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DEVELOPING AN ARTIFICIAL INTELLIGENCE-SUPPORTED INSTRUCTIONAL DESIGN SYSTEM FOR TRAINERS IN A SOUTH AFRICAN BANK.

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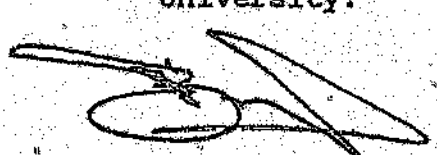
ABSTRACT

This study represented a preliminary attempt to develop and evaluate an artificial intelligence-supported instructional design system. The system was intended to guide novice instructional designers, employed by a major South African banking group, through the instructional design process. The system consisted of an expert system providing recommendations in three areas, namely training needs analysis, instructional method selection and instructional media selection. A qualitative evaluation of the system was conducted using a case study approach. Techniques including unstructured observation, focused interviewing and content analysis were used to gather and analyse the reactions of small groups of pilot test system users. It was found that the majority of users reacted positively, but not uncritically, towards the system. The system also appeared to enhance both the range and quality of instructional design decisions made by the users. A series of guidelines for the development of similar systems in the future were produced.

------OOOOOO------

DECLARATION

I declare that this report is my own, unaided work. It is being submitted for the Degree of Master of Education in the University of the Witwatersrand, Johannesburg. It has not been submitted for any degree or examination in any other University.



(signed) [illegible] day of June, 1992.

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I am deeply indebted to my two friends and research supervisors, Jo Ewart-Smith and Ken Fargher, for their astute guidance and persistent enthusiasm and support. I particularly wish to thank Jo for the time she sacrificed from her own studies, and Ken for clarifying to me in a dozen words what an equal number of books on Artificial Intelligence had failed to do.

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CHAPTER 1 - INTRODUCTION

1.1 Background to the Problem

Decades of official educational neglect, the effect of international trade sanctions, and the geographic isolation of South Africa, have been cited as factors contributing towards a critical skills shortage in South Africa (Nasson and Samuel, 1990; Gilbert, 1987). In early 1989, as newly-appointed Manager, Instructional Design, of a large financial institution (which will be referred to simply as "the Bank" in this report), I was becoming conscious of how this shortage of skills extended into the field of Instructional Design (ID).

Annually, some thirty to forty separate instructional programmes (training courses, workshops, etc) were being produced by trainers employed by the Bank. Some ten percent of the instruction was technology based, and produced at a considerable cost per hour of instruction. The instructional design activity was taking place in six different regions around the country, and little attempt was being made to guide, train or otherwise assist those charged with the task of designing the programmes. There was no standardised, systematic approach to ID. Finally, it seemed to me that the resulting instruction met with varying, and often limited, degrees of success.

The problem was compounded by a relatively high turnover of trainers, many of whom were clerical staff. Such trainers were temporarily seconded to the training function from line functions in the Bank's branch network, for periods ranging from one to three years, before returning to their mainstream career paths. This turnover resulted in a lack

of time, and often of commitment on the part of trainers, to gain expertise in training in general, and in ID in particular.

To counter this ID skills shortage I had scant resources. In terms of ID experience, I had some eight years of experience in design, mainly in the design of Computer-Based Training (CBT) programmes, while my two assistants had only about two years of ID experience between them. In addition, the time available for the establishment of ID skills in the organisation was limited by the fact that my department was also reponsible for the design and development of several CBT programmes, a very time-consuming activity[1].

Faced with the situation outlined above, it was decided to adopt a three-pronged approach to the ID skills shortage problem:

1. First, a simplified approach to ID was devised, based on the Instructional Systems Design (ISD) model (see Chapter 2). The approach was based to a large extent on one version of the ISD model, the Competency-Based Training model described by Blank (1982). This model was freely adapted to suit the Bank's specific needs.

   The Bank's approach was structured around an instructional design document (referred to as the "ID document"), which was intended to guide the designer through the first two phases of the ID process, namely the front-end analysis and the actual design phases (see Appendix A).

2. An ID workshop was developed and presented to trainers who were required to design instructional programmes for the Bank. This workshop was intended to introduce the trainers to the concepts and practices of ID in general, and to the application of the Bank's ID model

in particular. A practical requirement of the four-day workshop was that each delegate design a module of instruction by the end of the workshop (see Chapter 3).

3. The third prong in the attempt to overcome the ID skills shortage was to develop some form of automated guidance system, to assist trainers in the design of their programmes. The eventual outcome of this, in the shape of an Artificial Intelligence-based ID system, forms the subject of this report.

1.2 Artificial Intelligence and Expert Systems in Banking

> According to some, Artificial Intelligence is on the verge of transforming the way we do business. Soon, we are told, "smart" computer programs will begin replacing doctors, and lawyers, factory workers and managers. In the face of such hyperbole, it is hard to know whether to jump on the bandwagon or to dismiss the whole enterprise out of hand. (Shiel, 1987:15).

