are given in Rugby Community Drug Team's letter, a copy of which is shown in appendix F. One unit, Coventry Community Drug Team, had developed the first ever system using the self knowledge elicitation concept a number of years ago. This system on drug misuse was installed on the other 21 sites (as option 2) as one of three sub-systems in order to demonstrate and evaluate the concepts and to test whether a system developed by one unit would be useful to other units.

Features of the System

The features of the system that users particularly liked were:

- easy and quick to learn
- easy and quick to use
- speed of information retrieval
- depth of details on AIDS/HIV advice and information, not easily available elsewhere
- structure and content of counselling information
- ability to add and modify information in reports
- ability to add and modify structure of system
- minimum space taken up on their computer to have the whole system

The features of the system that users particularly disliked were:

- DOS based
- lack of advanced editing facilities
- use of function keys for commands
- some information out of date
- text output and presentation
- had to go backwards first to go to a new topic

The features that users felt were lacking from the system were:

- windows based environment
- printing facilities
- keyword search
- password protection
- mouse support
- graphics output
- table generation in reports
- spell checker
- choice of font, font size, style and colour when formatting text
- central source for updating core information
- source and date of the information in each section of the system

5.6 Conclusions

From the results of the evaluation of the self knowledge elicitation concept at 20 different sites using informal visits and discussions and a structured questionnaire completed by each unit, a number of conclusions were drawn. Overall, users found the system generally satisfactory as shown in figure 5.7(c). There were a number of positive features of the system that contributed to this. Users found the system easy to learn and use and so they could make full use of it immediately without any steep learning curves. Users thought that the speed of information retrieval was good and the ability to add or modify any of the components that made up the system very useful.

The structure, content and level of detail of the information was appreciated, especially in the counselling and AIDS/HIV modules, as this was not easily or readily available from other sources. However, not all of the information was timely, with large sections of the system being out of date. One of the problems that many units experienced during the evaluation period was the shortage of computer and staff resources, and this would be a potential problem in the future. The units that had all their PCs networked locally and had the system available on the network via any of the PCs had fewer problems gaining access to the information system.

Although users liked the facility to update and maintain the system and its information content, they did not feel that (a) they would have the required resources; (b) they have the necessary links to information suppliers; and (c) it was efficient for each unit to duplicate all the effort required to update the same information. It was felt that the most cost effective and efficient method of updating and maintaining the core information structure and content was to set up a central team.

The way this would work could be discussed by initially holding a meeting of all 22 units involved in the evaluation and any other interested parties. Nevertheless, users still wanted the ability to add, modify and maintain additional information which may be more specific to their local needs. The use of passwords was suggested to stop unauthorised use of the system, and the use of different levels of access giving users permission to only retrieve and edit information in specific sections, retrieve all information but no editing, or full permission to the whole system for access and editing.

The negative features of the system that many users highlighted and important features that they felt were missing were listed at the end of the previous section. A large proportion of these are because the system currently uses a DOS-based rather than a Windows-based environment, which nowadays is a standard operating system supplied with all PCs, and so users are more familiar with it. Redesigning the system in a windows environment and then linking a standard word processing packages (e.g. Word, Wordstar, WordPerfect) for use when editing reports would provide many of the features that users found lacking. These include mouse support, graphics output, table generation, spell checker, choice of text size, fonts, styles and colour, printing facilities and the use of standard keys instead of function keys. In fact, it would be possible go give users the facility to link any word processor to the system for editing of reports. This way they could use one with which they were familiar and one which they had already purchased for general word processing for their office.

Most users indicated that the system would be an ideal tool for training their own staff as well as other professionals who contact them for training requests. Education was also suggested by many users as a useful application. This included giving read-only access to clients who use their services by having the system on a PC in their waiting or reception areas. However, they would need to look at the resource implications in terms of PC equipment and floor space as many of them were working to a tight budget and usually in offices with limited space. Using it as an education tool in libraries, schools and other public places was also suggested, but the ability to modify information would have to be limited or removed for obvious reasons.

Another suggestion by approximately half of the units was to make the system available on the internet although this would have cost implications which they would have to consider. Even if the system was not on the internet, this technology could be used to distribute updates of the system in a quick and efficient manner. Access to the system on the internet or intranet could be tailored so that some of the general information was available to other users e.g. students could log on to it themselves and get the information required instead of having to ring or visit the agencies. An interactive section could also be set up where drug and other professionals (depending on the information in the system) could liaise to develop and maintain data sets.

The formal evaluation process involving the completion and analysis of the questionnaires was a worthwhile exercise as it appeared to give a good indication of users' views and experience of using the system. This was qualified by the informal discussions during visits to their offices. Some of the questions on the questionnaire were subjective and so one must be careful not to read too much into all the results obtained. Very often, the answers will depend on the expectations and experience of the person completing the questionnaire. Also he/she may not portray a true picture of the unit's experience as a whole, especially if they haven't even discussed the system with other users.

It is worth making another important point about the users who completed the questionnaire. Some of them regarded the system installed at their site as a prototype system which was being evaluated to see if it could become a real operational system, and to find out what enhancements were needed to achieve this. On the other hand, some users thought of the system being evaluated just on its present form rather than also taking its potential into consideration. This meant that these two groups probably answered the questionnaire with slightly different agendas.

Keyword searches and printing facilities were suggested by users as important features that were missing from the system. These two facilities were part of the original AID/HIV Expert Advisory System but these were deactivated from the system which was evaluated in order to simplify the system and make the set-up for evaluation easier. For example, it would have taken some time to configure the system with each unit's appropriate printer in a DOS environment. However, this process is not necessary in a windows environment, which automatically recognises existing printers.

I have two further suggestions which would enhance the system further in a windows environment, and these ideas were the result of informal discussions with users. The first is to have the facility to see the whole structure in a diagrammatic form on the screen when adding or editing items. This would also help when retrieving information because the user would see how deep into the structure he had gone and how this fitted in with the structure as a whole. An item which was four or five levels below the main menu would be accessed in one step by clicking the mouse on the required object and also there would be no need to go back several levels before going forward to select another item. Links from one item to another could be displayed using continuous lines. One problem which would be encountered if there were many links going across the whole network (cross-sectional links as well as simple links) is lack of clarity and visibility. Using a combination of dotted lines or different coloured lines would help to resolve this problem.

My second suggestion is to have hypertext links to selected items in the structure and selected words in a report, so that users can get an explanation or further information on that item with one click of the mouse. This is becoming a common feature of many windows applications and is in fact used by the Windows operating system when accessing help files.

Coventry CDT have had the system for several years and they are the only unit, from the 22 where the system was installed for evaluation, that have the information system integrated with their database management system. How this was done has already been described in detail in chapter three (section 3.6). This facility was not provided for the other units because they all have different database management systems for client contacts, and the time taken to program each one would have been quite significant. Evaluation of this *integrated* system at Coventry CDT has indicated that it is not a practical tool for day-to-day interactive use with clients present. However, they still think that it is worth having the integrated system available, for four main reasons:

1) The integrated system can act exactly like two separate systems and so having the 'extended' facility does not affect normal operational use.

2) It has proved to be a useful tool for training staff, especially new recruits. This had been done in the form of case studies by first studying a client's details as entered in the database management system. Then, the trainee would work out what counselling, advice and information would be required for that client and write it down as brief headings. The integrated system would then be activated

for that client, and the suggested headings produced by the system compared to the trainees list.

3) Using a similar idea to (2) above, the integrated system has helped to improve and extend the information system, even when the latter is used as a stand-alone system.

4) for wider use in the future when the need arises.

There are a number of reasons why the integrated system cannot at present be used as a practical day-to-day tool at Coventry CDT. When clients are seen by the workers, their details are recorded on paper forms which are later input into the database management system by administration staff. In order to use the integrated system, the workers would firstly need to have a PC available in the interview room (connected to their PC network). They would have to enter the client's details straight into the database management system and then activate the information system, which would provide the information and support required. The client would also have to be asked if this was acceptable before going ahead. For repeat clients, the majority of the information will already have been entered on a previous occasion and so only an update would be needed.

Since up to seven workers could each be seeing a client simultaneously, Coventry CDT would need a PC in all seven interview rooms, each connected to the network. At the moment none of these rooms have a PC in them. Their existing seven PCs are located in two main office rooms, one on each floor, where only staff are allowed in.

No	Component	Description	Q Ref.
1	*Acceptability*	whether the people who are using the system find the system satisfactory and whether it fulfils their information needs. This includes business users and managers and their requirements	22
2	*Availability*	whether it is accessible; when and where required	8; Units
3	*Cohesiveness*	whether there is interaction between components (subsystems) so that there is overall integration of both information systems and associated manual and business systems	Inte-grated
4	*Compatibility*	whether the system fits with other systems and other parts of the organisation	Inte-grated
5	*Documentation*	whether there is good documentation to help communications between operators, users, developers and managers	14
6	*Ease of learning*	whether the learning curve for new users is short and intuitive	6
7	*Economy*	whether the system is cost-effective and within the resources and constraints	Units
8	*Effectiveness*	whether the system performs and operates in the best possible manner to meet its overall business or organisational objectives	Units
9	*Efficiency*	whether the system utilises resources to their best advantage	Units
10	*Fast development rate*	whether the time needed to develop the project is quick, relative to its size and complexity	29
11	*Flexibility*	whether the system is easy to modify and whether it is easy to add or delete components.	29
12	*Functionality*	whether the system caters for the requirements	22
13	*Implementability*	whether the changeover from the old to the new system is feasible, in technical, social, economic and organisational senses	✓
14	*Low coupling*	whether the interaction between subsystems is such that they can be modified without affecting the rest of the system	Future Research
15	*Maintainability*	whether it needs a lot of effort to keep the system running satisfactorily and continuing to meet changing requirements over its life time	Future Research
16	*Portability*	whether the information system can run on other equipment or in other sites.	✓
17	*Reliability*	whether the error rate is minimised and outputs are consistent and correct	✓
18	*Robustness*	whether the system is fail-safe and fault-tolerant	✓
19	*Security*	whether the information system is robust against misuse	✓
20	*Simplicity*	whether ambiguities and complexities are minimised	✓
21	*Testability*	whether the system can be tested thoroughly to minimise operational failure and user dissatisfaction	✓
22	*Timeliness*	whether the information system operates successfully under normal, peak and every condition, giving information when required	19
23	*Visibility*	whether it is possible for users to trace why certain actions occurred	✓

Figure 5.10

The Components of Quality of an Information System

Another problem with the integrated system is that, unlike the self knowledge elicitation tool, all aspects of it cannot be updated and maintained by the user. They need a developer/programmer to create the necessary links because these are 'hard coded' and are not dynamic. The reports can be updated and maintained but the structure of the system cannot be modified or deleted if it is referenced by 'links' from the database management system.

Figure 5.10 represents Avison and Fitzgerald's (1995) attempt to address some of the components of quality of an information system. Where possible, the question number from the questionnaire which was used for evaluating the self knowledge elicitation tool formally (see appendix G), has been added in the 'Q Ref.' Column. Some of these components are in the control of the units where the system is installed e.g. availability, economy, effectiveness, efficiency. Other components are only applicable to the integrated system (which only Coventry CDT have) e.g. cohesiveness, compatibility. There are also components which will be listed under proposals for future research in the final chapter e.g. low coupling, maintainability.

It should be noted that maximisation of all the listed criteria is not possible. In fact, some actually work against each other. Ideally, an information system methodology can be tuned so that emphasis can be given to those components which are particularly important in the problem situation.

This section has highlighted the results and experience of evaluating the self knowledge elicitation concept. The next chapter is the final chapter of this thesis and this presents the key findings from the whole study which began with the development of an Expert Advisory System for AIDS/HIV, described in the first chapter.

CHAPTER 6

CONCLUSIONS AND PROPOSALS FOR FUTURE RESEARCH

"What we call the beginning is often the end
And to make an end is to make a beginning.
The end is where we start from..."

T. S. Eliot,
Four Quartets.

CONCLUSIONS

This thesis has described the development of a number of computerised decision support systems ranging from an Expert System for AIDS to a Self Knowledge Elicitation Tool. The whole period of the research was action research led and this approach was maintained throughout the research programme, from its inception to its conclusions. Each chapter in this thesis has concluded with a discussion on the research experience and findings of the project. Therefore, this final chapter does not go into depth about all these findings again. Instead, it presents a brief outline of the most important findings both in terms of the application area of AIDS/HIV and drug misuse, and also those which are generalisable and can be applied to other subject domains.

Conclusions Specific to AIDS/HIV and Drug Misuse

The techniques of knowledge based systems are difficult to apply in the subject area of AIDS because of a number of reasons. There is a lack of knowledge about the causal mechanism of the disorder. Knowledge about the subject is continually changing as clinicians are learning more because they are experiencing an increasing number of patients with AIDS and HIV. AIDS advice, information and expertise is dominated by qualitative terminology and this makes modelling the problem for a computer based system even more difficult.

AIDS knowledge is required by a multiple of user groups and it is required in different areas. For example, management of resources, clinical knowledge, counselling topics and techniques, education of the general public - especially school children. It is therefore important that any computer based decision support system addresses the needs of all these groups. There are multiple levels of expertise within each user group and this also has to be taken into account. A member of the general public may only need to access one module of the system but a clinician will need access to all the modules because he is expected to provide his expertise to groups requiring different levels of advice.

An Expert System approach in the area of AIDS was found not to be successful. An Information System approach was far more acceptable and was adequate for a large number of user groups. Evaluations indicated that the AIDS Information System provided a positive, interactive learning environment which suggested that it would be a useful tool for educating school children. The detailed content of information in the General Public module and the speed of retrieval could assist telephone helplines in answering specific questions on AIDS/HIV. With a personal subject like AIDS/HIV, the anonymity provided by a computer was important, because some people may not seek help and advice because they are afraid that others will not maintain confidentiality.

A formal trial carried out at the Alderman Smith School in Nuneaton using the Information Systems approach indicated that school children were more likely to access information in this manner and that it was effective.

The Information System approach still contained a number of deficiencies, which led to the development of an Expert Advisory System (EAS) Approach. Although numerous trials were carried out with the computerised decision support tools, these were mainly in research and prototype environments. Before the EAS can be used in an unsupervised and routine manner, several important issues need to be investigated. These mainly concern the <u>responsibility</u> of the knowledge contained in the system, <u>maintenance</u> of the system and that of <u>consensus</u>.

Who is responsible for the information given by the system? Is it the experts who contribute their knowledge, the system designer or knowledge engineer who transcribe it, or the user who accepts the advice? The problem of consensus arises because different centres have different treatment regimes for particular diseases. An example of this is the use of a drug for treating patients with PCP: St. Stephen's Hospital uses co-trimoxazole; St. Mary's Hospital uses pentamidine.

It is suggested that an editorial board be used to tackle these issues. The editorial board would ensure that the knowledge in the system is correct and be responsible for maintaining the system as well as sending regular updated versions to users. This board would also tackle the problem of consensus by giving the user either one choice or a number of ranked alternatives.

The possibility of setting up such a board needs to be investigated further. An editable version of the EAS would be a valuable tool if an editorial board was set up to be responsible for maintaining and updating the AIDS/HIV knowledge base.

General Conclusions

This section briefly outlines the conclusions of the action research project that can be generalised and applied to other subject domains. An expert system approach in a large and complex subject area is very limited. Firstly, it only serves a narrow user group, which usually consists of specialists in the field. Secondly, knowledge can only be accessed in a consultative mode.

An information system approach is able to provide different levels of use by providing browsing and referencing facilities through the use of menus, keywords, and free-text searches. This approach can accommodate different interests within a single framework as well as accommodate enquirers with different levels of expertise. It can also provide a useful mechanism for experts to share specialist information with others.

One of the disadvantages of an information system approach is that it expects the user to have a certain level of knowledge. This is needed in order to find in which area of the system the required information is located. Also, this approach cannot accommodate queries which require information that is not present explicitly because there is no capability for deduction. There are also problems of inconsistency and updatability because reports are pre-constructed and not produced dynamically.

An expert advisory system approach accommodates multiple types of user groups and multiple levels of expertise within each user group (see figure 1.3). Features derived from the expert system approach help the least experienced users; features derived from the information system approach help the most experienced users.

An editable expert advisory system approach can be used by an editorial board or other group responsible for maintaining an information/knowledge base. The facility to enter comments interactively, like the feedback facility in the Expert Advisory System, can be a useful method of evaluating a system.

The self knowledge elicitation concept emerged following the development of the Expert Advisory System for AIDS/HIV. This tool was evaluated at 20 different sites using several informal visits to each of the participating organisations where detailed discussions took place. This was followed by asking each organisation to complete a standard structured questionnaire about their experience of using the self knowledge elicitation tool. From these results it was concluded that many found this system useful because it was easy to learn and use, the structure and information content was well presented, information retrieval was fast, and the facility to add or modify the system was very helpful and unique to this system.

However, due to constraints in resources and for the sake of efficiency, users did not feel they should be responsible for updating all the information. It was suggested that a central team consisting of a number of experts in the application areas being considered should be set up. This team would then be responsible for maintaining and updating the information structure and content, and also for distributing it to all the units. The updates could either be distributed over the internet or through the post using CD-ROM. Nevertheless, users still wanted the ability to add, modify and maintain additional information which may be more specific to their local needs.

There were many features that users did not like or felt they missing. Most of these could be resolved by writing the system in a Windows environment and linking an advanced word processing package for editing reports. The most important suggested uses were training (their own staff as well as other professionals), education (libraries, schools, other public places). The use of the internet to store and/or distribute the system and its information was also suggested by users.

The self knowledge elicitation tool was integrated with a database management system in order to develop an 'extended' system and this has been available at one of the 20 units for several years. Following evaluation of this extended system, it was found that it is a useful tool for training staff and improving the information content of the system. However, it was found that it cannot at present be used as a practical day-to-day tool at Coventry CDT, although this would possibly change in the future.

The main reasons for its limited use are: clients' details are not entered into the database management system during their visit; lack of PC resources; acceptance by clients; maintenance of system needs the assistance of a system developer.

One of the limitations of this research study is that only one organisation used the self knowledge elicitation concept for several years whilst the others have only had it available for up to six months. The use of the system for a longer period by the other agencies may have had an effect on the results of the study. Also, the extended system was only made available to one organisation and it would have been useful to evaluate this system at additional Sites.

Another problem was that the evaluation was limited to only one type of service. Most of these have limited resources, and they are relatively small. Some of the questions on the questionnaire used for evaluation were subjective, and some users saw the system as a prototype whilst others treated it as the final product. This would inevitably have affected the results of the study to some degree.

Overall, the concept of self knowledge elicitation was well received by most users. With enhancements in functionality and a windows based environment, nearly all users indicated that they would show a strong interest in it. The Rugby Community Drug Team, the Alcohol and Drugs Advisory Service in North Warwickshire, and Warwickshire Education Department have jointly submitted a bid for funding from the 'Drugs Challenge Fund' (see appendix I). The proposal is to develop an information system about substances, for use by young people, using the concept of self knowledge elicitation.

Looking back at the literature following the evaluation of the self knowledge elicitation concept, it would be fair to say that there was a general shortage of documentation on reviews/evaluations. The reasons for this is partly because (a) a post-implementation review rarely occurs in the first place; and (b) there is a wide range of information systems that are developed under different circumstances, making it difficult to have one method or technique for evaluation.

I found the work by Buckland (1991) and Farbey et al (1993) most useful for my research. I used the matrix method by the latter because it was quick and easy to use, and I found that it promoted an awareness of the different options available for evaluation. I felt that the theory in the literature was comprehensive but it was not backed-up by examples of real research. There needs to be more work on evaluation techniques, especially for longitudinal research studies such as the one reported in this thesis.

Proposals for Future Research

Evaluations have indicated that to make the self knowledge elicitation concept a more practical tool for regular use, it needs to be re-written in a windows environment. This will then make it easier to incorporate other features requested by the users, as discussed above. This should be relatively straightforward, but two projects are proposed following this initial development.

(1) Setting up and making the system available over the internet (or intranet) needs to be investigated. Can the internet be used to distribute updated information of this type? Can professionals in the application field being considered, liaise using an interactive session on the net in order to develop

and maintain information, and then distribute it to users and other professionals?