Whatever one's personal doubts, hopes or fears might be regarding the relatively new technology of Artificial Intelligence (AI), there is ample evidence of a burgeoning interest in the field. Chorafas (1987:72) referred to "the industrialisation of knowledge" as a second wave of the information revolution, and new books and articles on the subject seem to appear on a daily basis.

The trend towards AI has been particularly pronounced in financial institutions.

> When it comes to technology, banks are big spenders. It is estimated that they forked out over $10 billion in 1987 alone (Young, 1988:47).

According to a 1988 report by Louis Harris and Associates in the USA, of 250 US financial institutions, one in five

already had an Expert System (ES) (see Appendix C), and almost half of the 250 were expected to be making use of the technology by 1990 (Bircher, 1988).

In South Africa, some major financial institutions were not lagging far behind their overseas counterparts. First National Bank, for example, had by 1988 already been engaged for some four years in investigating the use of AI technology. One result of their efforts was the development of a loan authorisation ES, which was used, inter alia, to teach branch managers some of the intricacies of lending money to customers (Cox, 1989).

By early 1988 my own employers had established a four-person team of experts in its Operations Research Department to investigate and develop applications for AI. Several small-scale ESs were already in use or undergoing acceptance testing. These ESs dealt with topics such as home loans credit assessment, the identification of insurance cross-selling[2] opportunities, and the provision of financial advisory services. I had already been peripherally involved in the development of a product cross-selling opportunity ES for the Bank.

According to the Bank's Assistant General Manager, Education and Training Division, ESs were viewed by the Bank as one way around the perceived skills and knowledge backlog in the South African workplace. AI and ES technology were seen as means of deskilling[3] certain jobs, and of supporting decision-making with less demands on the individual employee.

1.3 Reservations about Using the Technology

It seemed to be only a matter of time before AI became a significant technology in training and education. Both

locally and internationally, the writing was on the wall. However, I had a number of reservations about using the technology for the design of training for adult learners. Foremost amongst these reservations were:

1. Would the AI technology be effective in the field of ID? My concern here was that, as Bell and Putnam (1979:24-27) noted, there is more art than craft involved in the ID process. I was not convinced that the technology would be able to cater for either the complexity, nor the demands for creativity, that I believed were essential ingredients for the design of successful instruction.

2. Would an approach to the design of instruction based on the relatively unknown technology of AI be regarded by the trainers as too mechanistic (see Chapter 2, page 2.5) in nature? In addition, the approach had an undeniably top-down, prescriptive element in it. Greater reliance was to be placed on the expertise of the trainer and of the AI-based system than on any participation by learners. I questioned whether such an approach would be suited to the design of instruction for adult learners.

   This mechanistic and prescriptive orientation was in contrast with a popular trend in adult education towards a more humanistic approach (see Chapter 2, page 2.4) to the design and delivery of learning for adults, causing me to have some doubts and misgivings about the outcomes of the enterprise.

3. As had occurred with CBT, the development of the AI-based training might have become dominated by experts in computer technology, to the exclusion of people with a more specialised understanding of adult learning processes and adult learner needs.

I feared that such a situation could lead to a repetition of problems encountered during the early development of CBT (Alessi and Trollip, 1985:78; Kearsley et al, in: Chambers and Sprecher, 1983:24). Often, early CBT lessons had been models of electronic wizardry, but found to be wanting in terms of instructional effectiveness.

To avert the recurrence of such problems, I intended to retain control of the development of the AI-based ID system within the Bank's education and training function, rather than relying on the Bank's information systems function or on external consultants. However, although I had several years of experience in designing and producing CBT lessons, I was by no means an expert in the field of AI. This being the case, the system described in the present study is not to be regarded as a showcase example of AI technology, but rather as an example of how a person with some computer experience, but little AI expertise, might go about making practical use of AI technology.

1.4 The Aims of the Study

The aims of this study were fourfold:

1. To discover what would be learned from the development of an AI-based ID system intended for use by Bank trainers.
2. To determine the reactions of a sample of Bank trainers to the system[4].
3. To assess the impact of the system on ID decisions made by the sample of Bank trainers.
4. To establish a set of guidelines for the development of future AI-based ID systems in the Bank.

Each of the above aims was associated with a number of research questions, as detailed below:

Aim 1: To discover what would be learned from the development of an AI-based ID system intended for use by Bank trainers

Questions arising from this aim included:

1a. What technology and expertise would be required to produce the system?

1b. How long would it take to develop the system?

1c. What lessons would be learned about the scope, acquisition of content, and logic of the system?

Aim 2: To determine the reactions of a sample of Bank trainers to the system

Questions arising from this aim included:

2a. Would the trainers encounter difficulties in using the system?

2b. Would the trainers judge the system to be applicable to their ID requirements?

2c. What suggestions would the trainers make for improvements or alterations to the system?

Aim 3: To assess the impact of the system on ID decisions made by the sample of Bank trainers

Questions arising from this aim included:

3a. Would the quality of any alterations made by trainers to their instructional designs after exposure to the system measure up to my personal standards of ID effectiveness?

3b. Would the trainers reject certain recommendations made by the system?

3c. Would the system fail to make certain recommendations that I would regard as valid?

Aim 4: To establish a set of guidelines for the development of future AI-based instructional systems in the Bank.

The question arising from this aim was:

4a. What guidelines could be derived from an examination of the processes of development and evaluation of the system?

1.5 Scope and Limitations of the Study

As will be seen later in this report, the scope of the study changed as my experience with AI technology grew more extensive. I had originally intended to develop an AI-based ID system that would guide Bank trainers through much of the ID process, including:

* The analysis of training needs
* The definition of the target learner population
* The task analysis process
* The setting of instructional objectives
* The selection of instructional methods and media
* The selection of learner assessment strategies.

In addition, I had intended to develop an eclectic approach to ID, incorporating the expertise of several different experts in the field of ID into the system.

The scope of the study narrowed down as follows:

1. The focus shifted from general AI to specific ES technology.
2. The range of the ID process dealt with by the system narrowed down to three specific areas, namely:
   a. Training needs analysis
   b. Instructional method selection
   c. Instructional media selection.

3. The number of sources of expert ID knowledge was reduced, with usually no more than two major contributors per area of the ID process.

Limitations of the study included the following:

1. As will be described in Chapter 2, a structural/functionalist approach to adult learning was adopted. This resulted in less attention being paid to alternative approaches to adult learning, including the humanist/interpretive approach popular with many adult educators.
2. The new system dealt with only three areas in the ISD approach to ID. As will be seen, even within these areas, it became necessary to narrow the focus.
3. The system became an ES. Other than ES technology, no attempt was made to incorporate other aspects of AI technology, such as natural language processing, pattern recognition, machine learning or intelligent tutoring (see Appendix C). As noted on page 1.6, I was by no means an expert in AI technology.
4. The ES was intended as an adjunct to the trainer's own design decisions, not as an omniscient oracle that would lead the trainer automatically to some ideal instructional design. In the field of ID, many decisions are made in terms of particular contextual factors, and at times little agreement as regards specific solutions may exist, even between expert designers. I therefore considered it important to leave the ultimate decision-making to the individual designer, with the ES acting more as an advisor than as a maker of final design decisions.
5. The present study was exploratory in nature, a first look at an emerging technology. As such, little attempt was made to arrive at conclusive evidence for or against the use of AI technology in ID and adult learning. The intention was rather to provide guidelines for future exploration.

6. As already noted on page 1.6, the ES produced was not intended to be a model of leading edge AI technology, but an attempt by a non-expert user of the technology to produce a practical AI-based tool.

7. Finally, the evaluation of the ES was confined to examining the reactions of users of the ES and to the presumed effects of the ES on the instructional designs produced by these users. No attempt was made to evaluate the effects of the ES on the final products of the design process, namely the actual resulting training programmes, nor to examine the reactions of the ultimate recipients of these programmes, namely the target learners. My experience had shown that frequently, in the Bank, significant alterations to the original design of an instructional programme occurred during the actual development and delivery of the programme. Often, individuals other than the designer of the programme participated in the development process, individuals such as subject-matter experts, audiovisual specialists, CBT programmers and technical writers. These individuals tended to alter the design of the programme in terms of their own expertise and personal preferences. In addition, other factors, such as budgetary restraints, staff transfers, and changes to banking procedures and policies, tended to influence the end product of the training design process. With all of the above factors intervening between the possible influence of the ES and the final training programme as it would be delivered to the target learners, I decided to limit my examination of the impact of the ES to the initial design process alone.

1.6 Major Assumptions Underlying the Study

The following major assumptions underlying this study were identified:

1. That a structural/functionalist approach to adult learning was an appropriate model to adopt for the design of instruction in the Bank.
2. That it was appropriate to base the ES on the ISD approach to ID.
3. That the three focus areas of the ES (training needs analysis, instructional method selection, and media selection) deserved priority attention.
4. That an ES based on a production-rule form of knowledge representation would be appropriate (see Appendix C).
5. That the resulting knowledge base would be comprehensive enough to provide useful and meaningful information to users of the ES.
6. That the sources of expertise used to compile the knowledge base were authoritative, valid, reliable and sufficiently comprehensive.
7. That a more qualitative, as opposed to a quantitative methodology, was suited to this study (see Chapter 3).
8. That the sample of trainers selected to test the ES was adequate for a qualitative study of this kind, both in terms of sample size and in terms of method of selection.
9. That the method of evaluating the ES, i.e. by means of a series of ES consultation sessions based upon the practical component of an ID workshop, was sufficiently similar to a real-life application of the ES to provide useful and valid information.