(2) The 'extended' application of the self knowledge elicitation concept, where it is integrated with a database management system also needs to be researched further. The extended system cannot be developed by the user even if he deduces the necessary links required and has to rely on a system developer to do this. Also, this integrated system cannot be updated and maintained by the user because the created links are not dynamic. Can the self knowledge elicitation concept be developed further so that it allows the user to first develop and then update and maintain an integrated system?

REFERENCES

"By doubting we are led to enquire;

by enquiry we perceive the truth.

Pierre Abelard
12^{th} Century

REFERENCES

Abrams, D., Abraham, C. (1988). Social Psychology and the spread of AIDS. The Psychologist Feb., 46.

Adams, I., Chan, M., Clifford, P., Cooke, W., Dallos, V., de Dombal, F., Edwards, M., Hancock, D., Hewett, D., McIntyre, N., Somerville, P., Spiegelhalter, D., Wellwood, J., Wilson, D., (1986). Computer aided diagnosis of acute abdominal pain : a multicentre study. British Medical Journal 293, 800-804.

Aggleton, P., Warwick, I. (1988). How Young People Really See AIDS. The Psychologist, Feb., 48.

Aikins, J., Kunz, J., Shortliffe, E., Fallet, R. (1983). PUFF: an expert system for the interpretation of Pulmonary Function data. Computers and Biomedical Research 16 : 199-208.

Alter, S. (1996) Information Systems - A management perspective. 2nd Edition. The Benjamin/Cummings Publishing Company, Inc.

Astrahan, M. M. et al. (1976). System/R: A relational approach to data management. ACM Transactions on Database Systems, 1, 97-137.

Avison, D.E., Fitzgerald, G. (1995) Information Systems Development : Methodologies, Techniques and Tools. 2nd Edition. McGraw Hill.

Black, W. J. (1986). Intelligent Knowledge Based Systems: An Introduction. Van Nostrand Reinhold (UK). Co. Ltd.

Blum, R. (1982). Discovery and Representation of Causal Relationships from a Large Time Oriented Database : The RX Project. Springer - Verlag, Berlin.

Boldy, D., Gupta, R., Moran, A., Weller, P., Stableforth, D. (1988). The West Midlands Cystic Fibrosis Register. Cystic Fibrosis Research Trust, Research Workers' Conference, University of Manchester Institute of Science and Technology, 14-15 December.

Boldy, D., Gupta, R., Moran, A., Weller, P., Stableforth, D. (1989). The West Midlands Cystic Fibrosis Register. 16th Annual Meeting of the European Working Group for Cystic Fibrosis, Prague, Czechoslovakia, June 6-9.

Bramer, M. A. (1982). A survery and critical review of expert systems research, In: Michie, D (ed.). Introductory readings in expert systems, Gordon and Breach, 3-27.

Brittain, R. (1988). The Knowledge Explosion in Medicine. North Warwickshire Health Authority, Nuneaton.

Brittain, R., Hurrion, R., McMorran, J., Gupta, R., McMorran, S. (1988). An Expert Advisory System for AIDS. In: Duru, G., Engelbrecht, R., Flagle, C., Van Eimeren, W. (Eds). La Science des Systemes dans le domaine de la sante. No. 140, Collection de Medecine Legale et de Toxicologie Medicale.

Buchanan, B., Shortliffe, E. (1984). Rule Based Expert System : the MYCIN Experiment of the Stanford Heuristic Programming Project. Addison Wesley, Reading, Mass.

Buckland, M. (1991) Information and Information Systems. Greenwood Press.

Burch, J. G., and Grudnitski, G. (1986). Information Systems Theory and Practice. John Wiley and Sons.

Burch,J.G.,Jr., Strater, F.R., Grudnitski, G.(1983) Information Systems: Theory and Practice. 3rd Edition. John Wiley and Sons.

Bylander, T., Mittal, S., Chandrasekaren, B. (1983). CSRL: A language for Expert Systems for Diagnosis. In : Proceedings of Eighth International Joint Conference on Artificial Intelligence, 218-221.

CDSC (1988). Communicable Diseases Surveillance Centre. Communicable Disease Report Weekly Edition 88/09.

Chen, M.(1988). "The Integration of Organisation and Information System Modelling: A Metasystem Approach to the Generation of Group Decision Support Systems and Computer-Aided Software Engineering." Doctoral Dissertation, University of Arizona.

Choo, C. W. (1998). The Knowing Organisation. Oxford University Press.

Clancey, W. J. (1981). Methodology for building an intelligent turoring system, Computer Science Department Report No. STAN-CS-81-894, Stanford University, Palo Alto, CA.

Clancey, W. J. Letsinger, R. (1981). NEOMYCIN: Reconfiguring a rule based Expert System for Application To Teaching. Proceedings of seventh International Joint Conference on Artificial Intelligence, 829-836.

Clare, c. p. and Loucopoulos, p. (1986). Data Processing : Current Theories and Practices, second edition, Abacus.

Clare, C., Stuteley, G. (1995). Information Systems - Strategy to Design. Chapman & Hall.

Codd, E. F. (1970). A Relational Model of Data for Large Shared Data Banks. Communications of the ACM, June.

COHSE (1987). Guidelines for Health Staff Dealing with Patients Suffering From the Acquired Immune Deficiency Syndrome (AIDS).

Couger, (1987). In Information Analysis - selected readings. (ed. by Galliers, R.), Addison-Wesley.

da Silva, C. (1982). The Development of a Decision Support System Generator via Action Research. Ph.D thesis, University of Warwick.

Davis, G. B., Olson, M. H. (1985) Management Information Systems, second edition, Mcgraw Hill, New York.

Davis, R. (1979). Interactive Transfer of Expertise, Artificial Intelligence, 12, 121-157.

Davis, R. (1982). Expert Systems: where are we? and where do we go from here? AI Magazine, 1982, 3(2), 3-22.

de Neergard, L. (1988). Adolescents : knowledge, attitudes and practice. In : World Health Organisation, United Kingdom Government (Eds.). AID Prevention and Control - World Summit of Ministers of Health on Programmes for AIDS Prevention. Pergammon Press, Oxford.

Department of Health (1989). Health Circular HC(89)30, HMSO, London.

DHSS (1976). The Report of the Committee of Enquiry into an outbreak of Food Poisoning at Stanley Royd Hospital. HMSO, London.

DHSS (1988). AIDS and Drug Misuse Part I. Advisory Council on the Misuse of Drugs, HMSO, London.

DHSS (1989). AIDS and Drug Misuse Part II. Advisory Council on the Misuse of Drugs, HMSO, London.

DHSS/COI (1988). Drug Misuse - A Basic Briefing, Department of Health and Social Security/Central Office of Information, London.

Druglink (1990a). The Journal on Drug Misuse in Britain, Jan/Feb, vol.5, issue 1. The Institute for the Study of Drug Dependence, London.

Druglink (1990b). The Journal on Drug Misuse in Britain, March/Apr, vol.5, issue 2. The Institute for the Study of Drug Dependence, London.

Edwards, J. S. (1991). Building Knowledge-Based Systems: Towards A Methodology. Pitman.

Farbey, B., Land, F.., Targett, D. (1993). How to assess your IT investment : A study of methods and techniques. Butterworth-Heinemann, Oxford.

Farhoomand, A.F., (1987) Scientific Progress of Management Information Systems. In : Information Systems Research - Issues, methods and practical guidelines (ed. By Galliers, R., 1992). Blackwell Scientific Publications.

Feigenbaum, E., McCorduck, P. (1983). The Fifth Generation. Reading, MA: Addison-Wesley.

Fox, J. (1984). Doubts about induction, Bulletin of SPL Insight, SPL International, Abingdon, Oxford.

Fox, J., Myers, C., Greaves, M., Pegram, S. (1985). Knowledge Acquisition for Expert Systems : Experience in Leukaemia Diagnosis. Meth. Inform. Med. 24, 65-72.

Fox, J., O'Neill, M., Glowinski, A., Clark, D. (1988). A Logic Of Decision Making. Illinois interdisciplinary workshop on decision making, University of Illinois, Urbana, Champaign.

Galliers, R., (1992) Information Systems Research - Issues, methods and practical guidelines. Blackwell Scientific Publications.

Galliers, R.D., (1991) Choosing Appropriate Information Systems Research Approaches: A Revised Taxonomy. In: H-E Nissen, et al. (1991), op cit., pp327-345.

Gardarin, G., and Gelenbe, E. (1984). (Eds.) New Applications of Data Bases. Academic Press, Inc.

Gaschnig, J. (1982). Prospector: an expert system for mineral exploration, In: Michie, D. (ed.). Introductory readings in expert systems, Gordon and Breach, 47-64.

Gillam, S. J., Jarman, B., White, P., Law, R. (1989). Ethnic differences in consultation rates in urban general practice, British Medical Journal, 14th October, 299, 953-957.

Glanz, A. et al. (1990). Prevention of AIDS Among Drug Misusers: the Role of the High Street Pharmacy. Institute of Psychiatry, Addiction Research Unit, London.

Gremillion, L., Pyburn, P. (1988). Computers and Information Systems in Business - An Introduction. McGraw-Hill.

Groneman, N., Meroney, J. (1991). Information Systems Applications, Evaluation, and Selection. South-western Publishing Co.

Hamilton, S., Ives, E., (1982) MIS Research Strategies. In : Information Systems Research - Issues, methods and practical guidelines (ed. By Galliers, R., 1992). Blackwell Scientific Publications.

Hart, A. (1986). Knowledge Acquisition for Expert Systems. New Technology Modular Series. Kogan Page.

Hartnoll, R., Daviaud, E., Lewis, R., Mitcheson, M. (1985). Drug Problems: Assessing Local Needs, Drug Indicators Project, Department of Politics and Sociology, Birkbeck College, University of London, London.

Hayes-Roth, F. (1984). The Knowledge Based Systems. Van Nostrand Reinhold (UK) Co. Ltd., Woking, Berkshire.

Hayes-Roth, F. (1987). Expert Systems. In : Amarel, S., Findler, N., Mcdermott, J., Minker, J., Walker, D., Waltz, D.(Eds) Encyclopedia of Artificial Intelligence, 2, 28-298.

Hayes-Roth, F., Waterman, D. A., Lenat, D. B. (1983). Building Expert Systems. Reading, Mass, Addison-Wesley.

House of Commons (1987). 3rd Report to Social Services Select Committee Session; 1986-7. Problems Associated with AIDS. HMSO, London.

Hirschheim, R. and Smithson, S., (1987) Information Systems Evaluation Myths and Reality. In Information Analysis - selected readings. (ed. by Galliers, R.), Addison-Wesley.

ISDD (1984). Surveys and Statistics on Drugtaking in Britain. Institute for the Study of Drug Dependence, London.

King, J. (1981) Evaluating Data Base Management Systems. Van Nostrand Reinhold.

Linstone, H., Turoff, M. (1975). The Delphi Method, Techniques and Applications. Addison Wesley, Reading, MA.

Loomis, M. E. S. (1987). The Database Book. Macmillan Publishing Company, Basingstoke.

Lucas, H.C., Jr. (1976) The Analysis, Design, and Implementation of Information Systems. McGraw-Hill.

Lucas, H.C., Jr. (1973) Computer Based Information Systems in Organisations. Science Research Associates.

Mader, C. (1979). Information Systems - Technology, Economics, Applications, Management 2nd Edition. Science Research Associates.

Mann, J. (1988). Global AIDS: epidemiology, impact, projections, global strategy. In: World Health Organisation (Eds). AIDS: Prevention and Control. Invited Presentations and Papers from the World Summit of Ministers of Health on Programmes for AIDS Prevention. Pergammon Press, Oxford.

Marlatt, G. A., Gordon, J. R. (1985). Relapse Prevention. Guildford Press, p.128-200, London.

McMorran, J. (1989). The Development of an Expert Advisory System for the Acquired Immunodeficiency Syndrome (AIDS), Ph.D. Thesis, University of Warwick.

McMorran, S. (1986). The Development of a Prototype Expert System for Rabies, M.Sc. Thesis, University of Warwick.

McKeown, P.G., Leitch, R.A. (1993). Management Information Systems - Managing with Computers. The Dryden Press, Harcourt Brace Jovanovich.

Michalski, R. S., Chilausky, R. L. (1980). Learning by Being Told and Learning from Examples: An Experimental Comparison of the two Methods of Knowledge Acquisition in the Context of Developing an Expert System for Soybean Disease Diagnosis. Policy Analysis Inform. Syst. 4, No. 2, Special Issue on Knowledge Acquisition and Induction.

Miller, D. (1987). Living with AIDS and HIV. The MacMillan Press, Basingstoke.

Miller, D., Jeffries, D., Green, J., Harris, J., Pinching, A. (1986). HTLV-III : should testing ever be routine? British Medical Journal 2, 941-943.

Miller, W. R. (1983). Motivational Interviewing with Problem Drinkers, Behavioural Psychotherapy: 2, p.147-182.

Miller, P., Blumenfrucht, S., Black, H. (1984). An Expert System Which Critiques Patient Workup : Modelling Conflicting Expertise. Computers and Biomedical Research 17, 554-569.

Miller, R., Pople, H. and Myers, J. (1982). INTERNIST-1, an experimental computer based diagnostic consultant for general internal medicine. NEJM, 307, 468-476.

Morris, A. (1987). Expert Systems and their implications for information science. Department of Library and Information Studies, Loughborough University.

Mulsant, B., Servan-Schreiber, D. (1984). Knowledge Engineering: A Daily Activity on a Hospital Ward. Computers and Biomedical Research 17, 71-91.

Obermeier, K. K. (1987). Natural Language Processing, Battelle Laboratories, Columbus Division, Colombus.

Parsaye, K., Chignall, M., Khoshafian, S., Wong, H. (1989). Intelligent Databases, John Wiley and Sons, New York.

Pascal (1989). Byte, Sept. 1989, p247-256.

Phillips, K. (1988). Strategies against AIDS. The Psychologist Feb., 46.

Prochaska, J. O., DiClemente, C. (1984). The Transtheoretical Approach Crossing Traditional Boundaries of Therapies. Homewood, Illinois: Dow Jones/Irwin.

Roussel, P. (1975). Prolog - Manual de reference et d'utilisation. Groupe d'Intelligence Artficielle, Marseille - Luminy.

Shortliffe, E. (1976). Computer Based Medical Consultations: MYCIN. Elsevier, North Holland Inc.

Schwartz, W. (1970). Medicine and the Computer : The Promise and Problems of Change. New England Journal Medicine 283, 23.

Sprague, R. H., Carlson, E.D. (1982) Building Effective Decision Support Systems. Practice-Hall.

St. Mary's Hospital (1987). Control of Infection Pack.

Stephan, M. (1988). An Evaluation of Methods of Education about AIDS/HIV for Schools. Red Cross, London.

Stonebraker, M., Wong, E., Kreps, P., Held, G. (1976). The design and implementation of INGRES. ACM Transactions on Database Systems, 1, 189-222.

Szolovits, P. (1982). (Ed.). Artificial Intelligence in Medicine, Boulder, Colo, Westview Press (AAAS Symposium Series).

Szyperski, N., Grochla, E. (Editors) (1979) Design and Implementation of Computer-based Information Systems.

Tandy, A., Box, M. (1987). AIDS : Health education in schools. The role of the community child health services. Children and Society 2, 148 - 156.

Thompson, C. W., Ross, K. M., Tennant, H. R., Saenz, R. M. (1983). Building Usable Menu-Based Natural Language Interfaces to Databases. Central Research Laboratories, Texas Instruments Incorporated, Dallas, Texas. Proc. 9th International Conference on Very Large Databases, 43-55.

Tsichritizis, D. C., Lochovsky, F. H. (1977). Data Base Management Systems. Academic Press.

Tyler, A. (1986). Street Drugs, New English Library, London.

University of London (1983). The Duckworth Report on Drug Addiction. University of London, London.

Van Bilston, H. P. (1986a). Motivational Milieu Therapy: Motivating Heroin Addicts for Change. Proceedings from the Fifteenth International Institute on the Prevention and Treatment of Drug Dependence.

Van Bilston, H. P. (1986b). Heroin Addiction: Morals Revisited, Journal of Substance Abuse Treatment, 3(4), p.279-284.

Van Name, M. L., Catchings, B. (1990). SQL: A Database Language Sequel to dBASE. Byte IBM Special Edition, Vol.14, No. 11, January.

Vasta, J. A. (1985).Understanding Data Base Management Systems, Wadsworth, Inc.

Waterman, D. A. (1986). A Guide to Expert Systems. Addison-Wesley.

Weiss, S., Kulikowski, C. (1979). EXPERT: A System for developing Consultation Models. In: Proceedings of Sixth International Joint Conference on Artificial Intelligence, 942-950.

Weizenbaum, J. (1966). ELIZA - A computer program for the study of natural language communication between man and machine, CACM 9(1), 36-45, January.

Wellbank, M. (1983). Knowledge Acquisition for Expert Systems : A Review of Techniques. Martlesham Consultancy Services, British Telecom Research Laboratories, Martlesham Health, Ipswich.

White, D. (1988). In : The Psychologist. June, 224.

WHO - World Health Organisation (1986). Acquired Immunodeficiency Syndrome (AIDS): WHO/CDC case definition of AIDS. WHO Wkly Epidemiol Rec 61(10): 69-72.

Wilkinson, P., Begley, P. (1986). Drug Misuse in Coventry - report of the Coventry Drug Problem Team, Coventry.

Zwass, V. (1992) Management Information Systems. Wm. C. Brown.

BIBLIOGRAPHY

"Life is painting a picture,

not doing a sum.

Oliver Wendell Holmes Jr.

Speeches 1913

BIBLIOGRAPHY

Acheson, D. (1988). Modes of Transmission : the basis for Prevention Strategies. In: World Health Orgainsation (Eds). AIDS : Prevention and Control. Invited Presentations and Papers from the World Summit of Ministers of Health on Programmes for AIDS Prevention. Pergammon Press, Oxford.

Adams, I., Chan, M., Clifford, P., Cooke, W., Dallos, V., de Dombal, F., Edwards, M., Hancock, D., Hewett, D., McIntyre, N., Somerville, P., Spiegelhalter, D., Wellwodd, J., Wilson, D. (1986). Computer aided diagnosis of acute abdominal pain : a multicentre study. British Medical Journal 293, 800-804.

Bannister, B. (1985). Methicillin-Resistant Staphyloccus Aureus. Communicable Diseases Surveillance Centre, London.

Barrett, M., Beerel, A. C. (1988). Expert Systems in Business: A Practical Approach. Ellis Horwood.

Bates, M. (1978). The Theory and Practice of Augmented Transition Networks. In : Bolc, L. (Ed.) Natural Language Communication with Computers. Springer - Verlag, Berlin.

Beck, E., Cunningham, D., Moss, V., Harris, J., Pinching, A., Jeffries, D. (1987). HIV testing : changing trends at a clinic for sexually transmitted diseases in London. British Medical Journal 295, 191-193.

Beerel, A. C. (1987). Expert Sytems: Strategic Implications and Applications. Ellis Horwood.

Benbasat, I. (editor) (1989). The Information Systems Research Challenge : Experimental Research Methods vol 2.

Boland, R. J., Hirschheim, R. A. (1987). Editors. Critical issues in Information Systems Research. John Wiley and Sons.

Bramer, M. (ed) (1990). Practical Experiences in Building Expert Systems. Wiley.

Brittain, R. (1988). The Creation Revolution. North Warwickshire Health Authority, Nuneaton.

Bryant, N. (1988). Managing Expert Systems. John Wiley.

Burch, J. G., and Grudnitski, G. (1986). Information Systems Theory and Practice. John Wiley and Sons.

Burton, S. (1987). The Psychiatry of HIV infection. British Medical Journal 295, 228-229.

Cameron, P. (1986). AIDS in haemophiliacs and homosexuals. Lancet, 36.

CBMC (1988). Bradford Needle and Syringe Exchange Scheme, City of Bradford Metropolitan Council, Bradford.

CDC - Centre for Disease Control (1981). Pneumocystic Carinii. Morbid Mortality Weekly 30, 250, 2.

CDP (1989). A Report on the Development and Operation of a Syringe Exchange Scheme Based at the Community Drug Project, February. The Community Drug Project, London.