1.7 Definition of Key Terms Used in the Study

Both the fields of AI and of ID are characterised by highly specific terminology, acronyms, and jargon. To assist the reader of the report, a number of these terms have been defined below. (A Glossary of Terms is also included at the end of this report).

Artificial Intelligence (AI)

Some writers on AI have tended to shy away from a formal definition of AI, claiming that the term `intelligence' is problematic. Minsky (1985:71), for example, wrote:

> Our minds contain processes that enable us to solve problems we consider difficult. "Intelligence" is our name for those processes we don't yet understand.

Minsky conceded that such a definition was vague (what, for example, is the criterion for the term `difficult'?), and subject to constant revision as mankind's understanding of mental processes increases.

Another objection to the term `intelligence' was aired by Shiel (1987:94), who claimed that the term could result in unrealistic expectations about the capabilities of a system bearing the AI label.

Taking Minsky's definition a step further, Rich (1983:1) attempted to define AI as "the study of how to make computers do things at which, at the moment, people are better." This definition includes reference to what appears to be a critical component of an AI definition, namely the computer.

Other writers attempted more precise definitions. Charniak and McDermott (1985:6) wrote: "Artificial Intelligence is the study of mental faculties through the use of

computational models." In spite of the authors' careful explication of the assumptions underlying their definition, in my own opinion it misses the point that much of the activity in the field of AI is not focused on "the study of mental faculties", but has a more practical bent.

The definition that I find most acceptable from a practical point of view is that furnished by Chorafas (1987:42), who defined AI as:

> the branch of information science that focuses on developing computer programs able to perform functions normally associated with intelligent human behaviour.

Although displaying the same vague meaning of the term 'intelligence' as the writings of Minsky and of Rich already mentioned, the above definition at least locates AI within a definite branch of knowledge (information science), and mentions that computers are involved. What I find particularly attractive about this definition is that no attempt is made to equate the underlying processes of AI with human mental faculties. Instead, it merely states that AI computer programs are able to "perform functions normally associated with" such mental faculties. Thus, a rule-based ES (see Appendix C), bearing little or no known resemblance to the human mind, can be included in the definition of AI. Implicit in the title of this present study is the inclusion of rule-based ES technology in the field of AI.

For the purposes of the present study, Chorafas' definition will be taken as the prevailing definition of AI.

Instructional Systems Design (ISD)

The definition of the term 'Instructional Systems Design' (ISD) will be approached by means of an analysis of the three words instruction, design, and system.

The term 'instruction' refers to a deliberate intervention by a third party to facilitate the acquisition of identifiable skills, knowledge or attitudes by a learner. Instruction could apply to the field of education, including adult education, where the skills, knowledge and attitudes might be broader and less specifically defined, or to training, where the skills, knowledge and attitudes might be more specifically defined (Romiszowski, 1981:3).

The Oxford Paperback Dictionary (1983:171) equates the verb 'to design' with 'to plan'. In the specific context of the ISD approach, however, the term has come to include more than than simply the planning of instruction. It refers to the complete process of creation of instruction, including activities such as the front-end problem analysis, planning, developing, implementing and evaluating of the instruction.

The noun 'system', again according to the Oxford Paperback Dictionary (1983:685), refers to "a set of connected things or parts that form a whole or work together." When it comes to the design of instruction, these "connected things or parts" relate to the components of the ID process noted above.

It is precisely the organised, integrated, systematic manner in which the various components of the design process interact that sets the ISD model apart from some other approaches to ID. Gropper and Ross (1987:201), for example, referred to the "comprehensive, rule-driven approach" of ISD "that distinguishes it from other less systematic approaches to training development."

Many of the component characteristics of ISD have been included in a definition of ID by Barker (1987:11): "the specification of procedures that facilitate knowledge and skills transfer between people." Borrowing from Barker's definition, ISD can be defined, for the purposes of this

study, as "an organised and integrated approach to the specification of procedures that facilitate the transfer of knowledge, skills or attitudes between people."

1.8 Conclusion to Chapter 1

In this chapter the background to the present study and the research issues were described. The development and evaluation of an AI-based ID system were proposed as a partial remedy to the Bank's ID skills shortage. Some aspects of AI in banking were outlined, as well as some of the potential dangers inherent in the use of AI in training for adult learners. An examination was made of the aims, scope and limitations of the study, some major assumptions underlying it, and some of the technical terms used.

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CHAPTER 2 LITERATURE REVIEW

The present study is concerned with a number of fields of study that are usually dealt with independently, namely adult education, AI, and ID. In this chapter, the literature, and some of the concepts, relating to these three fields of study are reviewed under the following headings:

2.1 Adult Education
2.2 Artificial Intelligence
2.3 Instructional Design

2.1 Adult Education

Romiszowski (1981:3) wrote that a distinction is sometimes drawn between training and education, based largely on the notion that the goals of training are more focused and specific than those of education. From an otherwise forgotten lecture that he had once heard, Romiszowski quoted that:

> 'Training' is akin to following a tightly fenced path, in order to reach predetermined goal at the end of it. 'Education' is to wander freely in the fields to left and right of this path - preferably without a map.