Centers for Disease Control (1985). Revision of the case definition of Acquired Immune Deficiency Syndrome for national reporting. Morbid Mortality Weekly 34, 257, 373-5.

Clocksin, W., Mellish, C. (1981). Programming in PROLOG. Springer - Verlag, Berlin.

Communicable Diseases Surveillance Centre (1988). Communicabe Disease Report Weekly Edition 88/09.

Curran, J., Morgan., Hardy, A., Jaffe, H., Darrow, W., Dowdle, W. (1985). The epidemiology of AIDS : current status and future prospects. Science 229, 1352-1357.

de Dombal, F., Leaper, D., Horrocks, J., Stainland, J., McCann, A. (1974). Human and Computer - Aided Diagnosis of Acute Abdominal Pain : Further

Report with Emphasis on Performance of Clinicians. British Medical Journal, 376 - 380.

Department of Trade and Industry (1992). Knowledge Based Systems - Survey of UK Applications. Written by Touche Ross Management Consultants.

DHSS (1986). Acquired Immune Deficiency Syndrome (AIDS): Guidance for surgeons, anaesthetists, dentists and their teams in dealing with patients infected with HTLV-III. HMSO, London.

Diaper, D. (ed) (1989). Knowledge Elicitation - Principles, Techniques and Applications. Ellis Horwood.

Dunea, G. (1987). AIDS Update. British Medical Journal 295, 492-493.

Englebrecht, R., Rothemund, M. (1987). Expert Systems in Medicine. In : Chytil, M., and Englebrecht, R. (Eds.) Medical Expert Systems Using Personal Computers. Sigma Press, Cheshire.

ESDSU (1988). CD-Pedia on CD ROM. World Health Knowledge Base - AIDS Expert/Information System, Expert Systems Unit, University of Warwick, Nimbus Records Ltd., Monmouth, U.K.

Feigenbaum, E., McCorduck, P., Nii, H. P. (1988). The Rise of the Expert Company: How Visionary Companies are Using Artificial Intelligence to Achieve Higher Productivity and Profits. Macmillan.

Fox, J., Glowinski, A., O'Neil, M. (1987). The Oxford System of Medicine : A Prototype for Primary Care. In AIME 87 : Proceedings of the International Conference on Artificial Intelligence in Medicine, Marselles. Lecture Notes in Medical Informatics. Springer - Verlag, Berlin.

Ginn, D. (1987). The AID Information Crisis : confluence of the Roles of Information Creator, Seeker and Provider. Bull. Med. Libr. Assoc. 75,4.

Green, J. (1986). Reduction of Risk in High Risk Groups. In : Miller, D., Weber, J., Green, J. (Eds). The Management of AIDS Patients. Macmillan Press, Basingstoke.

Greenwell, M. (1988). Knowledge Engineering for Expert Systems. Ellis Horwood.

Haggard, S. (1988). Preventing AIDS through general public education : experience from the United Kingdom. In : World Health Organisation, United Kingdom Government (Eds.). AIDS Prevention and Control - World Summit of Ministers of Health on Programmes for AIDS Prevention. Pergammon Press, Oxford.

Harmon, P., Maus, R., Morrissey, W. (1988). Expert Systems Tools and Applications. John Wiley.

Hendrix, G. G., Walter, B. A. (1987). The Intelligent Assistant, Byte, December.

Jackson, P. (1990). Introduction to Expert Systems. 2nd edition. Addison-Wesley.

Jacob, R. (1987). Human Computer Interaction. In : Amarel, S., Findler, N., Mcdermott, J., Minker, J., Walker, D., Waltz, D. (Eds.) Encyclopedia of Artificial Intelligence, 1, 383-388.

Johnson, L., Keravenou, E. (1985). Expert Systems Technology : A Guide. Tunbridge Wells : Abacus Press.

Kidd, A. L. (ed) (1987). Knowledge Acquisition for Expert Systems - A Practical Handbook. Plenum Press.

King, M. (1988). AIDS and the General Practitioner : views of patients with HIV infection and AIDS. British Medical Journal 297, 182-184.

Kraemer, K. L. (editor) (1991). The Information Systems Research Challenge : Survey Research Methods vol 3.

Lane, A. (1987). DOS in English, Byte, December.

Loomis, M. E. S. (1987). The Database Book. Macmillan Publishing Company.

Lucas, H. C. Jr., Land, F. F., Lincoln, T. J., Supper, K. (1979). Editors. The Information Systems Environment. Proceedings of the IFIP TC 8.2 Working

Conference on the Information Systems Environment, Bonn, W Germany, 11-13 June 1979.

Maniezzo, V., Morpurgo, R., Mussi, S. (1993). D-KAT: A Deep Knowledge Acquisition Tool. Expert Systems, Vol. 10, No. 3, August.

Masters, W., Johnson, V., Kolodny, R. (1988). Crisis : heterosexual behaviour in the Age of AIDS. Weidenfeld and Nicolson.

Medsker, L., Tan, M., Turban, E. (1995). Knowledge Acquisition from Multiple Experts: Problems and Issues. Expert Systems With Applications. Vol. 9, No. 1, 35-40.

Meyer, J. (1988). AIDS Prevention through Health Promotion - Introductory Address. In : World Health Organisation (Eds). AIDS : Prevention and Control. Invited Organisations and Papers from the World Summit of Ministers of Health on Programmes for AIDS Prevention. Pergammon Press, Oxford.

Miller, D. (1988). Counselling of persons with AIDS. In: World Health Organisation (Eds). AIDS: Prevention and Control. Invited Presentations and Papers from the World Summit of Ministers of Health on Programmes for AIDS Prevention. Pergammon Press, Oxford.

Miller, D., Weber, J., Green, J. (1986). (Eds.) The Management of AIDS Patients. MacMillan Press, Basingstoke.

Mills, S., Campbell, M., Waters, W. (1986). Public knowledge of AIDS and the DHSS advertisement campaign. British Medical Journal 293, 1089-1090.

Mittal, S., Chandrasekaran, B. (1985). Conceptual Representation of Patient Data Bases. J. Med. Syst. 4, 169-185.

Mockler, R. J., Dologite, D. G. (1992). Knowledge-Based Systems: An Introduction to Expert Systems. Macmillan.

Moss, A. (1987). AIDS and intravenous drug use : the real heterosexual epidemic. British Medical Journal 294, 6569, 389-390.

Olson, D. L., Courtney, J. F. (1992). Decision Support Models and Expert Systems. Macmillan.

Osborne, J. (1986). The AIDS Epidemic : multidisciplinary trouble. New England Journal Medicine, 314, 12, 779-782.

Pedersen, K. (1989). Expert Systems Programming: Practical Techniques for Rule-Based Systems. John Wiley.

San Marco, J. L., Thirion, X., Manel, C., Auquer, P., Dubuc, M. (1988). L'impact d'une campagne d'information sur le SIDA dans les lycees. In: Flagle, C., Van Eimeren, W. (Eds). La Science des Systemes dans le domaine de la sante. No.140, Collection de Medecine Legale et de Toxicologie Medicale.

Schechter, M., Bokyo, W., Douglas, B., Maynard, M., Willoughby, B., McLeod, A., Craib, K. (1986). Can HTLV-II be transimitted orally. Lancet 379.

Schildt, H. (1987). Natural Language Processing in C, Byte, December.

Silverman, B. G. (ed) (1987). Expert Systems in Business. Addison-Wesley.

Sowa, J. (1987). Semantic Networks. In : Amarel, S., Findler, N., Mcdermott, J., Minker, J., Walker, D., Waltz, D. (Eds.) Encyclopedia of Artificial Intelligence, 2, 1011-1024.

Stephan, M. (1988). An Evaluation of Methods of Education about AIDS/HIV for Schools. Red Cross, London.

Tandy, A., Bax, M. (1987). AIDS : health education in schools. The role of the community child health services. Children and Society 2, 148-156.

Tsichritizis, D. C., Lochovsky, F. H. (1977). Data Base Management Systems. Academic Press.

Turban, E. (1993). Decision Support and Expert Systems: Management Support Systems. 3rd edition. Macmillan.

Vincent, R. (1987). Robot Doctors Still a Pipe Dream. Health Service Journal, July.

Wall, A. (1986). The Challenge of AIDS to managers. The Health Service Journal 1517.

Warden, J. (1987). The Politics of AIDS. British Medical Journal 294, 455-456.

Warren, D. (1977). Implementing PROLOG - Compiling Predicate Logic Programs. Report No. 40, Dept. of Artificial Intelligence, Edinburgh.

Wickenden, S. (1989). An Investigation into the Prevalence of Intravenous Drug Use in Coventry; and Related Behaviour Changes that May Have Occured in the Light of HIV. Community Medicine Department, Coventry Health Authority, Coventry.

Woods, W. (1970). Transition Network Grammars for Natural Language Analysis. Commun. ACM 13, 591.

World Health Belief Network, AAH Meditel (1990). CD-Pedia on CD ROM. Principia Fidei et Communis Sensus. Nimbus Information Systems, Monmouth, U.K.

Xu, L. D. (1994). Developing a Case-Based Knowledge System for AIDS Prevention. Expert Systems, Vol. 11, No. 4 237-244, August.

Xu, L. D., Li, L. X. (1993). An Expert System Approach to AIDS Intervention and Prevention. Expert Systems With Applications, Vol. 6, 119-127.

Zeidenberg, M. (1987). Modelling the Brain, Byte, December.

Ziegler, J., Cooper, D., Johnson, R., Gold, J. (1985). Postnatal transmission of AIDS associated retrovirus from mother to infant. Lancet i : 896-898.

APPENDICES

"There's a man on the corner
With some goods to sell
He's sellin' minutes in heaven
for a lifetime in hell"

Danny O'Keefe,
Junkman, 1973.

APPENDIX A

DEMONSTRATION OF THE AIDS/HIV EXPERT ADVISORY SYSTEM

"The object of reasoning is to find out, from the consideration of what we already know, something else which we do not know."

DEMONSTRATIONS OF THE AIDS/HIV EXPERT ADVISORY SYSTEM

```
                    AIDS/HIV INFORMATION SYSTEM
                    ===========================

Developed by :-

             Expert Systems/Decision Support Unit,

             Institute for Management Research and Development,

             School of Industrial and Business Studies,

             University of Warwick,

             Coventry CV4 7AL


                                   Copyright (C) 1988
```

Press any key to continue...

....

This is the initial introduction screen which appears once the system has loaded up successfully. The user is prompted to press any key to continue to the next screen.

```
To whom it may concern :-

The information contained in this system has been
obtained from published literature and AIDS experts.

Whilst every effort has been made to ensure the
accuracy of this information, the authors and the
publishers cannot be held responsible for errors
or omissions.
```

```
Press any key to continue...
```

....

This is the disclaimer screen which is important to ensure that the development team at the Expert Systems/Decision Support Unit are not held responsible for any inaccuracies or omissions encountered in the knowledge contained in the system. If an Editorial Board is set up and established, they would then take responsibility for the system and its contents.

F1	TO MOVE UP ONE LINE	F8	TO OBTAIN HELP
F2	TO MOVE DOWN ONE LINE	F9	TO USE INDEX
F3	TO SELECT CHOICE	F10	TO LOOK UP ANY WORD
F4	TO RECORD A COMMENT	ESC	TO RETURN TO BEGINNING
F5	TO MOVE UP ONE PAGE	SH+F1	TO MOVE TO TOP OF LIST
F6	TO MOVE DOWN ONE PAGE	SH+F2	TO MOVE TO END OF LIST
F7	TO RETURN TO PREVIOUS SECTION		

MENU NAME : AIDS

Clinical information
Counselling information
guidelines (health professionals)
information for the general public

....

This is the top-level menu of the system. The instructions to operate the system are displayed at the top of each screen. Function keys have been used throughout and these were preferred by inexperienced users, even for moving around the screen. However, to maintain flexibility the arrow keys and the other 'home' keys can also be used in the normal way. The system highlights the current choice (indicated in bold in these examples) and the highlighter can be moved up or down to the required item and then F3 (or <return>) can be pressed to select that item.

There are four modules and these are shown in the top-level menu. The default mode of access is by menus; F9 activates the index mode; F10 activates the free-text mode; the differential diagnosis mode of access is only available with the clinical module.

F1	TO MOVE UP ONE LINE	F8	TO OBTAIN HELP
F2	TO MOVE DOWN ONE LINE	F9	TO USE INDEX
F3	TO SELECT CHOICE	F10	TO LOOK UP ANY WORD
F4	TO RECORD A COMMENT	ESC	TO RETURN TO BEGINNING
F5	TO MOVE UP ONE PAGE	SH+F1	TO MOVE TO TOP OF LIST
F6	TO MOVE DOWN ONE PAGE	SH+F2	TO MOVE TO END OF LIST
F7	TO RETURN TO PREVIOUS SECTION		

MENU NAME : Counselling information

Introduction
Breaking bad news to patients and relatives
Important facts to get across
Information which counsellor should obtain
Uncertainty and its implications
Anxiety
Depression
HIV disorders
Practicalities
Lovers, Friends and Relatives

....

This shows the screen obtained when the counselling information is selected. A sub-menu is provided showing the topics on which advice and information is available. It can be seen that the instructions have remained at the top of the screen and have not changed. The highlighter can be moved down to the required item and selected as before, or F7 can be used to return to the top-level menu.

F1	TO MOVE UP ONE LINE	F8	TO OBTAIN HELP
F2	TO MOVE DOWN ONE LINE	F9	TO USE INDEX
F3	TO SELECT CHOICE	F10	TO LOOK UP ANY WORD
F4	TO RECORD A COMMENT	ESC	TO RETURN TO BEGINNING
F5	TO MOVE UP ONE PAGE	SH+F1	TO MOVE TO TOP OF LIST
F6	TO MOVE DOWN ONE PAGE	SH+F2	TO MOVE TO END OF LIST
F7	TO RETURN TO PREVIOUS SECTION		

MENU NAME : information for the general public

Description, Causes, Origins of AIDS/HIV
Medical Aspects of AIDS/HIV
AIDS/HIV Higher Risk Groups
Transmission of AIDS/HIV
Advice Related to the AIDS/HIV Test
AIDS/HIV Statistics
AIDS and Children at School
AIDS and Employment
AIDS and First-Aid
AIDS and Travel
Sources for Advice, Help and Further Information

....

This is the main menu of the General Public Module. The 'Transmission of AIDS/HIV' item is currently highlighted by using the F2 key to move down; the F3 key is then pressed to select this item.

F1	TO MOVE UP ONE LINE	F8	TO OBTAIN HELP
F2	TO MOVE DOWN ONE LINE	F9	TO USE INDEX
F3	TO SELECT CHOICE	F10	TO LOOK UP ANY WORD
F4	TO RECORD A COMMENT	ESC	TO RETURN TO BEGINNING
F5	TO MOVE UP ONE PAGE	SH+F1	TO MOVE TO TOP OF LIST
F6	TO MOVE DOWN ONE PAGE	SH+F2	TO MOVE TO END OF LIST
F7	TO RETURN TO PREVIOUS SECTION		

```
MENU NAME : Transmission of AIDS/HIV

              How AIDS/HIV is Transmitted
              How AIDS/HIV is NOT Transmitted
              Reducing the Risk of Transmission
```

....

This gives a further breakdown of the information available to the user. Next, the item 'How AIDS/HIV is NOT Transmitted' is highlighted and selected.

F1	TO MOVE UP ONE LINE	F8	TO OBTAIN HELP
F2	TO MOVE DOWN ONE LINE	F9	TO USE INDEX
F3	TO SELECT CHOICE	F10	TO LOOK UP ANY WORD
F4	TO RECORD A COMMENT	ESC	TO RETURN TO BEGINNING
F5	TO MOVE UP ONE PAGE	SH+F1	TO MOVE TO TOP OF LIST
F6	TO MOVE DOWN ONE PAGE	SH+F2	TO MOVE TO END OF LIST
F7	TO RETURN TO PREVIOUS SECTION		

```
MENU NAME : How AIDS/HIV is NOT Transmitted

               Casual Contact
               Kissing
               Coughing, Sneezing or Spitting
               Communion Chalice
               First Aid
               Swimming Pools/Spa Baths/Jacuzzis
               Insects Such as Bed Bugs, Mosquitoes
               Sharing Washing and Toilet Facilities
               Sharing Eating and Drinking Utensils
               Other Ways AIDS/HIV is NOT Transmitted
```

....

This gives a list of the ways that AIDS/HIV is not transmitted. Originally this was a report but users were not satisfied with merely a list and wanted more detailed explanations of why the virus could not be transmitted via these routes. Therefore, a menu is now provided as shown.

CONTEXT: How AIDS/HIV is NOT Transmitted REPORT : Insects Such as Bed Bugs, Mosquitoes	F4 RECORD A COMMENT F5 UP ONE PAGE F6 DOWN ONE PAGE F7 PREVIOUS SECTION

<u>Insects such as bed bugs, mosquitoes</u> 1

There is absolutely no evidence that the AIDS virus (HIV) is transmitted by insects such as bed bugs and mosquitoes despite the very expensive epidemic of this disease in Africa. Children aged 2-12 years in Africa do not get AIDS yet they are frequently bitten by mosquitoes (malaria is common amongst them).

All other viruses transmitted by vector (eg Yellow Fever, Dengue) infect the salivary glands of the mosquito before being re-injected at a subsequent bite. This invariably requires the virus to multiply in the tissues. HIV has been shown not to survive in mosquitoes and certainly not multiply.

More evidence is provided by the fact that the amount of blood on the outside of the mosquitoes feeding stylet is so small that transmission

...continued

....

This shows the report that is obtained when the 'Insects such as bed bugs, mosquitoes' is selected. The instructions have now changed to reflect the fact that this is a report. The user can return to the previous menu list by pressing F7 or he can see the rest of the report by using F6, which gives the screen shown on the next page.

CONTEXT: How AIDS/HIV is NOT Transmitted REPORT : Insects Such as Bed Bugs, Mosquitoes	F4 RECORD A COMMENT F5 UP ONE PAGE F6 DOWN ONE PAGE F7 PREVIOUS SECTION

```
would be very unlikely to occur even if she fed immediately upon     2
another person (a rare event unless disturbed during a feed).  She
will not then feed again for 2 days or so and the virus cannot survive
for such a length of time.
```

....

The report ends here and the user has the option of returning to page 1 of the report by pressing F5 or he can return to the menus by using F7.

F1	TO MOVE UP ONE LINE	F8	TO OBTAIN HELP
F2	TO MOVE DOWN ONE LINE	F9	TO SPECIFY A TERM TO LOOK UP
F3	TO SELECT CHOICE	F10	TO REMOVE EXISTING REQUESTS
F4	TO RECORD A COMMENT	ESC	TO RETURN TO BEGINNING
F5	TO MOVE UP ONE PAGE	SH+F1	TO MOVE TO TOP OF LIST
F6	TO MOVE DOWN ONE PAGE	SH+F2	TO MOVE TO END OF LIST
F7	TO RETURN TO PREVIOUS SECTION	SH+F3	TO SHOW WORDS REQUESTED

```
INDEX OF KEYWORDS RECOGNISED BY SYSTEM

            acas
            accidents
            acupuncture
          { africa
            aids related complex
            aids test
            antenatal care
            antibodies
            antibody test
            antigen test
            anxiety
            arc
```

....

This screen is obtained when F9 is pressed from the menu mode, and it presents a list of words which can be selected. The instructions have changed to reflect the different mode of access. The F1 and F2 keys can be used to move the highlighter up or down as previously. When F9 is pressed, a tick is displayed next to the currently highlighted item to indicate that it has been selected. Any number of keywords can be selected before pressing F3 to execute the search.

F1	TO MOVE UP ONE LINE	F8	TO OBTAIN HELP
F2	TO MOVE DOWN ONE LINE	ESC	TO RETURN TO BEGINNING
F3	TO SELECT CHOICE	SH+F1	TO MOVE TO TOP OF LIST
F4	TO RECORD A COMMENT	SH+F2	TO MOVE TO END OF LIST
F5	TO MOVE UP ONE PAGE	SH+F3	TO SHOW WORDS REQUESTED
F6	TO MOVE DOWN ONE PAGE		
F7	TO RETURN TO PREVIOUS SECTION		

TOPICS RELEVANT TO SEARCH

Insects Such as Bed Bugs, Mosquitoes
Origins of AIDS/HIV
African Kaposi's sarcoma

....