Romiszowski made the point that most instructional activities lie somewhere along a continuum which has education, with its often less closely-defined goals, on the one extreme, and training, with more closely defined goals and objectives, on the other.

Rather than split hairs about real or imagined differences between education and training in the present study, the

term 'adult education' has been taken to include the training of adults. This view has been supported by many writers in the field of adult education, including Knowles (1978:105), Darkenwald and Merriam (1982:14), and Kidd (1973:195), although some writers, such as Brookfield (1985:46) have drawn a clear distinction between adult education and training.

The present study is an investigation of an approach to the design of training for adults. As such, it may be placed into the context of the study of adult education as a whole.

A number of attempts have been made to classify the mainstream ideas or dominant paradigms of the field of adult education. Three of these attempts are examined below:

2.1.1 Burrell and Morgan's Four Socio-Political Paradigms

One attempt (Christie, 1983) to classify approaches to adult education was based on Burrell and Morgan's (1979) classification of socio-political thinking into four mutually-exclusive paradigms, or clusters of assumptions (see Figure 2.1).

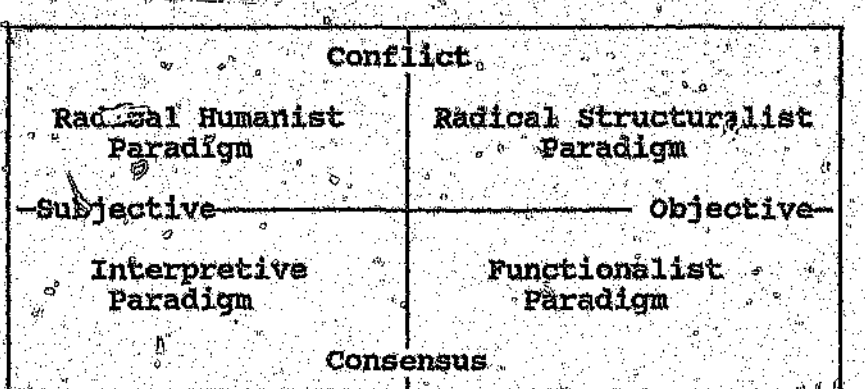

Figure 2.1: Burrell and Morgan's (1979) Four Paradigms

The four paradigms are:

* The radical humanist paradigm, exemplified in adult education by the work of Paolo Freire (1970:22-44). Two assumptions included in this paradigm are that individual needs take precedence over those of society, and that social change is brought about by revolution rather than by evolution.
* The interpretive paradigm, exemplified by the work of Malcolm Knowles (1970). In this paradigm, the assumption is that individual needs again take precedence over societal needs, but that social change is evolutionary rather than revolutionary.
* The radical structuralist paradigm, exemplified by the re-education campaigns during the Chinese Cultural Revolution (Harrison, 1983:27; Joyce and Weil, 1980:492). Here, the assumption is that societal needs take precedence over individual needs, and that social change is brought about by revolution rather than by evolution
* The functionalist paradigm, exemplified by the work of Tyler (1950). Here, the assumption is that societal needs take precedence over individual needs, and that social change is evolutionary rather than revolutionary.

The present study focused primarily on meeting the needs of the organisation (representative of the needs of society rather than of the individual), and on achieving change by means of cooperation and consensus between the agents of change (the AI-based system and the trainer) and the targets of change (the trainees). As such, the study could be classified as falling into Burrell and Morgan's functionalist paradigm.

2.1.2 Organismic versus Mechanistic Approaches to Adult Learning

Knowles (1978) distinguished between what he referred to as "organismic" and "mechanistic" approaches to adult learning.

According to Knowles, the organismic approach has the living biological organism as its metaphor. The approach is characterised by a holistic view of the learner, as an integrated, self-actualising being, able to participate in the direction and control of the learning process. Relying to a large extent on a humanistic approach to psychology[1], exemplified by the work of Rogers (1969) and Maslow (1962), the organismic approach is typified by a focus on the learner and his or her needs, rather than on the needs of the organisation or society. Knowles maintained that an organismic, humanistic approach was desirable for adult education, and outlined four assumptions of such an approach:

1. Adults have a deep need for self-directness.
2. Their experiences could serve as a rich resource for further learning.
3. Their readiness to learn is linked to what they perceive they need to fulfil their adult roles.
4. Their orientation to learning is towards immediate problem-solving rather than towards general subject-matter.