This shows the items obtained when the two terms 'bed bugs' and 'africa' are selected. Information on any of these can be accessed by selecting the required item. When a keyword search is done, the list obtained is ranked so that the items at the top of the list are relevant to more of the keywords specified and the items near the bottom of the list are relevant to fewer keywords (usually just one).

It is possible to return to the keywords list and add to the ones that have already been selected and request another search. Alternatively, some or all of the keywords can be removed before a new search is requested.

F1	TO MOVE UP ONE LINE	F8	TO OBTAIN HELP
F2	TO MOVE DOWN ONE LINE	F9	TO SPECIFY A TERM TO LOOK UP
F3	TO SELECT CHOICE	F10	TO REMOVE EXISTING REQUESTS
F4	TO RECORD A COMMENT	ESC	TO RETURN TO BEGINNING
F5	TO MOVE UP ONE PAGE	SH+F1	TO MOVE TO TOP OF LIST
F6	TO MOVE DOWN ONE PAGE	SH+F2	TO MOVE TO END OF LIST
F7	TO RETURN TO PREVIOUS SECTION	SH+F3	TO SHOW WORDS REQUESTED

ENTER TERM TO LOOK UP :-

....

This screen shows the free-text search facility, activated by pressing F10. The system warns the user that this may take quite a long time because the whole system has to be searched. If the user decides to proceed, he is prompted to enter the word or phrase which he wishes to search - shown above.

F1	TO MOVE UP ONE LINE	F8	TO OBTAIN HELP
F2	TO MOVE DOWN ONE LINE	F9	TO SPECIFY A TERM TO LOOK UP
F3	TO SELECT CHOICE	F10	TO REMOVE EXISTING REQUESTS
F4	TO RECORD A COMMENT	ESC	TO RETURN TO BEGINNING
F5	TO MOVE UP ONE PAGE	SH+F1	TO MOVE TO TOP OF LIST
F6	TO MOVE DOWN ONE PAGE	SH+F2	TO MOVE TO END OF LIST
F7	TO RETURN TO PREVIOUS SECTION	SH+F3	TO SHOW WORDS REQUESTED

```
SEARCHING FOR TERM :- insects
```

....

This shows the user requesting a search on 'insects'. This word would not be searched normally as it is available in the keywords search. The free-text facility is most useful for words which do not occur very frequently and are not in the list of keywords.

F1	TO MOVE UP ONE LINE	F8	TO OBTAIN HELP
F2	TO MOVE DOWN ONE LINE	F9	TO SPECIFY A TERM TO LOOK UP
F3	TO SELECT CHOICE	F10	TO REMOVE EXISTING REQUESTS
F4	TO RECORD A COMMENT	ESC	TO RETURN TO BEGINNING
F5	TO MOVE UP ONE PAGE	SH+F1	TO MOVE TO TOP OF LIST
F6	TO MOVE DOWN ONE PAGE	SH+F2	TO MOVE TO END OF LIST
F7	TO RETURN TO PREVIOUS SECTION	SH+F3	TO SHOW WORDS REQUESTED

TOPICS RELEVANT TO SEARCH

Insects Such as Bed Bugs, Mosquitoes

....

The system has found only one topic relevant to the search and this is displayed. It is highlighted because it is the only item in the list and therefore F3 will activate the report associated with it.

```
        F1        F2       F3        F4           F7
        UP        DOWN     LEFT      RIGHT        PREVIOUS SECTION

   -

There is absolutely no evidence that the AIDS virus (HIV) is
transmitted by insects such as bed bugs and mosquitoes despite the
very expensive epidemic of this disease in Africa.  Children aged
2-12 years in Africa do not get AIDS yet they are frequently bitten
by mosquitoes (malaria is common amongst them).

All other viruses transmitted by vector (eg Yellow Fever, Dengue)
infect the salivary glands of the mosquito before being re-injected
at a subsequent bite.  This invariably requires the virus to multiply
in the tissues.  HIV has been shown not to survive in mosquitoes and
certainly not multiply.

More evidence is provided by the fact that the amount of blood on the
outside of the mosquitoes feeding stylet is so small that transmission
                                                          ...continued
```

....

This shows the 'Enter Any Comment' (EAC) facility which is available at any time by using the F4 key. The user can enter any comments about this or any other section of the system. The window will keep scrolling up so the user can make his comments as long as he wishes. These comments are stored by the system and they can be accessed later by the development team. F7 will remove the EAC facility window and return the user to the place from where the facility was activated.

F1	TO MOVE UP ONE LINE	F8	TO OBTAIN HELP
F2	TO MOVE DOWN ONE LINE	F9	TO USE INDEX
F3	TO SELECT CHOICE	F10	TO LOOK UP ANY WORD
F4	TO RECORD A COMMENT	ESC	TO RETURN TO BEGINNING
F5	TO MOVE UP ONE PAGE	SH+F1	TO MOVE TO TOP OF LIST
F6	TO MOVE DOWN ONE PAGE	SH+F2	TO MOVE TO END OF LIST
F7	TO RETURN TO PREVIOUS SECTION		

MENU NAME : Clinical information

Definitions (AIDS,ARC,PGL,HIV Classification)
Differential diagnosis
Classification by cause
Classification by body system
Clinical Abstracts

....

This screen shows the menu of items obtained when clinical information is selected. Information can be obtained via menus by selecting the 'Classification by cause' option. However, this information can also be obtained by using 'differential diagnosis' and the next page shows the list which is obtained on selecting this mode of consultation.

F1	TO MOVE UP ONE LINE	F8	TO OBTAIN HELP
F2	TO MOVE DOWN ONE LINE	F9	TO SHOW CURRENT DIAGNOSIS
F3	TO SELECT CHOICE	ESC	TO RETURN TO BEGINNING
F4	TO RECORD A COMMENT	SH+F1	TO MOVE TO TOP OF LIST
F5	TO MOVE UP ONE PAGE	SH+F2	TO MOVE TO END OF LIST
F6	TO MOVE DOWN ONE PAGE	SH+F3	TO SHOW CURRENT FINDINGS
F7	TO RETURN TO PREVIOUS SECTION		

```
Findings of patient

           { cough
             breathlessness
             fever
             night-sweats
             tachypnoea
             chest-percussion
             hoarse-voice
             oral-thrush
             lesions
             esophageal-candiasis
             difficulty-in-swallowing
             x-ray
```

....

This shows a list of findings of a patient who is HIV positive (e.g signs, symptoms, results of tests). Any number of these can be selected and then a differential diagnosis requested by pressing F9. The system will 'tick' the items selected in a similar way to the keywords search.

F1	TO MOVE UP ONE LINE	F8	TO OBTAIN HELP
F2	TO MOVE DOWN ONE LINE	F9	TO SHOW CURRENT DIAGNOSIS
F3	TO SELECT CHOICE	ESC	TO RETURN TO BEGINNING
F4	TO RECORD A COMMENT	SH+F1	TO MOVE TO TOP OF LIST
F5	TO MOVE UP ONE PAGE	SH+F2	TO MOVE TO END OF LIST
F6	TO MOVE DOWN ONE PAGE	SH+F3	TO SHOW CURRENT FINDINGS
F7	TO RETURN TO PREVIOUS SECTION		

```
    severity of cough

                  variable
                  mild-at-first
                  severe
```

....

If cough is selected as one of the findings as in this case, the system will ask for the characteristics of the cough (above), the productivity of the cough and the presence of blood (below).

F1	TO MOVE UP ONE LINE	F8	TO OBTAIN HELP
F2	TO MOVE DOWN ONE LINE	F9	TO SHOW CURRENT DIAGNOSIS
F3	TO SELECT CHOICE	ESC	TO RETURN TO BEGINNING
F4	TO RECORD A COMMENT	SH+F1	TO MOVE TO TOP OF LIST
F5	TO MOVE UP ONE PAGE	SH+F2	TO MOVE TO END OF LIST
F6	TO MOVE DOWN ONE PAGE	SH+F3	TO SHOW CURRENT FINDINGS
F7	TO RETURN TO PREVIOUS SECTION		

```
presence-of-blood

          present
          variable
          absent
```

....

The system will ask for more details as each finding is selected. Here, the user indicates that blood is present.

F1	TO MOVE UP ONE LINE	F8	TO OBTAIN HELP
F2	TO MOVE DOWN ONE LINE	F9	TO SHOW CURRENT DIAGNOSIS
F3	TO SELECT CHOICE	ESC	TO RETURN TO BEGINNING
F4	TO RECORD A COMMENT	SH+F1	TO MOVE TO TOP OF LIST
F5	TO MOVE UP ONE PAGE	SH+F2	TO MOVE TO END OF LIST
F6	TO MOVE DOWN ONE PAGE	SH+F3	TO SHOW CURRENT FINDINGS
F7	TO RETURN TO PREVIOUS SECTION		

```
character of fever

            continuous
            intermittent
```

....

Fever is also selected in this example and so again the system requests further information about the fever.

F1	TO MOVE UP ONE LINE	F8	TO OBTAIN HELP
F2	TO MOVE DOWN ONE LINE	F9	TO SHOW CURRENT DIAGNOSIS
F3	TO SELECT CHOICE	ESC	TO RETURN TO BEGINNING
F4	TO RECORD A COMMENT	SH+F1	TO MOVE TO TOP OF LIST
F5	TO MOVE UP ONE PAGE	SH+F2	TO MOVE TO END OF LIST
F6	TO MOVE DOWN ONE PAGE	SH+F3	TO SHOW CURRENT FINDINGS
F7	TO RETURN TO PREVIOUS SECTION		

severity of night-sweats

mild
severe

....

Similarly, the user is asked to indicate the severity of night-sweats if this is also selected. It is possible to see the items and their characteristics as selected by the user by using Shift-F3 (i.e. pressing F3 while holding down the Shift key). When all the items have been selected, the F9 key can be pressed to request the system for a differential diagnosis based on the information given.

F1	TO MOVE UP ONE LINE	F8	TO OBTAIN HELP
F2	TO MOVE DOWN ONE LINE	F9	TO SHOW CURRENT DIAGNOSIS
F3	TO SELECT CHOICE	ESC	TO RETURN TO BEGINNING
F4	TO RECORD A COMMENT	SH+F1	TO MOVE TO TOP OF LIST
F5	TO MOVE UP ONE PAGE	SH+F2	TO MOVE TO END OF LIST
F6	TO MOVE DOWN ONE PAGE	SH+F3	TO SHOW CURRENT FINDINGS
F7	TO RETURN TO PREVIOUS SECTION		

CURRENT DIFFERENTIAL DIAGNOSIS FOR PATIENT

1 Pneumocystis carinii pneumonia
2 Mycobacterium tuberculosis
3 Atypical Mycobacterium infection
4 pulmonary Cytomegalovirus
5 Kaposi's sarcoma
6 bronchopulmonary Candidiasis

....

This shows a list of diseases obtained when a particular set of findings are indicated with their specific characteristics (see next page). The list obtained is ranked with the most probable disease being displayed at the top of the list. Any of these diseases can be highlighted and an explanation requested by pressing F9.

```
EXPLANATION FOR DIAGNOSIS:Pneumocystis carinii pneumonia | F7 | TO CONTINUE
```

```
Present :
   night-sweats
        duration     recent
        severity     severe
   - commonly but not overwhelmingly caused by
     Pneumocystis carinii pneumonia
   fever
        character     continuous
   - in a substantial minority of instances caused by
     Pneumocystis carinii pneumonia
   cough
        severity      variable
        character      frequent-not-paroxysmal
        productivity      colourless-sputum
        presence-of-blood      present
   - very exceptionally caused by Pneumocystis carinii pneumonia
```

....

This screen offers an explanation for choosing Pneumocystis carinii pneumonia (PCP) in the diagnosis. It states that given these characteristics the most probable disease is PCP.

	F7	TO CONTINUE

```
Findings expected but not found :
   breathlessness
   chest-percussion
   x-ray
```

....

This is the second screen of the explanation and lists the other findings which the system expected, which reminds the clinician to do more tests on some of these.

F1	TO MOVE UP ONE LINE	F8	TO OBTAIN HELP
F2	TO MOVE DOWN ONE LINE	F9	TO SHOW CURRENT DIAGNOSIS
F3	TO SELECT CHOICE	ESC	TO RETURN TO BEGINNING
F4	TO RECORD A COMMENT	SH+F1	TO MOVE TO TOP OF LIST
F5	TO MOVE UP ONE PAGE	SH+F2	TO MOVE TO END OF LIST
F6	TO MOVE DOWN ONE PAGE	SH+F3	TO SHOW CURRENT FINDINGS
F7	TO RETURN TO PREVIOUS SECTION		

```
Findings of patient

             { cough
               breathlessness
             { fever
             { night-sweats
               tachypnoea
               chest-percussion
               hoarse-voice
               oral-thrush
             { lesions
               esophageal-candiasis
               difficulty-in-swallowing
               x-ray
```

....

Now, if the user returns to the list of findings he can add more findings (e.g. if the patient gives more details or more tests have been carried out). For instance, if 'lesions' is added to the original list, the system will ask for more information on these (next page).

F1	TO MOVE UP ONE LINE	F8	TO OBTAIN HELP
F2	TO MOVE DOWN ONE LINE	F9	TO SHOW CURRENT DIAGNOSIS
F3	TO SELECT CHOICE	ESC	TO RETURN TO BEGINNING
F4	TO RECORD A COMMENT	SH+F1	TO MOVE TO TOP OF LIST
F5	TO MOVE UP ONE PAGE	SH+F2	TO MOVE TO END OF LIST
F6	TO MOVE DOWN ONE PAGE	SH+F3	TO SHOW CURRENT FINDINGS
F7	TO RETURN TO PREVIOUS SECTION		

```
    character of lesions

                  red
                  purple
                  black
                  crusted
```

....

The system asks for the character of the lesions, their colour and site. Now, the F9 key can be pressed to request the system for a differential diagnosis based on the new information.

F1	TO MOVE UP ONE LINE	F8	TO OBTAIN HELP
F2	TO MOVE DOWN ONE LINE	F9	TO SHOW CURRENT DIAGNOSIS
F3	TO SELECT CHOICE	ESC	TO RETURN TO BEGINNING
F4	TO RECORD A COMMENT	SH+F1	TO MOVE TO TOP OF LIST
F5	TO MOVE UP ONE PAGE	SH+F2	TO MOVE TO END OF LIST
F6	TO MOVE DOWN ONE PAGE	SH+F3	TO SHOW CURRENT FINDINGS
F7	TO RETURN TO PREVIOUS SECTION		

CURRENT DIFFERENTIAL DIAGNOSIS FOR PATIENT

1 Kaposi's sarcoma
2 Pneumocystis carinii pneumonia
3 Mycobacterium tuberculosis
4 Atypical Mycobacterium infection
5 pulmonary Cytomegalovirus
6 bronchopulmonary Candidiasis

....

Now the system has listed Kaposi's sarcoma at the top of the list of ranked diseases. Information on this can then be obtained by highlighting this item and then selecting it. It is possible to check the current findings which have been selecting by using Shift-F3.

CURRENT FINDINGS FOR PATIENT :	F7	TO CONTINUE

lesions
    character   purple
    site   hard-palate-and-skin
night-sweats
    duration   recent
    severity   severe
fever
    character   continuous
cough
    severity   variable
    character   frequent-not-paroxysm
    productivity   colourless-sputum
    presence-of-blood   present

....

This shows the current findings which have been specified by the user. This is important because it allows the user/consultant to check that everything has been entered correctly.

```
EXPLANATION FOR DIAGNOSIS : Kaposi's sarcoma    F7  TO CONTINUE
```

```
Present :
   lesions
        character     purple
        site      hard-palate-and-skin
   - pathogmonic for Kaposi's sarcoma
   cough
        severity    variable
        character    frequent-not-paroxysmal
        productivity    colourless-sputum
        presence-of-blood    present
   - rarely or unusually caused by Kaposi's sarcoma
Findings expected but not found :
   x-ray
```

....

This gives an explanation of the diagnosis for Kaposi's sarcoma. It can be seen why the present of lesions has changed dramatically the order of the list of ranked alternatives presented previously.

F1	TO MOVE UP ONE LINE	F8	TO OBTAIN HELP
F2	TO MOVE DOWN ONE LINE	F9	TO USE INDEX
F3	TO SELECT CHOICE	F10	TO LOOK UP ANY WORD
F4	TO RECORD A COMMENT	ESC	TO RETURN TO BEGINNING
F5	TO MOVE UP ONE PAGE	SH+F1	TO MOVE TO TOP OF LIST
F6	TO MOVE DOWN ONE PAGE	SH+F2	TO MOVE TO END OF LIST
F7	TO RETURN TO PREVIOUS SECTION		

MENU NAME : Kaposi's sarcoma

background
presentation
complications
investigations
treatment

....

This shows the information available on Kaposi's sarcoma when this option is selected. The clinician can, for example, select the treatment option to see the latest treatment regimes for this cancer. This information can be arrived at through the menu mode of access. However, the differential diagnosis mode assists the clinician in deciding what diseases to consider and he can choose not to do this if he wishes.

APPENDIX B1

A FORMAL EVALUATION OF THE AIDS INFORMATION PROGRAMME

"Research is often like a long jump,
you will go further if you go back a little first"

R. Gupta

Introduction

Using the General Public module of the system, a formal trial was carried out at the Alderman Smith School in Nuneaton. This group was chosen for the study because of the importance placed on educating the young by the Social Services Select Committee (House of Commons 1987). Other groups have also emphasised the need for this (San Marco et al 1988), Philips 1988, de Neergard 1988).

Also, various other studies had highlighted a number of serious problems. The West Midlands Regional Health Authority had carried out a study with youths aged 16-25 years. They found that although the level of knowledge about AIDS was high, there were a number of topics fundamental to the transmission of the virus about which people were "uncertain" (WMRHA 1988). Another study concluded that a large number of people were confused or ignorant about the issues involving AIDS (Aggleton and Warwick 1988).

Assessment of Current Methods

Several independent studies have been conducted to assess the effectiveness of the different approaches that have been adopted. The conclusions are varied but all imply that alternative methods should be examined.

The knowledge and attitudes to AIDS of young people aged 16-25 years in the West Midlands has been assessed by the West Midlands Regional Advisory Group on Health Promotion and Preventative Medicine. The study was conducted to identify educational and promotional targets.

The main findings of the group were as follows:

1) There is a lot of uncertainty about basic information on AIDS among 16-17 year olds. Uncertainty is as undesirable as incorrect knowledge.

2) There is a relatively high level of self-perceived need for more and better information.

3) The most useful sources of AIDS information are television chat show/discussions (30%), leaflets (20%), documentaries (16%), and advertisements (9%).

4) 59% of young people consider everyone to be at risk from AIDS. Self perceived risk decreases with age.

5) 18% had changed their behaviour to reduce the risk of infection by HIV.

The group concluded that the level of knowledge is generally high but that there are several topics, some fundamental to the transmission of the virus, about which people are uncertain. The authors suggest that steps must be taken to:-

- increase knowledge of transmission routes
- increase the belief that everyone is potentially at risk
- decrease the belief that a cure is imminent
- increase awareness of the risk of multiple partners
- develop appropriate educational material using a variety of different media
- provide accurate information within a context of general health and social education

The observations made by this group are supported by similar studies performed by Bristol Polytechnic (Aggleton and Warwick 1988) in the South West of England and by the British Red Cross at seven sites in England, Scotland and Wales.

White (1988), a psychologist at the North East London Polytechnic, suggests that the government's program on AIDS has changed people's general awareness but not their behaviour. The net effect is that people are more informed about the problems associated with AIDS but are also more anxious. These conclusions were based on studies carried out in London where the incidence of the disease is particularly high.

From these studies, it appears that young people have some knowledge of AIDS but that for many topics, their understanding is confused or inadequate to bring about desirable behaviour.

Problems with Current Methods

The methods currently being used to educate young people about AIDS have not been effective in conveying basic facts about the disease and promoting what is considered to be responsible behaviour.

Many reasons have been suggested to account for this situation. Phillips (1988) suggests that insufficient attention has been paid to identifying the variables which determine an individuals behaviour. This requires considerable effort because they will often be unique to different societal groups (Abrams and Abraham 1988).