Knowles subsequently adjusted his claim that the above assumptions applied exclusively to adult learning. In 1988, he was quoted as having said:

> Kids have just as much need for learning to be life-centred, task-centred and problem-centred. It's just that the nature of their tasks, problems and lives is different (Feuer and Geber, 1988:35).

In contrast, the mechanistic approach has the machine as its metaphor. The approach is characterised by a focus on the parts rather than the whole, and by a faith in the ability to control the learning process by manipulating variables via agents external to the learner. Thus, control over the learning process is taken from the learner and placed in the hands of experts. The approach is based to a large extent on a behaviouristic approach towards psychology, exemplified by the work of Watson (1916), Thorndike (1989) and Skinner (1953).

It might be useful, in practice, to regard the organismic and mechanistic approaches as two extremes of a continuum, along which most actual instruction can be placed. I would argue that the approach adopted in the present study was located closer to the mechanistic end of the continuum, for the following reasons:

* As Bell and Putnam (1979:24) pointed out, "the logic of machines has dominated the training world for many years". The legacy of this domination is to be found in the ISD model of ID. To a great extent, this model treats the ID process as a mechanical system composed of individual parts (eg the phases described in Chapter 1 of this report). The terminology used is the terminology of the machine, with use of words such as 'input', 'output' & 'feedback'.
* In the ISD model control over the design process is taken out of the hands of the learner, and placed in the hands of the expert instructional designer (Gery, 1990:40). In the present study, where the designer lacked expertise, a measure of the control resided in a machine that attempted to provide that expertise. One could argue that this made the approach in the present study doubly mechanistic, since, to some

extent, it took the control almost totally out of the hands of any human being at all. However, it might be unwise to exclude the possibility of organismic elements in the present study. In Chapter 5 of this report it is argued that, on occasions, the ES served as a rich source of ideas, and as a means of increasing human control (of designers, at any rate) over the process of ID, by making additional expertise available to the designer.

2.1.5 Education From Above versus Education Amongst Equals

Jarvis (1985:60-72) classified approaches to adult education into two mainstreams, in accordance with Dawe's "two Sociologies" (Dawe, 1970).

Jarvis characterised what he referred to as the structural functionalist (not dissimilar to Knowles' mechanistic) approach as involving "education from above" and "prescription by the professional." One reason given for the element of prescriptiveness was that, in the structural functionalist approach, society tends to be viewed as a complex system of interrelated parts, best left in the hands of experts.

The alternative approach to adult education in Jarvis' classification was referred to as "education amongst equals". This approach shares many of the characteristics of Knowles' organismic approach.

It can be argued that the present study, by using technology to place ID expertise in the hands of the professional trainer, falls into the structural functionalist category of adult education.

According to the classifications of adult education cited above, one could expect the present study to be characterised by:

* A somewhat prescriptive approach to ID, with more reliance being placed on professional trainer expertise than on the expressed needs of learners.
* A somewhat mechanistic, as opposed to a humanistic, approach to the design of instruction.
* Little attention being paid to forces external to the workplace, for example revolutionary forces of change.

It is to be noted that many humanistically-inclined adult educators, including Knowles (1978:105-111), have acknowledged that for the training, as opposed to the education, of adults, a mechanistic, systematic approach may be both necessary and appropriate at times.

2.2 Artificial Intelligence

2.2.1 Emergence of Artificial Intelligence

According to Chorafas (1987:44), the term 'Artificial Intelligence' was coined by John McCarthy in 1956, but AI-like concepts were introduced somewhat earlier. These included Claude Shannon's suggestions regarding a chess-playing program (Shannon, 1950) and the work of Alan Turing, a British mathematician and logician. Turing (1953) proposed the Turing Test for machine intelligence. A machine would pass the Turing Test if, in a teletype-mediated conversation with a human being, it could avoid being detected as a non-human entity by the human being.

Forsyth and Naylor (1986:1-8) separated the historical development of AI into decades, each one characterised by a significant trend in the technology. Each of these decades and their dominant trends are outlined below:

The 1950s were characterised by research into neural nets. During this decade, the focus of AI activity was on attempts to replicate the human brain, not only in function, but also in structure. Early work in the field was based on a model of the neuron in the human brain. This model was proposed by McCulloch and Pitts (McCulloch, 1943), and formed the foundation of what became known as the field of cybernetics, an early precursor to AI. The relatively limited progress of that approach to AI at the time was attributed to the limited sophistication of the computer technology then prevailing (Forsyth and Naylor, 1986:2).

The 1960s saw a focus on the development of heuristic search techniques[3] applied to the task of problem-solving. One influential product of this period was the General Problem Solver, developed by Newell and Simon (1973), and used to solve a variety of problems with limited domains and well-defined rules governing their resolution.