The presentation of the information also must be considered. It must be presented in such a way that it maximises effectiveness and minimises antagonism (Phillips 1988). This can be difficult with adolescents because they have a tendency to rebel against what is right and sensible (de Neergard 1988). The techniques currently used to present information about AIDS have been criticised for over emphasising the more frightening aspects of the disease (Vinberging 1988).

The highly personal nature of AIDS raises questions as to the usefulness of blanket media campaigns. The Red Cross (Stephan 1988) point out that much of the information distributed in this way never actually reaches the intended audience. They report that many parents destroy leaflets pushed through their doors and turn off the radio or television when broadcasts are made. It is suggested that parents behave in this way because they find the subject of AIDS too embarrassing to discuss within the home.

The Red Cross have been one of the few organisations to integrate the adult and adolescent community when assessing current education methods. They discovered that many parents felt that there was no need to talk to their children about AIDS because they assumed that the schools were "doing something". It is true that the schools have been encouraged to incorporate education about AIDS into the national foundation curriculum (House of Commons 1987) but equally true, is that there are no guidelines as to how this should be done. The Secretary of State for Education merely states that education about AIDS should be incorporated as part of general health or sex education. The responsibility for the content of such material is placed with the governing body.

The laissez faire attitude to education taken by the state has not been received favourably by the National Association of Teachers. They argue strongly for the establishment of an editorial board "to vet all educational material produced on AIDS and to assess the suitability of such material for use in educational institutions (House of Commons 1987). This is extremely important because children may confide in teaching staff about highly personal and emotive matters (Tandy and Box 1988).

Support for teaching has been founded on the conventional techniques of paper, television, radio, video and guest speakers. These are unsuited to problems such as AIDS where information is highly volatile. Printed leaflets cannot be updated, only re-issued, and videos normally require the supervision of a member of staff. Visiting speakers are useful to complement an existing programme but there is a need to have informed personnel at hand to answer queries as they arise.

Inadequate attention has been paid to the format of the present teaching material. The Royal College of Nurses have expressed dissatisfaction with the language used in many of the documents issued to schools (House of Commons 1987). Teachers are already stretched and to expect them to spend additional time to grasp the complex issues involved in AIDS in unrealistic (Tandy and Box 1988) especially when so little support is forthcoming from external bodies. There is also evidence that many teachers find it difficult to talk about AIDS and sex, and that teachers who feel uncomfortable about the topic they are presenting are not good educators (de Neergard 1988).

The Objectives of the Study

The preceding sections have described the approaches currently being used to promote education on AIDS among young people, and the impact that these methods have had. Some of the problems that have emerged have been discussed.

The AIDS Information System that has been developed as part of this project contains a strong educational element. The merits of this approach relative to the methods presently employed in AIDS education were tested by analysing:-

1) the impact that the module of the system designed for the general public had upon the attitudes of a group of school children towards AIDS and their perception of risk.

2) the influence of variables such as motivation and prior experience with computers on the use of the system to young people.

In addition, the evaluation collected information which could be compared with other studies made on the same age group (Aggleton and Warwick 1988; West Midlands Regional Health Authority 1988), and which served as useful feedback for suggesting improvements to the design of the system.

Preparation

The various studies cited earlier suggested that AIDS was a highly emotive issue. This meant that any evaluation of the system would have to be planned carefully. The program necessarily contained potentially explicit material so that it was important to allay any fears that parents might have that the system would become a tool of abuse rather than use.

A local secondary school was approached through the auspices of the Local Education Authority for North Warwickshire. The Headmaster of the school was given a demonstration of the AIDS computer program initially alone and then in conjunction with selected staff and representatives of the Parents Association. They were satisfied with the factual content of the program and the techniques that had been used to verify it and agreed that the study could proceed.

The trial was to focus on 15 to 16 year olds. It has been suggested that children are developing an awareness of their own sexuality and of the significance of sexual and emotional relationships by this age (House of Commons 1987) and so would be more likely to be concerned about AIDS than younger children. Older children were excluded from the trial because the period of study coincided with the start of the public examination programme.

The usefulness of the program would be assessed by questionnaire. This was designed in collaboration with psychologists from George Eliot Hospital in Nuneaton and social scientists at the University of Warwick. Note was taken of problems encountered during an earlier study of the system at a London school between November 1987 and April 1988 which had also been assessed by questionnaires.

The study comprised three groups of six, and one group of seven children. The four groups were taken from different classes selected according to availability. There were 16 boys and 9 girls. All had attended a compulsory AIDS foundation course consisting of film, video, and lectures which discussed AIDS and related topics such as contraception and sexually transmitted disease.

The system was set up on a standard IBM compatible personal computer in the main school library and each group was given access to it for approximately one hour. A standard format of analysis was used comprising of:

1) a short questionnaire to be completed prior to using the computer program;
2) a short demonstration of the program illustrating the minimum set of commands necessary to operate it;
3) unrestricted use of the system for approximately 35 minutes;
4) a longer questionnaire to be completed after using the system.

Further results were collected by making the program generally available to staff and pupils during the lunch hour. Notes were taken on the behaviour of each person who used the computer. The questionnaire which was used is shown in Appendix B.

Results of the Study (plus see Appendix C)

Information collected before using the Computer

<u>Amount of Computing Experience</u>

All of the sample had used computers before using the AIDS system. The majority (80%) classified themselves as inexperienced operators. The most popular use made of computers was that of entertainment in the form of computer games (80%). Other significant uses included programming (52%) and word processing (40%). No one recollected having used a computer for education.

<u>Amount of Information Received</u>

All of the sample had already received some information on AIDS. Most felt the amount to be small (64%).

Sources of Information

The most frequently names sources of AIDS information were from television programmes (88%) and from school (64%). Approximately half of the sample had looked at the leaflets issued by the government. No one claimed to have sought advice from either a helpline or their family doctor.

Some pupils had acquired this information deliberately (40%), others casually (48%), and a few as a matter of personal policy (12%).

Attitude to AIDS

The majority of pupils expressed some worry about AIDS (88%). These children considered the virus either to be very worrying (41% of this category) or quite worrying (59%). There was insufficient evidence to reject the null hypothesis that concern about AIDS was independent of the amount of information received about the virus (see Appendix D).

Perception of Risk

The pupils were asked to indicate the degree to which they felt at risk of infection. Most thought that they were at some risk but that it was low (72%). A few placed themselves in the high risk category (10%).

A Chi-square test was performed to investigate a possible relationship between a person's perception of risk and the amount of information that they had received (see Appendix D). There was insufficient evidence, at the 5% level of significance, to reject the null hypothesis that the amount of information a person has is independent of the degree to which they feel at risk of infection.

Information collected after using the computer

Use of the AIDS Computer System

All of the students in the sample said that they were able to operate the AIDS computer system and understand the information that it contained. The methods used to present the information did not pose any problems. There were no difficulties with the on-line help facilities or the variety of methods for accessing information (menus, keywords, and free word search). Nearly half the sample (48%) indicated that occasionally they had difficulty with some of the terminology used. The record facility in the system was used to capture these terms and it was found that they were all words specifically related to AIDS.

Extent of the AIDS Knowledge Base

The system provided new information to almost all the students (92%). Some indicated that the amount of new information was large (24%) whereas for others, the amount of new information to be gained was small (68%). Most of the students enjoyed the actual process of using the AIDS system (80%).

Perception about AIDS

The perceptions of students' own risk of AIDS did not alter very considerably after using the computer system. The proportion of students who considered themselves to be at "no risk" of infection from the virus fell from 20% to 16%. This was balanced by an increase from 72% to 76% of students who classified themselves as being at 'low risk' of infection. A small proportion of the same (8%) still considered themselves to be in the "high risk" category.

Attitude towards AIDS

There was a noticeable change in the distribution of the students attitude towards AIDS. Prior to using the system, 36% of the students considered AIDS "very worrying" and 12%, "not worrying". After running the program, these proportions were reduced to 28% and 4% respectively.

A Chi-square analysis using the statistical package MINITAB was performed on the change in attitude of the students (Appendix D). There was evidence for rejecting the null hypothesis that the system has not provoked a change in attitude of the students at the 5% level of significance. Owing to the small sample size and the constraints imposed by the Chi-square test, the two extreme groups were aggregated and tested against the more moderate group. There is evidence that using the AIDS computer system caused significant kurtosis in the distribution leading to more of the students moving into the more moderate class. Alternative combinations of the three groups, upholding the constraints of the Chi-square test, failed to produce any significant results.

The proposition that using the AIDS computer system had caused a change in attitude of the more extreme groups was investigated further. The Yates correction was applied and a further analysis performed by hand. The relationship was no longer significant. The Yates correction makes the Chi-square test particularly rigid and was conceived to safeguard against spurious results invoked by small samples.

Discussion

The study was concerned with examining the potential of an innovative computer program as a method for educating young people about AIDS. The strategies presently employed in teaching this age group are printed leaflets and books, television and radio programmes, videos and seminars. The problems associated with these techniques have been discussed earlier. To reiterate, these are the difficulty of keeping up to date media which inherently are permanent; of providing the necessary facilities to train staff in counselling; of ensuring that advice and basic factual information is available at all times; and of checking that all the advicc and information received is correct and understandable.

The school is seen as a repository for information and many parents have become complacent in ensuring that their children are made aware about AIDS because they assume that this will be done by the school. Most schools conduct an AIDS course of some description but the elements of this will vary from school to school. The Department of Education and Science (DES) believe that staff have a responsibility to educate pupils about AIDS and HIV but there are no provisions in the national foundation curriculum for this nor are there published guidelines as to what should be taught.

Young people also acquire information from the mass media campaigns that have been launched periodically since March 1986. The impact of such blanket techniques is questionable because of the wide range of individuals that have to be catered for. For example, the language that is most transparent to a father may be incomprehensible to his child.

The data obtained on sources of information and perceived risk of infection was consistent with studies conducted by other groups (e.g. Aggleton and Warwick 1988; de Neergard 1988) and that obtained from a study made earlier in London (see Appendix C). All of the subjects had received information on the basic facts about AIDS but most felt the amount was small. Excluding specific teaching in the school, the most common sources were television and radio programmes, and government leaflets. Information is unlikely to be obtained from family doctors or parents. A comparatively high proportion of the sample felt at risk of infection.

The use of computers in education programmes about AIDS had not been explored by other groups. Both the questionnaires and the behaviour of the subjects revealed that for most school children, using the computer was a familiar and enjoyable activity. The relationship between enjoyment and effectiveness in learning was not tested directly but the importance of the method used to present information has been stressed by others (Philips 1988).

Almost all the subjects indicated that they had learnt some new material from participating in the trial. This might be due to the program being more comprehensive than other sources of information or may reflect a greater interest in studying the information available because it was obtained by computer.

The results suggest also that the program affected the attitudes of the subjects towards AIDS by moderating the extreme beliefs, and that this change in attitude was not conditional on the amount of information received prior to the study. The sample is too small to analyse the validity of this finding further and it would be useful to investigate it more thoroughly in a larger trial. de Neergard (1988) has observed that the attitudes of adolescents are very polarised.

Computer technology offers the ability to provide easily maintainable and verifiable information. This has enormous benefits for areas such as AIDS where the basic factual information is changing frequently. The solution proposed in this study used a locally held database of information. This can be updated as required using magnetic disks or the telephone line.

A further benefit of the computer approach is that it is anonymous. AIDS is very much a personal and an emotive subject and it has been shown that people may not seek advice because of this (Miller 1986).

The development team found the feedback received from the formal trials very useful, with respect to the design and content of the system. The 'user-friendliness' of the system was confirmed by the study - most found searching by menus and keywords simple, fast and easy to understand. The main criticism was the preponderance of text used to display information. Many of the pupils identified a need for graphical representation of data and information. Also proposed was the use of a quiz to strengthen the learning element and make the use of the system more enjoyable. Another suggestion was the use of a mouse to manoeuvre around the screen and make selections.

APPENDIX B2

QUESTIONNAIRE FOR EVALUATION OF AIDS INFORMATION PROGRAMME

"There is no abstract art.

You must always start with something"

Pablo Picasso

QUESTIONNAIRE FOR EVALUATION OF AIDS INFORMATION PROGRAMME

Part I

1. What use have you made of computers?

   NONE LITTLE LOT

2. Was this for:

   GAMES WORD PROCESSING PROGRAMMING

   OTHERS: (Please give details)

3. How much information about AIDS have you received?

   NONE A LITTLE A LOT

4. Where did this information come from?

   DOCTOR TELEPHONE HELPLINE RADIO

   TELEVISION GOVERNMENT LEAFLET SCHOOL

   OTHER(Please give details).

5. Did you find out about AIDS:

   BECAUSE YOU WANTED TO

   BECAUSE YOU HAD TO

   BY ACCIDENT

6. Are you interested in using the AIDS education on the computer:-

   YES

   NO

   Why?

7. Do you consider AIDS

NOT WORRYING QUITE WORRYING VERY WORRYING

8. With regard to AIDS, do you consider yourself at:-

HIGH RISK LOW RISK NO RISK

Part II

9. Did you understand

a) How to use the AIDS system

YES

NO Please give details of difficulties

b) The information given about AIDS

YES

NO Please give details of difficulties

10 Did you have any problem with the way the information was presented?

a)	Words used	NO	YES	Please give details
b)	Reading the screen	NO	YES	Please give details
c)	Layout of the screen	NO	YES	Please give details
d)	Menu/Keyword approach	NO	YES	Please give details
e)	Instructions	NO	YES	Please give details
f)	Other:	Please give details		

11. How much of the AIDS information was new to you?

NONE A LITTLE A LOT

Please give details

12. Did you find the experience of using the computer for AIDS information interesting?

YES NO

13. Was this because you were:

a) finding out about AIDS

b) using the computer

c) other reasons: please give details

14. Do you feel that you now know more about AIDS?

NO

YES A LITTLE A LOT

15. Do you consider AIDS

NOT WORRYING QUITE WORRYING VERY WORRYING

16. With regard to AIDS, do you consider yourself at:-

HIGH RISK LOW RISK NO RISK

17. What did you like best about the AIDS education package

18. What did you like least about the AIDS education package

19. Any comments you would like to make, please list below

APPENDIX B3

SUMMARY OF DATA FROM
ALDERMAN SMITH SCHOOL NUNEATON

"The young have aspirations that never come to pan;
the old have reminiscences of what never happened"

SAKI (H.M. MUNRO)

SUMMARY OF DATA FROM ALDERMAN SMITH SCHOOL NUNEATON

1. Prior Use of Computers

NONE	0%
SOME	80%
LOT	20%

2. Experience of Computers

GAMES	84%
WORDPROCESSING	40%
PROGRAMMING	44%
EDUCATION	0%

3. Quantity of Information Received

NONE	0%
SOME	72%
A LOT	28%

4. Sources of Information

DOCTOR	0%
TELEPHONE HELPLINE	0%
RADIO	16%
TELEVISION	88%
GOVERNMENT LEAFLET	56%
SCHOOL	64%

5. Motivation for Obtaining Information

VOLUNTARY	40%
COMPULSORY	12%
CASUAL	48%

6. Attitude towards AIDS prior to use of system

NOT WORRYING	12%
QUITE WORRYING	52%
VERY WORRYING	36%

7. Assessment of Risk Prior to use of system

NO RISK	8%
LOW RISK	72%
HIGH RISK	20%

8. Presentation of Information

8.1 Instructions

CLEAR	100%
DIFFICULT	0%

8.2 Readability

UNDERSTANDABLE ALWAYS	56%
DIFFICULT AT TIMES	44%

9. Amount of New Information

NONE	8%
SOME	68%
A LOT	24%

10. Experience of Using AIDS System

ENJOYABLE	76%
NOT ENJOYABLE	24%

11. Amount of new information acquired from system

NONE	8%
SOME	52%
A LOT	40%

12. Attitude towards AIDS after using system

NOT WORRYING	4%
QUITE WORRYING	68%
VERY WORRYING	28%

13. Assessment of Risk after using system

NO RISK	16%
LOW RISK	76%
HIGH RISK	8%

14. Suggested Improvements

a) less text

b) make available in libraries and other public facilities

c) introduce a gaming element

d) ability to ask questions as one would a human

APPENDIX B4

PRINCIPAL STATISTICAL ANALYSIS PERFORMED FOR SCHOOLS TRIAL

"A great deal of what we see depends on what we are looking for"

Unknown

PRINCIPAL STATISTICAL ANALYSES PERFORMED FOR SCHOOLS TRIAL

1. Chi-squared Analysis of "attitude to AIDS" and "amount of information received”

Null Hypothesis: the amount of information that a person has does not affect their attitude towards AIDS

The Chi-square test requires that the expected value for all possible cells exceed 1.0. To ensure this, the "not worried" and "very worried" categories were aggregated and tested against the "quite worried" category.

Expected counts are printed below observed counts

	"quite worried"		"not + very worried"			Total
"some information"	12		6			18
	12.2		5.8			
"lot of information"	5		2			7
	4.8		2.2			
Total	17		8			25
Contributions to	0	+	0.01	+		
Chi-square	0.01	+	0.03	=	0.05	
Degrees of Freedom = 1						

Conclude that there is insufficient evidence to reject the Null Hypothesis at the 5% level of significance.

2. Chi-squared Analysis of "perception of risk" and "amount of information received”

Null Hypothesis: the amount of information that a person has does not affect their perception of their own risk.

To conform to the conditions of the Chi-square test, the "not at risk" and "at high risk" categories were aggregated and tested against the "at some risk" category.

Expected counts are printed below observed counts

	"at some risk"		"not + high risk"		Total
"some information"	13		5		18
	13.7		4.3		
"lot of information"	6		1		7
	5.3		1.7		
Total	19		6		25
Contributions to	0.03	+	0.11	+	
Chi-square	0.09	+	0.28	=	0.50
Degrees of Freedom = 1					

Conclude that there is insufficient evidence to reject the Null Hypothesis at the 5% level of significance.

3. Chi-squared Analysis of "attitude to AIDS" before and after using the computer

Null Hypothesis: using the computer has no affect on a persons attitude towards AIDS

To conform to the conditions of the Chi-square test, the "not worried" and "very worried" categories were aggregated and tested against the "moderately worried" category.

Expected counts are printed below observed counts

	"moderate"		"not + very worried"	Total
"change in attitude"	0		4	4
	2.1		1.9	
"no change"	13		8	21
	10.9		10.1	
Total	13		12	25
Contributions to	2.08	+	2.25 +	
Chi-square	0.40	+	0.43 = 5.16	
Degrees of Freedom = 1				

Conclude that there is evidenced to reject the Null Hypothesis at the 5% level of significance.

The analysis was repeated using different aggregations to attempt to determine the direction of the relationship.

	"high"		"medium + not"	Total
"change in attitude"	2		2	4
	1.5		2.5	
"no change"	7		14	21
	7.5		12.5	
Total	9		15	25
Contributions to	0.17	+	0.10 +	
Chi-square	0.03	+	0.02 = 0.32	
Degrees of Freedom = 1				

Conclude that there is insufficient evidence to reject the Null Hypothesis at the 5% level of significance.

The results tentatively suggest that by the use of the computer has caused a significant change in kurtosis mediated by movement out of the extreme categories into a moderate one. The analysis is repeated applying the Yates Correction. This correction has the effect of moderating the observed values towards their expected values by subtracting 0.5 from the observed value where this is greater than the expected figure, and adding 0.5 where the observed value exceeds its corresponding expected value.

	"moderate"	"not + very worried"	Total
"change in attitude"	0.5 (0)	3.5 (4)	4
	2.1	1.9	
"no change"	12.5 (13)	8.5 (8)	21
	10.9	10.1	
Total	13	12	25
Contributions to	1.2 +	1.3 +	
Chi-square	0.22 +	0.24 = 2.97	
Degrees of Freedom = 1			

N.B. the figures in parentheses refer to the actual observed values i.e. without Yates correction applied.

Conclude that there is insufficient evidence to reject the Null Hypothesis at the 5% level of significance when the Yates correction is applied.

APPENDIX B5

INFORMAL EVALUATIONS OF THE AIDS/HIV EXPERT ADVISORY SYSTEM

"Education's purpose is to replace
an empty mind with an open one."