The 1970s saw the development of ESs, with the name of Edward Feigenbaum at the forefront. As early as 1967, Feigenbaum et al developed DENDRAL, acknowledged as the first true ES (Chorafas, 1987:45; Forsyth and Naylor, 1986:5), and used to examine molecular structures. Another early ES, MYCIN, developed by Shortliffe (1976), was used to diagnose blood infections and make prescriptions based on the diagnoses. MYCIN was to be hailed not only as the first clear rule-based ES, but also, via one of its successors, EMYCIN, as the precursor of the ES shell (Siegel, 1986:83) (see Appendix C for

details regarding ESs, rule-based systems and ES shells). Another early ES was PROSPECTOR, also developed at Stanford, by Hart et al (1978). This system was used assist in geological searches for mineral ore deposits.

The 1980s were characterised as the decade of machine learning. In the preceding decade, Winograd (1972) had developed a pioneering AI product in the field of machine learning, SHRDLU, capable of solving a simulated toy brick puzzle by learning from experiance. The 1980s saw the development of EURISKO, capable of automatically extending its body of knowledge, to the extent that the program developed the capacity to even invent novel solutions to problems (Forsythe and Naylor, 1986:6).

The 1990s have so far seen a return to a focus on neural nets, originally studied in the 1940s and 1950s. This became evident in the theoretical literature somewhat earlier than the 1990s (eg Minsky, 1985; Hofstadter, 1979), and was followed by the development of a number of of practical systems in the 1990s (Entsminger, 1990). It may be that an increase in the power and accessibility of computers in the 1990s will result in greater success in this approach than in the 1950s. Despite these advances over the years, however, some students of AI have expressed the belief that true human intelligence will take many more years, if not forever, to emulate, given the complexity and sophistication of the human being (Ferguson, 1988:80; Minsky, 1985).

2.2.2 AI Applications in Instruction

Lippert (1989) listed three separate roles for the application of AI in instruction, namely those of tutor, tutee or tool. These roles are examined separately below:

1. AI Systems as Tutors

AI-based tutoring systems have often been referred to as Intelligent Tutoring Systems (ITSs) (Lippert, 1989; Trollip et al, 1989; Breuker, 1988). Essentially, an ITS is intended to take the place of a human tutor, guiding a learner along an optimal learning path, determined by the system's capability for intelligent decision making and the information it has gathered about a particular learner's needs and preferred learning style. In addition to the specific knowledge of a particular domain, an ITS also contains instructional expertise (Breuker, 1988:310). Often underlying the operation of an ITS is the notion of student modelling (Self, 1974; Suppes, 1979), in which a model of the cognitive and/or learning styles of the learner is formulated and used to determine delivery of individualized instruction.

Numerous examples of ITSs have been developed over the past decade (Self, 1988; Lippert, 1989), although critics of such systems have been quick to point out that few have been applied outside research situations (Linton, 1989:8; Megarry, 1988:173). Another criticism of ITSs has been that they tend to be too directive, imposing a learning pattern rather than empowering learners to select their own learning pattern (Todd, 1988:199; Megarry, 1988:173). Despite such criticisms, some ITS projects have met with considerable success. Lippert (1989) and Linton (1989) have both cited several examples of successful ITSs, including one (the Recovery Boiler Tutor developed by Woolf) which has been used in over sixty pulp and paper mill sites in the USA.

Related to ITSs are AI applications involving student assessment and problem diagnosis and . An early and somewhat transparent example of a diagnostic AI application was ELIZA, created in 1963 by Weizenbaum (1976). This system simulated a Rogerian counselling dialogue[4] with its human user (Rogers, 1971). The idea of using such a dialogue to assess a learner's needs, understanding and/or learning style, has been applied in the field of instruction, for example by Palmer and Oldehoeft (1975) and by Powell (1987). In section 2.2.3 of this report, criticisms of this use of AI, presented by Weizenbaum (1976) himself, are examined.

2. AI Systems as Tutees

The assumption underlying the application of an AI-based system (usually an ES) as a tutee is that, by having to teach knowledge to the computer program, a person is forced to clarify the meaning, structure and logic of the knowledge in his or her own mind, before being able to communicate it to the computer program.

An early example of the use of the computer (although not necessarily of AI) as a tutee, can be found in the work of South African-born Seymour Papert. A student of cognitive development theorist Jean Piaget, Papert focused on ways that computers could support human cognitive development (Papert, 1980). Perceiving a parallel between computer reasoning and human problem-solving, he developed the LOGO programming language. LOGO was intended primarily for use in teaching spatial and mathematical concepts to young children, by encouraging them to seek solutions that would be acceptable to the merciless logic of the computer program.

Costa et al (1988:157), have since questioned Papert's assumption that the use of a computer would inevitably result in the development of improved problem-solving skills. They also questioned Papert's use of the computer as a passive instrument, without building in some form of intelligent guidance to assist the learner.

Notwithstanding such criticisms, it has also been claimed that, by simply using an ES, users can increase their understanding of a knowledge domain (eg Trollip et al, 1989). Eary (1987) even proposed that the use of an ES could be regarded as a form of "training by stealth", encouraging learning on the part of an ES user without him or her being aware of being trained.