Malcolm S. Forbes

COMMENTS FROM A USER AT THE BRITISH COMPUTER SOCIETY

current node = AIDS

test

current node = AIDS

current node = Medical Aspects of AIDS/HIV

current node = AIDS

1. if you try to enter F5 from other than the entry screen the systems hangs. This is what I did.
    1. f3 search by keyword
    2. pick item
    3. look at item
    4. Seeing a mistake I pressed F5
    5. nothing happened so I pressed f1
    6. then F5 again. Quite correctly nothing happened so I pressed f2 for advie. On pressing f1 again it hung.

This seemed to happen if ever f5 is pressed at the wrong time. There should either be a warning that f5 is only available on the entry screen or the bug needs sorting.

2. In the info on Bed-bugs there is a spelling error on the last page "lentgh"

3. It is not obvious from the Index Menu Selection Screen that it is necessary to flag the items before searching
   The Prompt line makes it seem you only press enter

current node = AIDS

current node = AIDS

you can't spell! General Practitioner is spelt incorrectly on the search menu.

current node = How AIDS/HIV is Transmitted

current node = Reducing the Risk of Transmission

in the discussion on oral sex the point is made that females
may receive the virus from the mans semen. Would it be worth commenting on the safety of oral sex when the man performs it on the woman Many couples indulge in this form of sex. If it is safe it should be encouraged or vice versa.

current node = Medical Aspects of AIDS/HIV

spelling mistakes;

info on 'aids and karposi sarcoma" p1 feint should be faint

p2 seccumb should be succumb.

info on "sex toys""heighteningis spelt incorrectly

current node = Medical Aspects of AIDS/HIV

if the section on medical aspects is to be seen by the general public it will inevitably cause alarm.The symptoms as described apply to so many other more benign conditions that it is confusing. e.g if every woman with vaginal thrush thinks she may have AIDS the health service will collapse. The section should either be restricted or the warning that symptoms are an insignificant part of the diagnosis must be MUCH stronger and put a the beginning of the section.

current node = Medical Aspects of AIDS/HIV

My son asked me;"if there are antibodies present why do they not kill the virus and cure the patient?"

current node = AIDS

current node = AIDS

would it be worth considering a facility for
the user to obtain a print-out of relevant parts. This may

improve the recipients retention of the information after
they have finished with the system

current node = Description, Causes, Origins of AIDS/HIV

Grammar'description of AIDS" P2 :"studies...shows" should be show
"Introduction to System" P2 "first-Aid" wrong spelling
"Causes of Aids" P1 "....the cells which the virus is infecting"
should be "are"

current node = AIDS and First-Aid

introduction to aids and first aid...para 2 second line ..disposable
an apron.
current node = Medical Aspects of AIDS/HIV

The more I read the "Medical apects of AIDS" the more worried I become. So many of the symtoms mentioned are so common that it would create panic amongst my patients. I strongly belive that if this section is for public consumption a whole screen BEFORE the information must be inserted stating clearly and simply that the symptoms are irrelevant to the diagnosis and that in 99.9% of cases they will NOT be due to AIDS.

A LETTER FROM USERS AT THE ENVIROMENTAL SERVICES DEPARTMENT OF THE BIRMINGHAM CITY COUNCIL

AIDS Package - Comments on the mictocomputer package from Warwick University

1. The value of the package was thought to be more in the promotion and educational fields. Since most of the information was either general or vary clinical (and therefore

too complicated for the general public), staff would need to use their expertise and such aids as the Helpline list of local agencies to assist enquirers further. Staff felt that children might enjoy the system - Individually or in classes, kids might find it satisfying and quicker to get questions answered, worries calmed or curiosity satisfied.

2. The package was still not that easy to use and so good instruction would need to be provided. The following comments were made:-

(a) To find out how to use the system effectively, you need to use F8. There are 13 pages of information. Even if this facility is found, these pages must be printed on the searcher would need to refer to them.

(b) When the index of terms is on the screen, it is not vlesr how to select your term.

(c) If a term is entered duting a freetext search that is unavailable, the system does not give any options. It does not inform you that your term is not on the base.

(d) You cannot combine terms in the freetext search as in conventional database searches.

(e) There are statistics on the base but these cannot be retrieved using the freetext facility. Also, if you enter 'libraries' using the index, you retrieve 'clubs, disxos and libraries'. If you enter 'libraries' as a gree text search term, however, you get two bits - 'clubs, disxos and libraries' and 'public libraries'. How many other examples are there of this inconsistency?

(f) If the clinical section is for the medical profession, the system should say so so. If not, the terms need to be simplified.

(g) The text goes across the instructions, at times.

(h) The counselling section was liked.

COMMENTS FROM NORTH WESTMINSTER COMMUNITY SCHOOL

% North Westminister Community School %

current node = AIDS

THE PROGRAM WAS USEFUL FOR MY STAS PROJECT ON ACUPUNCTURE.

current node = AIDS

current node = AIDS

please enter any question or comment

tnemmoc ro noitseuq yna retne esaelp

current node = AIDS

EXELENT INFO ON AIDS

current node = Description, Causes, Origins of AIDS/HIV

IF A MAN IF HAVING ANAL INTERCOURSE CAN HE BECOME INFECTED THROUGH HIS PARTNERS RECTUM TO HIS PENIS

current node = AIDS

current node = AIDS

Odo

do you need condoms

current node = AIDS

how old can a child be to catch th aids virus?

current node = AIDS

current node = Transmission of AIDS/HIV

HOW DO HOMOSEXUALS GET THE AIDS VIRUS?

current node = AIDS

where did aids come from///

--98

current node = AIDS

current node = AIDS

where did aids came from 1

COMMENTS BY A STUDENT AT WARWICK UNIVERSITY

% current node = AIDS statistics for UK

Could you show the age/region breakdowns on a "per person" basis (eg are there 25 * more people in NE Thames therefore no real difference in occurence rate)?

Some piccys would be nice!

How about projections?

************ (3rd Year Student)

p.s. Very nice really - good idea!

p.p.s. Do you know they're massaging the HIV test data?

p.p.p.s. What's the prognosis for HIV-positives(some of the recent research points to dementia resulting???)

p.p.p.p.s. Bye!!

End of text comment %

SUMMARY OF DATA FROM THE NORTH WESTMINSTER SCHOOL LONDON

1. Prior Experience of Computers

SOME	100%
NONE	0%

2. Uses of Computer

GAMES	100%
WORD PROCESSING	40%
DATABASE	13%
PROGRAMMING	60%
EDUCATION	20%

3. Sources of AIDS information

DOCTOR	7%
STD CLINIC	1%
TELEPHONE HELPLINE	1%
SCHOOL	74%
GOVERNMENT LEAFLET	54%
RADIO	60%
TELEVISION	74%
FRIEND	14%
FAMILY	7%
JOURNAL	7%

4. Motivation behind receipt of AIDS information

VOLUNTARY	14%
COMPULSORY	7%
CASUAL	67%

5. Presentation of Information

5.1 Instructions

CLEAR	80%
DIFFICULT	13%

5.2 Readability

UNDERSTANDABLE AT ALL TIMES	73%
DIFFICULT AT TIMES	7%

6. Form of Access

MENU ONLY	0%
KEYWORD ONLY	7%
BOTH	67%

7. Preferred Approach

MENU	33%
KEYWORD	27%
BOTH	33%

8. Suggested Improvements

a) include a quiz

b) use of mouse

c) use of graphics

d) other subjects e.g. world affairs

APPENDIX C

(1)

TREE STRUCTURE FOR AIDS AND DRUG USERS

(2)

DEMONSTRATIONS OF THE AIDS/HIV EDITABLE EXPERT ADVISORY SYSTEM

"If the doors of perception were cleansed,

everything would appear to man as it is, infinite."

Christopher Smart
A song to David, 1763

TREE-STRUCTURE FOR AIDS AND DRUG USERS

1 AIDS and Drug Users

Introduction
Helping Agencies
Addiction/Dependency
High Risk Activities
Incidence of HIV and Injecting Drugs
Human Body and Drugs
HIV Test for Drug Users
Policies
Training

2 Helping Agencies

National Agencies
NHS Drug Dependence Units
Local Agencies
Residential Rehabs

3 National Agencies

ISDD
SCODA
ADFAM
Turning Point
Other

3 NHS Drug Dependence Units

Aims of DDUs
Prescribing policies
HIV testing

3 Local Agencies

Non-statutory street agencies
Statutory - Community Drug Teams
GPs
Education Department - Co-ordinator for Drug Education
NHS Health Education/Health Promotion

3 **Residential Rehabs**

Therapeutic Communities
Religious-based houses
Private fee-paying houses
Other

2 **Addiction/Dependency**

What is meant by ...
Why people become dependent
Difficulties in changing
Dependency and HIV/AIDS

2 **High Risk Activities**

Injection
Sex

3 **Injection**

Why drug users inject
Types of injection
Sites of injection
Dangers of injection
Availability of needles/syringes

4 **Dangers of Injection**

Knowledge of how to inject
What is injected
Sharing of needles

4 **Availability of Needles/Syringes**

Chemists
Bleach and Teach information
Needle exchange
Disposal of needles/syringes

2 **Incidence of HIV and Injecting Drugs**

England

Scotland

2 **Human Body and Drugs**

Injection
Health and Diet
Menstrual Cycle
Pregnancy

3 **Injection**

Dangers of Injection
Effects on the Immune System

2 **HIV Test for drug users**

Pro's
Cons
Which drug users are at risk
Where to have test
Support for those sero-positive

2 **Policies**

National Government
Local Government
Home Office Notification System
Drugs Advisory Service
Drug Dependency Units
Law

3 **National Government**

Advisory Council on the Misuse of Drugs
Reports of the Social Services Committee
DHSS Guidelines

3 **Law**

Misuse of Drugs Act
Prisons

2 **Training**

DEMONSTRATIONS OF THE AIDS/HIV EEAS - THE 'EDITABLE' VERSION OF THE EAS

F1	TO MOVE UP ONE LINE	F8	TO OBTAIN HELP
F2	TO MOVE DOWN ONE LINE	F9	TO USE INDEX
F3	TO SELECT CHOICE	F10	TO LOOK UP ANY WORD
F4	TO RECORD A COMMENT	ESC	TO RETURN TO BEGINNING
F5	TO MOVE UP ONE PAGE	SH+F1	TO MOVE TO TOP OF LIST
F6	TO MOVE DOWN ONE PAGE	SH+F2	TO MOVE TO END OF LIST
F7	TO RETURN TO PREVIOUS SECTION		

MENU NAME : AIDS

Clinical information
Counselling information
guidelines (health professionals)
information for the general public
AIDS and Drug Users

....

This shows the 'Editable' Expert Advisory System (EEAS). It looks exactly like the EAS except that another module is presented at the top-level menu - AIDS and Drug Users.

F1	TO MOVE UP ONE LINE	F8	TO OBTAIN HELP
F2	TO MOVE DOWN ONE LINE	F9	TO USE INDEX
F3	TO SELECT CHOICE	F10	TO LOOK UP ANY WORD
F4	TO RECORD A COMMENT	ESC	TO RETURN TO BEGINNING
F5	TO MOVE UP ONE PAGE	SH+F1	TO MOVE TO TOP OF LIST
F6	TO MOVE DOWN ONE PAGE	SH+F2	TO MOVE TO END OF LIST
F7	TO RETURN TO PREVIOUS SECTION		

```
MENU NAME : AIDS and Drug Users

              Introduction
              Helping Agencies
              Addiction/Dependency
              High Risk Activities
              Incidence of HIV and Injecting Drugs
              Human Body and Drugs
              HIV Test for Drug Users
              Policies
              Training
```

....

The expert/user has access to all the facilities that were available with the EAS. If 'Helping Agencies' is highlighted and then selected, another sub-menu appears which shows all the helping agencies on which information is available.

F1	TO MOVE UP ONE LINE	F8	TO OBTAIN HELP
F2	TO MOVE DOWN ONE LINE	F9	TO USE INDEX
F3	TO SELECT CHOICE	F10	TO LOOK UP ANY WORD
F4	TO RECORD A COMMENT	ESC	TO RETURN TO BEGINNING
F5	TO MOVE UP ONE PAGE	SH+F1	TO MOVE TO TOP OF LIST
F6	TO MOVE DOWN ONE PAGE	SH+F2	TO MOVE TO END OF LIST
F7	TO RETURN TO PREVIOUS SECTION		

MENU NAME : Helping Agencies

National Agencies
NHS Dependence Units
Local Agencies
Residential Rehabs

....

This reflects the structure which has been constructed by the Expert and programmed into the system by the development team. If National Agencies is selected, the next menu obtained is shown on the next page.

F1	TO MOVE UP ONE LINE	F8	TO OBTAIN HELP
F2	TO MOVE DOWN ONE LINE	F9	TO USE INDEX
F3	TO SELECT CHOICE	F10	TO LOOK UP ANY WORD
F4	TO RECORD A COMMENT	ESC	TO RETURN TO BEGINNING
F5	TO MOVE UP ONE PAGE	SH+F1	TO MOVE TO TOP OF LIST
F6	TO MOVE DOWN ONE PAGE	SH+F2	TO MOVE TO END OF LIST
F7	TO RETURN TO PREVIOUS SECTION		

MENU NAME : National Agencies

ISDD
SCODA
ADFAM
Turning Point
Other

....

These items represent the National Agencies and when ISDD is selected from this list, the system displays a blank area on the screen because there is no information which has been entered on this agency in the form of a report.

CONTEXT : National Agencies REPORT : ISDD	F1 F2 F7 F8	UP ONE LINE DOWN ONE PAGE PREVIOUS SECTION COMMANDS TO EDIT

```
----------------------------TOP-------------------------------------



----------------------------END-------------------------------------
```

....

Since this is the editable version of the EAS, the user can type in any information he wishes between the top and bottom lines of the blank report which has been presented by the system. The instructions at the top of the screen have changed to indicate that this is the report stage of the item. The user has the facility to display the editing commands (by pressing F8).

F1 - TO MOVE UP A LINE F2 - TO MOVE DOWN A LINE F3 - TO MOVE LEFT F4 - TO MOVE RIGHT F5 - TO MOVE UP A PAGE F6 - TO MOVE DOWN A PAGE F7 - TO RETURN TO PREVIOUS SECTION (DO NOT SAVE CHANGES) F8 - HELP F9 - TO INSERT A NEW LINE F10- TO DELETE A CHARACTER INS- TO CHANGE BETWEEN INSERT AND OVERTYPE MODES	SH+F1 - TO MOVE TO TOP OF FILE SH+F2 - TO MOVE TO END OF FILE SH+F3 - TO MOVE TO START OF LINE SH+F4 - TO MOVE TO END OF LINE SH+F5 - TO SPILT A PAGE SH+F6 - TO JOIN A LINE SH+F7 - TO RETURN TO PREVIOUS SECTION (SAVE CHANGES) SH+F8 - TO DELETE TO END OF LINE SH+F9 - TO DELETE A LINE SH+F10- TO DELETE PRECEDING CHARACTER

...any key to continue

------------------------------TOP----------------------------------

------------------------------END----------------------------------

....

These are the editing commands and the user can refer to these at any time by pressing F8 and then any key to return to the report. The home and arrow keys can also be used as normal for moving around the screen. When the user has finished typing the report he can save this (Shift-F7) and return to the menus to select another item which needs a report. This procedure can be continued until all the reports have been entered. Then, this facility can also be used to modify or update any of the reports that have been entered either for the AIDS and Drug Users section or any other section of the system.

APPENDIX D

DEVELOPING A PROTOTYPE SYSTEM
USING A SELF KNOWLEDGE ELICITATION TOOL

"Experience is never limited and it is never complete,
it is an immense sensibility,
a kind of huge spider-web of the finest silken threads
suspended in the chamber of consciousness,
and catching every airborne particle in its tissue."

Henry James
Partial Portraits:
The Art of Fiction, 1988

DEVELOPING A PROTOTYPE SYSTEM USING A SELF KNOWLEDGE ELICITATION TOOL (WEBOFAX)

This Appendix shows how the tree-structure shown partly in Figure 3.6 and listed in full in Appendix C can be used to build a system using Webofax. The CDT expert used this structure when he first started using Webofax. The system which he had after just three months of development looked completely different from the initial version, showing the usefulness of the flexibility and other features implemented into Webofax. The system went through a large number of intermediate stages, although the main difference between the first version and the version after three months, was that the latter catered for more information relating to drugs and drug misuse which was not necessarily related to AIDS/HIV.

```
add-Above add-Below Reposition Join Modify Delete Link Copy Exit
```

```
ENTER NEW ITEM
```

```
< WEB-O-FAX >

   +_
```

(a)

```
add-Above add-Below Reposition Join Modify Delete Link Copy Exit
```

```
< WEB-O-FAX >

  + Introduction
```

(b)

Figure D.2

Webofax: (a) the initial screen (b) with one entry.

The commands for building, deleting and modifying the menu structure are displayed at the top of each screen when running Webofax. However, the commands for editing the reports are provided on a printed instruction sheet which also lists the menu commands in more detail (see end of this Appendix).

The rest of this section describes how Webofax allows the user to build a knowledge base, by demonstrating the various facilities available to assist with the construction. Figure D.2(a) shows what the initial screen looks like once Webofax has loaded. The top line is the command summary line and the letters in bold indicate the key which has to be pressed on the keyboard to activate a particular command. These letters are actually highlighted in a different colour on the screen for easier readability. In the illustrations below, menu items are displayed in bold typeface to indicate that they are currently highlighted. It should also be noted that the command line is not shown in all the examples in order to conserve space.

Adding Menu Items and Reports

Initially, Webofax displays the message "ENTER NEW ITEM" and positions the cursor below the heading "WEB-O-FAX" ready for the user to enter the first item. It can be seen from the expert's tree-structure (see Appendix F), that there are nine items in the top-level menu. The first of these is "Introduction" and so this needs to be typed in at the keyboard, followed by the <return> key. Then, the screen will appear as shown in figure D.2(b), with "Introduction" being highlighted by Webofax because it is the only entry in the system so far. Then, "Helping Agencies" needs to go below the highlighted entry and therefore the letter "B" is pressed. This moves the cursor below the first entry and re-displays the message "ENTER NEW ITEM". This is entered in the same way as the first item and this process continues until all the items in the top-level menu have been inserted.

Further items can be added at a later stage by moving the highlighter up or down (using the <Up-Arrow> or <Down-Arrow> keys) to the required position and then pressing "A" (or "B") for adding a new item above (or below) the currently highlighted item.

Next, the "Helping Agencies" sub-menu items can be added by first moving the highlighter to this position and then pressing the <return> key. The system will prompt the user to define this entry by pressing "M" to define it as a menu; "R" to define it as a report; or "ESC" (the Escape key) to abandon the definition (see figure D.3(a)). In this example, "M" is pressed to indicate that it is a menu item, and this results in the screen shown in figure D.3(b). Then, the four items under this heading can be entered using the same principle as described above for the top-level menu of the structure.

```
add-Above add-Below Reposition Join Modify Delete Link Copy Exit
```

```
                              < Helping Agencies >
                                  is not defined. Define as :-
< WEB-O-FAX >
                                  non-ground term (Menu)
     + Introduction               ground term (Report)
     + Helping Agencies           abandon definition (Esc)
     + Addiction/Depende
     + High Risk Activities
     + Incidence of HIV and Injecting Drugs
     + Human Body and Drugs Users
     + Policies
     + Training
```

(a)

```
add-Above add-Below Reposition Join Modify Delete Link Copy Exit
```

```
          ENTER NEW ITEM

< HELPING AGENCIES >

     + _
```

(b)

Figure D.3

Defining sub-menu items in Webofax.

```
add-Above add-Below Reposition Join Modify Delete Link Copy Exit
```

```
INSERT                               COL: 0  LINE NO: 1  OF  1
-----------------------------------------------------------
_
```

(a)

```
add-Above add-Below Reposition Join Modify Delete Link Copy Exit
```

```
SAVE ANY CHANGES MADE? Yes No   COL: 55 LINE NO: 11 OF 11
-----------------------------------------------------------
Injecting drugs is becoming a common way of using them and
is the most dangerous. The most common drugs are opiates,
sedatives, stimulants and certain tranquillisers.

Dependency may be more likely when the drug is injected
because of:
  the "rush" experience
  increasing dosage
  the injecting ritual

Dependence is not inevitable and takes time to develop._
```

(b)

Figure D.4

Defining and entering reports in Webofax.

In this way, the whole tree-structure of Appendix C can be created quite quickly and with relative ease. When an item has no further sub-menus, it can be defined as a report by pressing "R" when prompted by the system. For this example, "Introduction" will be defined as a report as will all the "National Agencies" (i.e. "ISDD", "SCODA", "ADFAM", "Turning Point" and "Other"). Figure D.4(a) shows the screen when a report is first defined; while figure D.4(b) shows a completed report which has been typed in and the function key F7 has just been pressed to exit from the report.

The top line of the report displays the cursor coordinates as the cursor is moved around on the screen. The "INSERT" flag indicates that input is presently in the insert mode as opposed to the "OVERTYPE" mode. When the user has finished editing the report, he can press the function key F7 to indicate this. The system will ask the user if he wants to "SAVE ANY CHANGES MADE? **Y**es **N**o". The current report can be saved by pressing "Y"; or "N" can be pressed to abandon the changes that have been made since the report was activated.

Repositioning Menu Items

To reposition an item to a different part of the tree-structure (network), it is first necessary to move the highlighter to that item. Pressing the letter "R" activates the reposition command and the system prompts the user with the message shown in figure D.5(a) and at the same time removes the highlighted item from the menu. The highlighter is then moved to the required position before "A" or "B" is pressed to complete the move. Figure D.5(b) and figure D.5(c) demonstrate the item "Helping Agencies" being repositioned to the bottom of the top-level menu - by selecting (highlighting) the item "Training" and then pressing "B". It should be noted that it is possible to reposition an item to any level in the hierarchical structure.

Joining Menu Items

Two or more items can be selected from anywhere in the network and joined together to form the sub-menu items for a new item. As an example, figure D.6 shows how to join the items "Addiction/Dependency", "High Risk Activities", "Incidence of HIV and Injecting Drugs" and "Human Body and Drug Users" and place them under a new heading "Risks in Misusing Drugs". On pressing "J" the system prompts the user to insert the new definition and then displays the instructions for selecting items and exiting. A marker is placed to the left of each item which has been selected, and on pressing the function key F9 the join command is completed. This leaves only five items in the top-level menu of the structure being used here for demonstrating the features of Webofax (see figure D.6(c)). Now, on selecting the item "Risks in Misusing Drugs", the system will display the four items that were 'joined' to form this new item.

```
                              Below item highlighted
                  reposition  Helping Agencies
                              Above item highlighted
< WEB-O-FAX >

   ┼ Introduction
   ┼ Addiction/Dependency
   ┼ High Risk Activities
   ┼ Incidence of HIV and Injecting Drugs
   ┼ Human Body and Drugs Users
   ┼ Policies
   ┼ Training
```

(a)

```
                              Below item highlighted
                  reposition  Helping Agencies
                              Above item highlighted
< WEB-O-FAX >

   ┼ Introduction
   ┼ Addiction/Dependence
   ┼ High Risk Activities
   ┼ Incidence of HIV and Injecting Drugs
   ┼ Human Body and Drugs Users
   ┼ Policies
   ┼ Training
```

(b)

```
< WEB-O-FAX >

   ┼ Introduction
   ┼ Addiction/Dependency
   ┼ High Risk Activities
   ┼ Incidence of HIV and Injecting Drugs
   ┼ Human Body and Drugs Users
   ┼ Policies
   ┼ Training
   ┼ Helping Agencies
```

(c)

Figure D.5

Repositioning menu items in Webofax.

NEW DEFINITION: Risks in Misusing Drugs

< WEB-O-FAX >

- Introduction
- **Addiction/Dependency**
- High Risk Activities
- Incidence of HIV and Injecting Drugs
- Human Body and Drugs Users
- Policies
- Training
- Helping Agencies

(a)

NEW DEFINITION: Risks in Misusing Drugs

F8	select/unselect item as a member of new definition
F9	Exit - selected items form new definition
F10	Exit - all items form new definition
ESC	Abandon making a new definition

< WEB-O-FAX >

- Introduction
- Addiction/Dependencey
- High Risk Activities
- Incidence of HIV and Injecting Drugs
- **Human Body and Drugs Users**
- Policies
- Training
- Helping Agencies

(b)

< WEB-O-FAX >

- Introduction
- **Risks in Misusing Drugs**
- Policies
- Training
- Helping Agencies

(c)

Figure D.6

Joining menu items in Webofax.

Modifying Menu Items

The heading of any menu item can be edited by highlighting it and then pressing the letter "M". The message "AMEND DESCRIPTION" appears on the screen to indicate that this command has been activated. This feature is useful because it allows the user to edit incorrect item headings without the need to delete them completely and then have to re-insert them correctly. Figure D.7 shows the item "Risks in Misusing Drugs" being modified to "The Risks Involved".

Deleting Menu Items

An item which does not have a sub-menu can be deleted by highlighting it and then pressing the letter "D" followed by the function key F9 (see figure D.8(a)). In this example, the item "Introduction" is not deleted by pressing the "ESC" key. If the item has underlying definitions, then all or part of these can be inherited to replace the deleted item. Figure D.8(b) shows all the attributes of the item "Helping Agencies" being inherited to replace the item itself (which of course will be deleted) by pressing the function key F10. Alternatively, it is possible here to use the function key F8 to select only some of the items to replace the deleted item.

< WEB-O-FAX >

- Introduction
- **Risks in Misusing Drugs**
- Policies
- Training
- Helping Agencies

(a)

AMEND DESCRIPTION

< WEB-O-FAX >

- Introduction
- **Risks in Misusing Drugs**
- Policies
- Training
- Helping Agencies

(b)

< WEB-O-FAX >

- Introduction
- **The Risks Involved**
- Policies
- Training
- Helping Agencies

(c)

Figure D.7

Using the 'Modify' command in Webofax.

Linking Menu Items

The link command enables any number of items not accessible immediately from the currently highlighted item, to be linked from other parts of the network into the current item. This facility is useful because the same information can be accessed from different parts of the network without the need for duplication. This also makes updating the system quicker and simpler because the information needs to be changed only in one place, but the changes will be reflected in all the sections which are linked to it.

For example, if the three items required under "Training" are "ISDD", "SCODA", and "ADFAM" (which are currently three of the five sub-menu items under "National Agencies"), then these can be selected and linked as shown in figure D.9. It should be noted that it is first necessary to select the item to which other items will be linked. When the link command is activated it will display another copy of the whole menu-structure in a box, from which items can be selected by pressing the function key F8, and then linked using the function key F9.

```
< Introduction >
is defined as ground term with no attributes

 F9     Delete term
 ESC    Do not delete term
```

```
< WEB-O-FAX >

   Introduction
   The Risks Involved
   Policies
   Training
   Helping Agencies
```

(a)

```
Delete  < Helping Agencies >
 F8   select/unselect attribute
 F9   Delete object - only selected attributes replace it
 F10  Delete object - inherit all attributes to replace it
 ESC  Abandon making a new definition
```

```
< Helping Agencies >

   National Agencies
   NHS Drug Dependence Units
   Local Agencies
   Residential Rehabs
```

```
< WEB-O-FAX >

   Introduc
   The Risk
   Policies
   Training
   Helping Agencies
```

(b)

```
< WEB-O-FAX >

   Introduction
   The Risks Involved
   Policies
   Training
   National Agencies
   NHS Drug Dependence Units
   Local Agencies
   Residential Rehabs
```

(c)

Figure D.8

An example of the 'Delete' command in Webofax.

```
Link to < Training >
 F8   select/unselect item to link
 F9   Exit - link in selected attributes
 ESC  Do not link any attributes
```

```
< Training >          < WEB-O-FAX >

   +                   + Introduction
                       + The Risks Involved
                       + Policies
                       + Training
                       + National Agencies
                       + NHS Drug Dependence Units
                       + Local Agencies
                       + Residential Rehabs
```

(a)

```
Link to < Training >
 F8   select/unselect item to link
 F9   Exit - link in selected attributes
 ESC  Do not link any attributes
```

```
                      < National Agencies >

< Training >             ISDD
                         SCODA
   +                     ADFAM
                       + Turning Point
                       + Other
```

(b)

```
< Training >

  + ISDD
  + SCODA
  + ADFAM
```

(c)

Figure D.9

Using the 'Link' command in Webofax.

Copying Menu Items

The copy command works in a similar way to the link command except that the selected items are duplicated. This means that one part of the tree-structure can be copied to a different part of the network (which requires similar information), and then this copied structure can be modified for that part of the network. Unlike the link command, the changes made will not be reflected in the original section from where it was copied. This saves having to re-type large sections of the network if they are similar to a section which has already been entered.

The example shown above for the link command may have different sub-headings or reports for the "ISDD", "SCODA" and "ADFAM" items than the original ones. In this situation, the copy command would be used instead of the link command. The sub-headings or reports can then be tailored to the required format.

Exiting from Webofax

The user can exit from Webofax by pressing the letter "E". The system will ask the user if he wishes to save the latest changes that have been made or whether he wishes to abandon these changes, before returning the user to the operating system prompt.

APPENDIX E

USING THE AIDS/HIV AND DRUG MISUSE INTELLIGENT DATABASE

"One can live in the shadow of an idea without grasping it."

Elizabeth Bowen
The Heat of the Day, 1949

USING THE INTELLIGENT DATABASE

Please Note

The examples used in this appendix do not represent real clients data. However, the examples have been *constructed* to give representative client profiles.

Figure E.1 shows the message which is displayed on the screen when the 'Knowledge Base' option is chosen from the EXIT menu of the CDTDBase. It was still possible to activate the ADMKBase without considering a specific client. This was the only option available before the two systems were fully integrated. If this option is selected (by pressing "N") then the user will be presented with the three top-level menu items of the ADMKBase, once it has loaded.

If "Y" is pressed to activate the ADMKBase with a specific client, the system will display a sub-menu so that the user can choose the type of service being offered to the client in question (Figure E.1). The System will then prompt the user to enter the client number if the 'User Referral' or 'Relative/Friend' Databases are selected; or to enter the referral date if the 'Information/Advice' Database is selected (Figure E.2).

```
ADD   EDIT   COUNT   LIST   PRINT   DELETE   EXIT   3:32:42 pm

                                          Exit CDTDBase
                                          Needle Exchange
                                          Knowledge Base
                                          ------------------
                                          Back-Up CDTDBase
                                          Back-Up NSXDBase

              AIDS & Drug Misuse Knowledge Base

              Do you wish to activate ADMKBase
                  with a specific client?

          Position: --||      Select: --
      Y: yes   N: no   ANY OTHE KEY: cancel
```

```
ADD   EDIT   COUNT   LIST   PRINT   DELETE   EXIT   3:32:49 am

                                     Exit CDTDBase
                                     Needle Exchange
                                     Knowledge Base
                                     -----
                                     Monl  User Referral
                                     Gena  Info./Advice
                                           Relative/Friend

     Position: --||      Select: --      Abort/Pause: F7
Pick a client from the User Referral Database - for Use With ADMKBase
```

Figure E.1

Activating the ADMKBase from within the CDTDBase.

AIDS & DRUG MISUSE KNOWLEDGE BASE

3:19:02 pm

CHOOSE A SPECIFIC CLIENT

Enter Client Number

473

Press 0 and <return> to EXIT

AIDS & DRUG MISUSE KNOWLEDGE BASE

3:19:24 pm

Client No. : 473

Ref. Date : 31/10/89

SIMON HUNT

Address:
16 KERMSTEAD WAY
ALLESLEY
CV 12

Sex: M Age: 35 DOB: 12/08/54

Select **N**ext **P**revious **R**estart -

Cheking and Analysing Client Details
Please Wait

Figure E.2

Specifying a client for use with the ADMKBase.

The System will remember and display the client number or the referral date of the last record which was either added or edited, in the database being searched. In this situation, the user needs only to press the <return> key. The next screen displayed by the system is similar to the 'EDIT' and 'DELETE' facilities and allows the user to have a final check to confirm that the correct client has been selected. It is possible to move up or down to any record as well as re-insert a completely different client number. When basic information of the required client is displayed, the "S" key can be pressed to select that choice. This will give the message "Checking and Analysing Client Details - Please Wait" followed by "Loading AIDS/HIV and Drug Misuse Knowledge Base - Please Wait" before displaying the top-level menu of the ADMKBase.

This is illustrated in Figure E.3 and it can be seen that there are four items in the top-level menu - the first three are exactly the same as those obtained when the Knowledge Base is loaded without a specific client. The heading of the fourth item consists of the name and client number of the client being considered to indicate that the information under this option is for use only with that client because it relates to his/her personal situation, needs and characteristics. The second part of Figure E.3 also shows the sub-menu obtained when this fourth option is selected. The list of items presented here reflects the advice and information needs of the client as analysed by the Intelligent Database using the information stored in the CDTDBase. This particular client is the first of four examples demonstrated later in this Appendix, which discusses the advice offered by the Intelligent Database for each client.

Loading AIDS/HIV & Drug Misuse Knowledge Base

Please Wait

```
MENUS  : add-Above  -Below  Reposition  Join  Modify  Delete  Link  Copy  Exit
         : position      - : select     <Backspace>: return to previous menu
REPORTS: --: postn.  Home/End: top/bottom  PgUp/PgDn: page up/down  F7:exit
 (lines) F1/F2: insert/del.  F3/F4: join/split  F5/F6: beg/end  F9: del to end
```

```
< ADMKBase >

  ┼ DRUG MISUSE INFORMATION
  ┼ AIDS/HIV INFORMATION
  ┼ COUNSELLING ADVICE
  ┼ CLIENT 473 (MR W)
```

```
MENUS  : add-Above  -Below  Reposition  Join  Modify  Delete  Link  Copy  Exit
         : position      - : select     <Backspace>: return to previous menu
REPORTS: --: postn.  Home/End: top/bottom  PgUp/PgDn: page up/down  F7:exit
 (lines) F1/F2: insert/del.  F3/F4: join/split  F5/F6: beg/end  F9: del to end
```

```
< CLIENT 473 (SIMON HUNT) >

  ┼ Sentencing Options
  ┼ List of Solicitors
  ┼ Barbiturates
  ┼ Rehabilitation Hostels
  ┼ Mixed Sex Hostels
```

Figure E.3

ADMKBase: loading-up message; main menu; client-specific menu.

The automatic generation of a client-specific tree of information solved the problem of having to search different parts of the large Knowledge Base to find the relevant information for different needs and situations. This feature can be compared to the keywords mode of access available in the Expert Advisory System (EAS) for AIDS/HIV, which was described in chapter two. Single or multiple keywords could be selected for the search which resulted in a menu of items relevant to the required topics.

The Intelligent Database being discussed here treats the contents of the fields in the CDTDBase as keywords for use during the search for information from the ADMKBase. One important difference is that the search is done automatically without the need to specify any keywords.

EXAMPLES OF THE INTELLIGENT DATABASE

This Appendix demonstrates the Intelligent Database in use by showing and explaining the advice and information which is offered by the ADMKBase when it is activated with specific clients who have been entered in the CDTDBase. Four clients are considered here and their personal details are summarised in figure E.4 for convenient reference. It is assumed that the full details of each of the examples being considered is stored in the CDTDBase.

Again, it is important to point out that the examples used here do not represent real client data for resons of confidentiality. The first three examples uses clients who are drug misusers and their details are therefore stored in the User Referral Database; the fourth example is a general enquiry and this information is stored in the Advice/Information Requests Database. The section above described how the ADMKBase can be activated with a specific client, which results in four

	Example 1	Example 2	Example 3	Example 4
Client Number	473	556	458	1327
Name of Client	Mr W	Miss X	Mr Y	Miss Z
Service (Database)	User Referral	User Referral	User Referral	Relative/Frd
Referral Date	31/10/89	27/04/90	15/05/90	18/05/90
SSD Area	Allesley	Willenhall	Foleshill	Hillfields
LA Ward	Whoberley	Cheylesmore	Foleshill	St. Michaels
Sex	Male	Female	Male	Female
Age	35	22	22	39
Drug Use 1	Barbiturates	Amphetamines	Opiates	Cocaine
Drug Use 2		Cannabis		
Inject Drugs	N	Y	Unknown	N/A
Share 'Works'	N	N	Unknown	N/A
Infections	N	N	Unknown	N/A
Sex for Money/Drugs	N	N	Y	N/A
Legal Situation	On Bail	None	None	N/A
Current Offence	Drug Related	None	None	N/A
Marital Status	Co-habiting	Single	Separated	N/A
Children	N	Unknown	Y	N/A
Employment	Part-time	Full-time	Unemployed	N/A
Accommodation	Council Rentd	Parents	Temporary	N/A
Presenting Need 1	Court Apprnce	Medical Trtmt	Child Care	AIDS/HIV
Presenting Need 2	General Suppt		AIDS/HIV	Housing
Concerned About	N/A	N/A	N/A	Son

Figure E.4

Sample data from four records in the CDTDBase items in the top-level menu when the ADMKBase loads up. The rest of this section discusses the advice and information which is obtained for each of the four examples.

Example 1

The list of headings obtained under this client are as follows:

- Sentencing Options
- List of Solicitors
- Barbiturates
- Rehabilitation Hostels
- Mixed Sex Hostels
- Penalties

The first two items have presented because the client's presenting need is a court appearance. The 'List of Solicitors' gives the names, addresss and telephone numbers of the individuals and the firms that the CDT work with regularly. These solicitors are particularly experienced with representing cases for drug misusers. Barbiturates is the drug being misused by the client and therefore it appears as an item in the list. It provides general information on the drug, its legal status, and the effects of short-term and long-term use. Clients who are 'on bail' often need information on rehabilitation hostels. The complete list is presented here, and there is also a separate list consisting of mixed sex hostels because the client is presently 'living' with someone. The last item, which has appeared because the client's current offence is 'drug related', explains the penalties associated with barbiturates and other drugs.

Example 2

For this particular client the list of topics which the Intelligent Database has listed are:

- Cheylesmore (GP's)
- Amphetamines
- Cannabis
- Injecting Drugs

All the general practitioners in and around the Cheylesmore area of Coventry are listed under the first heading which has appeared because the client is in need of medical treatment. The general practitioner list provides details of the name, address and opening hours of each surgery and includes only those practitioners who specialise in detoxification and other treatments for drug misusers. This client is on 'multi-drugs' and the two main drugs being misused are the next two items in the list. As with all the other drugs, general information is provided on the background of the drug, the legal status, the penalties involved and the effects of both short-term and long-term use.

The System has been programmed to recognise the importance of providing advice to intravenous drug misusers. The 'Injecting Drugs' topic provides detailed advice and information on the dangers of injecting, safer injecting, how to clean injecting equipment, and the local Needle and Syringe Exchange Scheme.

Example 3

- Foleshill (SSD Team)
- Opiates
- Sexual Partners of Higher Risk Groups
- Housing

Four topics have been found to be important for this client and these are shown above. This client's presenting need is 'child care' and therefore the Foleshill SSD Team Manager's name and telephone is available under the first heading. This client has indicated that he has had sex for money or drugs, which is the reason why the System has offered advice and warnings about the risks involved. The client is living in temporary accommodation at present and therefore may need advice on housing and information about housing agencies.

Example 4

This client's details are stored in the Relative/Friend Referral Database of the CDTDBase, and she is in fact concerned about her son who is experiencing difficulties with his landlord who suspects that his tenant has got AIDS/HIV. The System finds the following headings:

- AIDS/HIV Information
- Housing Advice
- Cocaine

The System does not know which section of the AIDS/HIV Information is required because not enough information has been provided by the client. Therefore, the whole section of this information is presented for the expert to explore with his client. The 'Housing Advice' section sub-divides into further topics which have a special emphasis on AIDS/HIV:

- Advice if your landlord is trying to evict you
- Advice if you are homeless
- Advice if the council cannot help
- House Owners
- Further Information

The client's son is misusing cocaine and although information on this drug may not be required by the client, it is still presented here by the System.

APPENDIX F

LETTERS RECEIVED FROM USERS OF SELF KNOWLEDGE ELICITATION TOOL

"When you have nothing to say,

say nothing."

Charles Caleb Cotton
Lacon, 1820

Your reference: Our reference:

Date:

Shropshire's
Mental Health
NHS Trust

Shropshire's Mental Health
National Health Service Trust

Shelton Hospital
Bicton Heath
Shrewsbury SY3 8DN

Extension:

Mr R Gupta
Gupta Computer Solutions
55 Grove Vale
Great Barr
Birmingham
B43 6DB

Dear Rakesh,

Please find the floppy disk with my attempt at using the "Build a System from Scratch" facility. I am sure you won't be too impressed!

Here is my feedback on the system as a whole.

1. The information on HIV and Counselling is very easy to access. It is also very helpful, clear, concise, and reads easily. I had no problems getting to learn how to use the system, and found it easy to alter information on reports if I wished to.

2. Printing facilities would improve the system. I did not think that the lack of mouse facility was a problem. I quickly picked up the necessary key strokes to move around the tree.

3. I used the system for only a couple of hours. I particularly liked the tree structure and the speed with which you could access different parts of the tree. The fact that you can edit the tree and the reports is marvellous.

4. It was quick and easy to build a system as well. I haven't had the time to work on my own small tree, and I would want to go back and edit the structure and the way I have displayed the various branches.

5. In my opinion this is a highly usable and valuable system. It would require minimal training for all staff to become familiar with it. Some important parts of data might need to be protected from being changed, and some might require access codes for security.

6. My main suggestion to improve the system is for a print facility to be added.

I'm glad that I've got the system to use. I hope my comments are helpful.

I look forward to continuing to work with you on the New House drug data software.

Best wishes.

Yours sincerely,

CHARTER

DRUG MISUSE database

The Regional Drug Misuse Database Project
West Midlands
HIV & Sexual Health Unit
District Offices (Blue Box)
Birmingham Health Authority
Vincent Drive
Edgbaston
Birmingham B15 2TZ

Rakesh Gupta
55 Grove Vale Avenue
Great Barr
Birmingham
B43 6DB

Dear Rakesh

Firstly I must apologise for the length of time it has taken me to respond to your request. Please find enclosed my comments.

Aside from the F7 issue I found the system very easy to use, and would imagine that if your intention is to put this on the NET then it would be used. My concern is that some of the agencies do not even have fax machines so to get them hooked up to the NET would have major cost implications.

Leaving that point aside, I used the both the information systems (HIV and Drugs). I found them both easy to follow and understand, and could think of loads of other menu bar which could be added. One thing that I did find difficult was that when you arrived at the information I found that there was often too much text to take in. I would suggest breaking up the information using bullets points, or using more sub-heading on the menus so that there was not so much text at the end.

I also had a go at setting up a mini system on statistical information, this included menus on RDMD, Home Office Addicts Index, Agency Information etc. I then broke this down further into Health Authorities area, and even further into agencies and hospitals in that particular area. I found this easy to do, but I was wondering whether it would be possible to put tabular and graphical information onto the system, as I would find this essential ?

Also if this was to go on the NET I thought it would be a good idea if there could be an interaction section where drugs professionals could liaise, although I'm sure you have already thought of this.

I hope you find these comments useful, although I realise they are short. If you have any queries please do not hesitate to contact me.

Yours

West Midlands Drug Misuse Database Project Manager

DATABASE REVIEW

By

Rugby Community Drug Team

Ease of Use

All members of staff have found the package easy to use to use, even those members of staff who have never used a computer before. This refers to not only accessing, but also inputting information

To date the package has been used by members of staff, students and volunteers

Initially one of the major problems experienced was coming out of each module, or saving information. However with practice this has been overcome.

Information

The areas into which the information is placed again are very straight forward and easy to understand The process of accessing information flows in a logical sequence

One of the main concerns expressed by staff is to how/who should maintain updates of information on the system. I think that the majority verdict was that it would be useful that any major changes could be done through a central system, but that any local changes could be done by the relevant service as and when.

CDT Database

As part of the agreement CDT have designed a database information service on Ecstasy tablets. To this end Rugby CDT have liased with the Government Forensic Science Laboratory and now have a detailed list of every Ecstasy tablet that has been seized and tested from as early as 1992

Due to the volume of information that needs to be inputted this has yet to be completed.

However the database has already been trialed with a few clients who have been both amazed and extremely grateful for being able to access such a service Comments have been very positive and that this should be something that happens everywhere.

How the CDT Database Works

If an individual presents to the service wishing to ascertain the identity/contents of an Ecstasy tablet, the process is as follows

1) Identify shape

2) Identify colour

3) Identify markings

4) Identify special characteristics

5) Identify size

Once this process has been followed it is then possible to give a list of possibilities as to what the tablet is and the possible effects that could be experienced

Recommendations

1) The central input location for new/additional information

2) That information accessed can be printed

3) That the database can be linked to a number of other computers in the agency/and or possibly externally to other organisations such as Probation

03-04-97 11:43 FROM:NWCDT-KIDDERMINSTER 01562 753922 TO:0121 357 2293 PAGE:02

CDT

COMMUNITY DRUG TEAM

8A Church Green East, Redditch B98 8BP 01527 61010

28 29 New Road, Kidderminster DY10 1AF 01562 823211

Database Management System and Drug Information System

We have been using the Database Management System and Drug Information System at North Worcestershire Community Drug Team for a number of months. In terms of it being used as a day to day tool, it has been fairly limited. This is mainly due to time constraints on maintaining and updating data. However, it does offer a number of possible benefits for a service such as ours.

The ability to obtain relevant information on drug use, drug services and related topics would be extremely useful as long as it was regularly updated. As mentioned previously, we would not have the resources to maintain a current database, but a centrally produced update which could be added to our own would alleviate this problem. I can think of a number of ways this could be achieved. A disk Cd Rom could be provided to update the system or updates could be obtained form the Internet. The second option would require us to update our present computer system to enable us to use the Internet. This has been discussed at length and we do not feel that there would be sufficient benefit in accessing the Internet at the present time to justify the costs involved.

The present format of the system also created difficulties for us. Most computer applications are Windows based and this is the platform that most people feel confident with. If the system was to become 'user friendly' it would need to be transferred to a Windows based programme.

Topics that the database could include are:

- Residential Rehabilitation Units
  Location, Cost, Method of Referral, Research Data
- Drug Services
- Related Services
  HIV HEP C, Suppliers (Condoms, Injecting Equipment, Leaflets etc.),
- Specific Drug Information
- Other Resources
  Institute for the Study of Drug Dependence (ISDD) other international resources
- Links to the Internet
  Other useful sites for information etc., mailing list for discussion etc.

For a computer database to be useful, it needs to offer more than is available at the present time. I feel that the ability to access the internet would offer the most appropriate method of providing an up to date database. Each service would be able to access a home page on the WWW which would be constantly updated. Information could then be downloaded to a local database. This would allow the user to be specific about what information they require. The main problem would be proving such a venture would be worth the capital outlay.

COVENTRY
CDT
COVENTRY COMMUNITY DRUG TEAM
Services for Drug Users
2,DOVER ST
COVENTRY CV1 3DB
TEL. (01203) 553845
FAX.(01203) 257231

Rakesh Gupta
GCS
55 Grove Vale Avenue
Birmingham
B43 6DB

Dear Rakesh,

Re: Webofax

Further to your inquiry regarding the usefulness and potential applications of the system I should like to make the following observations.

The system, due to its flexibility, has a number of potential applications within the drugs field. As a stand alone system it could be configured to provide a comprehensive source of information on illegal drugs and allied matters for the general public. This core component could be extended to provide more detailed information for use by drug services, especially where volunteers are used. Having information which is supplied with the package, which can't be altered by the user, combined with the facility to add local information would enhance the programme.

For users who wish the ability to link client referrals with information on Webofax would also be an advantage. I am not sure how much this facility would be used and it might require some consumer research to decide how useful it might be. In terms of style the presentation obviously needs to be designed in to improve the image. The contents should be relatively easy to define and select for inclusion, but there would be a need for updates to reflect changes. For example, the information on the system on the Misuse of Drugs Regulations is now out of date as the Addicts Index is now redundent.

Overall, I feel that by defining the target audience and the core information, improving the presentation and having the facility to configure the system locally there should be a market for Webofax.

Yours

APPENDIX G

QUESTIONNAIRE FOR EVALUATION
OF SELF KNOWLEDGE ELICITATION TOOL

"By doubting we led to enquire;

by enquiry we perceive the truth"

Pierre Abelard
12^{th} Century

Questionnaire for Evaluation of AIDS/HIV, Drug Misuse and Counselling Information System, in which information can not only be retrieved but also maintained and updated.

Please complete this questionnaire as honestly as possible, as this evaluation is an important phase in a research project. The names of individuals completing the questionnaire will be kept strictly confidential. Use the space on the right-hand side of the page to make any additional comments or to clarify any answers you have given.

Comments

1. What is your position in the organisation?
   - ☐ Manager/Team Leader
   - ☐ Worker/Counsellor
   - ☐ Administrator
   - ☐ Other (specify)

2. How much experience do you have with computers? *(tick all that apply)*
   - ☐ Programming/Development
   - ☐ Good/Reasonable Level
   - ☐ Word Processing
   - ☐ Some or V. little
   - ☐ Database/Spreadsheet
   - ☐ None

3. How many full-time staff use a personal computer at this site ?__________

4. How many PCs (including notebook computers) are there at your site ?__________

5. Are your personal computers networked locally? ☐ Yes All ☐ Yes Some ☐ None

6. (a) On how many PCs is the Information System Installed on/accessible from ?__________

   (b) Did this include a laptop? ☐ Yes ☐ No

7. How much use did you and others make of the Information System over the last 3 months (on average)?
   - ☐ None at all
   - ☐ Several hrs/fortnight
   - ☐ Less than one hr in total
   - ☐ Several hrs/week
   - ☐ Several hrs in total
   - ☐ One hr/day
   - ☐ Several hrs/month
   - ☐ Several hrs/day

8. Did you encounter problems gaining access to a personal computer with the Information System on it and why ?__________

9. How many other staff used the Information System on more than a few occasions over the last 3 months? __________

10.What services does your organisation provide *(tick all that apply)* ?

- ☐ Counselling
- ☐ Advice/Info on drugs
- ☐ Advice/Info on alcohol
- ☐ Adv/Info on AIDS/HIV
- ☐ None of the above

11.How easy or difficult did you find it to *learn* the Information System?

V. easy 1 2 3 4 5 V.difficult

12.How easy or difficult did you find it to *use* the Information System?

V. easy 1 2 3 4 5 V.difficult

13.Did you use the instruction manual for the Information System?

All the time 1 2 3 4 5 Never

Why ? ____________________

14.How useful/helpful did you find the instruction manual?

V. helpful 1 2 3 4 5 V.unhelpful

15.Did the system improve client services?

Significantly 1 2 3 4 5 Not at all

16.How did using the system affect your job satisfaction?

Got a lot better 1 2 3 4 5 Got a lot worse

17.Did the system speed up information retrieval?

Always 1 2 3 4 5 Never

Comments

		Comments
18. How accurate/inaccurate did you find the information?	Highly accurate 1 2 3 4 5 Highly inaccurate	
19. How timely did you find the information on : (a) Drug Misuse _____ (a) Counselling _____ (a) AIDS/HIV _____	Timely 1 2 3 4 5 Out of date	
20. How relevant did you find the information?	Useful 1 2 3 4 5 Useless	
21. Generally, did the system contain the information you wanted?	Always 1 2 3 4 5 Never	
22. Overall, how satisfactory did you find the Information System?	V.satisfactory 1 2 3 4 5 V.unsatisfactory	
23. What features of the system did you like ? _____		
24. What features of the system did you dislike ? _____		
25. What features did you think were lacking ? _____		
26. How often did you use this system to obtain advice or information as an alternative to obtaining it elsewhere ?	All the time 1 2 3 4 5 Never	
27. Did you modify any of the information? *(Give details)* _____		

28. Did you add any new information (using options 2 or 3)? *Give details* ______

29. Did you develop a new application (using option 1)?: ☐ Yes ☐ No

If no, give reasons : ______

If yes, answer the following:

(a) Did you find it easy to develop? V. easy 1 2 3 4 5 V.difficult

(b) Did you find it easy to modify and maintain? V. easy 1 2 3 4 5 V.difficult

(c) Did you find it useful once developed? Useful 1 2 3 4 5 Useless

(d) Did other people use this application? All the time 1 2 3 4 5 Never

(e) Any other comments : ______

30. What other uses do you think a system of this type could have ? ______

31. Please give any other comments or suggestions you may have ? ______

Comments

APPENDIX H

SUMMARY OF RESULTS
FROM FORMAL EVALUATION
OF SELF KNOWLEDGE ELICITATION TOOL

"Lost, yesterday,

Somewhere between Sunrise and Sunset,

two Golden Hours,

each set with sixty Diamond minutes.

No reward is offered,

for they are gone forever."

Horace Mann
Lost, Two Golden Hours

Summary of results from formal evaluation of self knowledge elicitation tool

1. What is your position in the organisation?

Manager/Team Leader	30%
Worker/Counsellor	40%
Administrator	30%
Other (specify)	0%

2. How much experience do you have with computers? *(tick all that apply)*

Programming/Development	0%
Word Processing	35%
Database/Spreadsheet	5%
Good/Reasonable Level	15%
Some or V. little	25%
None	20%

3. How many full-time staff use a personal computer at this site?

2	15
3	10
4	15
5	25
6 +	35

4. How many PCs (including notebook computers) are there at your site?

1	25%
2	25%
3	20%
4 +	30%

5. Are your personal computers networked locally?

Yes All	30%
Yes Some	15%
None	55%

6(a). On how many PCs is the Information System Installed on/accessible from?

1	25%
2	30%
3	20%
4 +	25%

6(b). Did this include a laptop?

Yes	25%
No	75%

7. How much use did you and others make of the Information System over the last 3 months (on average)?

None at all	0%
Less than one hr in total	0%
Several hrs in total	0%
Several hrs/month	30%
Several hrs/fortnight	20%
Several hrs/week	30%
One hr/day	20%
Several hrs/day	0%

8. Did you encounter problems gaining access to a personal computer with the Information System on it and why?

Yes	60%
No	40%

9. How many other staff used the Information System on more than a few occasions over the last 3 months?

0	15%
1	20%
2	25%
3	15%
4 +	25%

10. What services does your organisation provide *(tick all that apply)*?

Counselling	95%
Advice/Info on drugs	85%
Advice/Info on alcohol	30%

Adv/Info on AIDS/HIV		10%
None of the above		0%

11. How easy or difficult did you find it to *learn* the Information System?

V. easy	1	70%
	2	30%
	3	0%
	4	0%
V. difficult	5	0%

12. How easy or difficult did you find it to *use* the Information System?

V. easy	1	90%
	2	10%
	3	0%
	4	0%
V. difficult	5	0%

13. Did you use the instruction manual for the Information System?

All the time	1	0%
	2	10%
	3	5%
	4	80%
Never	5	5%

14. How useful/helpful did you find the instruction manual?

V. helpful	1	80%
	2	15%
	3	5%
	4	0%
V. unhelpful	5	0%

15. Did the system improve client services?

Significant	1	20%
	2	10%
	3	10%
	4	30%
Not at all	5	30%

16. How did using the system affect your job satisfaction?

Got a lot better	1	15%
	2	40%
	3	45%
	4	0%
Got a lot worse	5	0%

17. Did the system speed up information retrieval?

Always	1	0%
	2	20%
	3	50%
	4	20%
Never	5	10%

18. How accurate/inaccurate did you find the information?

Highly accurate	1	15%
	2	70%
	3	15%
	4	0%
Highly inaccurate	5	0%

19. How timely did you find the information on :

		Drug Misuse	Counselling	AIDS/HIV
Timely	1	80%	80%	0%
	2	20%	20%	15%
	3	0%	0%	15%
	4	0%	0%	55%
Out of date	5	0%	0%	15%

20. How relevant did you find the information?

Useful	1	30%
	2	55%
	3	10%
	4	5%
Useless	5	0%

21. Generally, did the system contain the information you wanted?

Always	1	0%
	2	55%
	3	30%
	4	15%
Never	5	0%

22. Overall, how satisfactory did you find the Information System?

V. satisfactory	1	25%
	2	45%
	3	30%
	4	0%
V. unsatisfactory	5	0%

26. How often did you use this system to obtain advice or information as an alternative to obtaining it elsewhere ?

All the time	1	0%
	2	50%
	3	35%
	4	15%
Never	5	0%

27. Did you modify any of the information?

Yes	80%
No	20%

28. Did you add any new information (using options 2 or 3)?

Yes	75%
No	25%

29. Did you develop a new application?

Yes	70%
No	30%

29(a). Did you find it easy to develop?

V. easy	1	79%
	2	21%
	3	0%

	4	0%
V. difficult	5	0%

29(b). Did you find it easy to modify and maintain?

V. easy	1	57%
	2	43%
	3	0%
	4	0%
V. difficult	5	0%

29(c). Did you find it useful once developed?

Useful	1	29%
	2	71%
	3	0%
	4	0%
Useless	5	0%

29(d). Did other people use this application?

All the time	1	29%
	2	29%
	3	29%
	4	13%
Never	5	0%

APPENDIX I

A BID FOR CHALLENGE FUNDING

"To see the World in a Grain of Sand,

And a Heaven in a Wild Flower,

Hold Infinity in the palm of your hand,

And Eternity in an hour."

Horace Mann
Lost, Two Golden Hours

CHALLENGE FUNDING

Proposal from the Rugby CDT in conjunction with ADAS, supported by Warwickshire Education Department.

Proposal

To establish a computerised one stop advice and information system about substances and their use, in Warwickshire, for young people between the ages of eleven and eighteen.

Introduction

This proposal has been put together as a response to requests from young people, to have immediate access to objective and impartial information concerning substances; and to have information about statutory and voluntary agencies that are available to support them.

Our definition of substances includes legal drugs such as alcohol, tobacco, glues and solvents; as well as illegal drugs and prescribed drugs covered by the Misuse of Drugs Act 1971, and The Medicines Act.

The philosophy is to help young people make an informed choice about drugs and their use in the context of promoting a healthy life style.

The proposal works within the frame work of tackling drugs together, pulling together information gathered from the various agencies working with young people and/or their parents.

It is the intention that once this project is established, revenue costs will be minimal, and only relate to updating the information on the database.

Aim

Is to provide up to date, accurate and consistent information for young people in places assessible and familiar to them.

Objectives:

1. To increase the flow of accurate information to young people about substances and their use.

2. To provide accurate information which is immediately accessible to young people.

3. To reduce the acceptability of drugs to young people by providing information about physical, psychological, social and legal aspects of substance use.

4. To provide information about agencies which offer help, support and advice to young people.

5. To make information available to adults who work with young people eg. teachers, youth workers.

Process

The Rugby CDT and ADAS will identify the information which needs to be included on the database, taking account of views expressed by young people in Warwickshire. Rakesh Gupta Computer

Services will produce the database in a format compatible with the I.T. systems in schools and other youth venues. Warwickshire Education department through the County Inspector for P.S.E.; and Health Promotion Departments through the manager of North Warwickshire Health Promotion will be available for help and advice.

The database will then be piloted on a sample of young people in three different locations, and amendments made if necessary.

It is envisaged the stages of the project will be as follows:

3 months for information collection
6 months - to research the I.T. availability and format the disks
2 months - to be piloted on young people
1 month - for possible amendments and distribution.

We anticipate information on the database will consist of:

(i) Basic information on substances
(ii) Legal aspects of drug use
(iii) Harm reduction information
(iv) Specific information about drug use and gender
(v) Health risks eg. HIV, Hep B, C etc
(vi) Glossary of terms
(vii) Where and how to access help
(viii) Warwickshire Education Department guidance on drug education and responding to drug related incidence in schools (to be published July 97).

Costs

It is estimated that the overall funding for the project will be £14,000. This incorporates buying in the services of Rakesh Gupta, the purchase of approximately 50 disks, the packaging and distribution of the disks, the time commitment of the workers from Rugby CDT and ADAS. A more detailed breakdown of costs will follow if the bid is successful.

The funding for this is broken down as follows:

Rakesh Gupta Computer Services	£ 3,000 (offered)
Rugby Rotary Club	£ 5,000 (offered)
Challenge funding	£ 6,000

Total	£14,000

Fiona Stephenson
9th April 1997.