A series of studies on the use of an AI-based system as a tutee were conducted by Trollip et al (1989). Basing their approach on earlier research by Starfield and Bleloch (1983) and by Starfield et al (1985), Trollip and his colleagues arranged for graduate students to construct their own rule-based knowledge bases (see Appendix C), focused on the domain of CBT screen design. It was reported that this approach to instruction:

* Encouraged peer interaction.
* Was highly motivating for the learners.
* Was particularly suited to the learning of procedural knowledge.
* Enhanced problem-solving skills.

Similar findings were reported by Starfield and Smith (1990) whose samples of learners ranged from high school pupils to adult university staff.

Finally, in the area of financial training, Schofield (1987:16) described the use of the CRYSTAL III ES to

enable bank trainees to "examine different options in order to develop an intuitive applied understanding of (financial) situations." The ES was purported to allow a learner to explore numerous "if...then" possibilities, in other words to learn by exploring the consequences of various alternative decision paths (see Appendix C).

3. AI Systems as Tools

At the time of writing, a number of AI-based systems have been produced for use as tools to assist designers of instruction, although few reports of research into the application and validity of such systems have appeared.

Swartz and Petrie (1988:33) listed three commercially available ES-based ID tools from the USA:

* EXPERT MEDIA SYSTEM by IntelliSys in New York.
* COURSEBUILDER by PEAKSolutions in Minneapolis.
* EXEMPLAR COURSE GENERATOR by BehaviorTech in Irving, Texas.

The uses of these systems ranged from the classification of instructional objectives and assessment of mastery of these objectives, to recommendations regarding the selection of instructional media. No reports of research conducted on these products have come to hand.

A reportedly successful AI-based instructional tool has been produced by Steelcase Inc (Camillo, 1990). This tool was designed to help learners determine their own preferred learning styles, and to advise learners on how to devise their own individualised curricula. The significance of these features is their potential for increasing learner control over the learning situation, thereby counteracting the prescriptiveness of the ID tool (see pp 2.35 - 2.36 in this chapter).

Barker and Proud (1987:158) proposed the development of a CBT author's "workbench", consisting of a "wide variety of 'intelligent' software tools" designed to provide comprehensive assistance to CBT authors designing and producing CBT courses. At the time of writing this report, no reports of the completed product have come to hand.

Lippert (1989:13) reported on three systems developed in the USA:

* At Utah State University, AI was used to assist in the generation of special education programmes, and to classify disabled students.
* Kearsley, also at Utah State University, developed a product called CBT Analyst, to assist in decision making in the CBT developent process, particularly as regards the process of media selection (see also Kearsley, 1991:32).
* Again at Utah State University, Merrill and Jonassen were reported to be developing a comprehensive AI-based system to automate the entire ID process from needs analysis to evaluation (see also Geber, 1990:31).

An AI-based tool that is commercially available in South Africa is Palmarozza's CBT Adviser. Like Kearsley's system, this ES attempts to provide assistance with the CBT decision making process. To derive the knowledge base for this system, Palmarozza collected the expertise of twenty five CBT consultants, users and suppliers from the USA and the United Kingdom (Palmarozza, 1989). The resulting system provides comprehensive advice on many aspects of CBT, such as the selection of topics suitable for CBT, cost/benefit analysis, development time

estimates and even predictions of the success of CBT implementations.

A final example of an AI-based tool was that developed by Aderet (1989). The aim of this tool was no less than the automated generation of CBT lessons. The tool was intended to guide the CBT designer through the ID processes of analysis, design (formalisation of learning objectives, course flow), development (text, menus, questions and feedback, and even generation of programming code), and implementation (production of computer diskettes). Aderet claimed that the tool reduced the amount of expertise required of the CBT developer, as well as speeding up design time.

2.2.3 Using AI - An Emotional Issue

Berry (1983:25) wrote that: "Few projects have aroused as much emotion as the proposal to design machines which would be as intelligent as people." In my experience, the question of whether the use of AI should or should not be encouraged is one which arouses much of the emotion to which Berry referred.

One of the most notable critics of the use of AI technology has been Weizenbaum (1976), himself an early pioneer of the technology, and creator of the ELIZA program (see p2.11). Intending ELIZA only as part of an experiment in natural language processing, Weizenbaum was surprised to note the degree to which people would confide in the program, in effect laying their souls bare to an inanimate machine. He noted the "enormously exaggerated attributions an even well-educated audience is capable of making, even strives to make, to a technology" (Weizenbaum, 1976:7), and warned of dangers associated with such attributions.

Weizenbaum also noted another dehumanising tendency associated with computer (and particularly AI) technology. He described the developer of computer programs as the "creator of a universe for which he alone is the lawgiver" (Weizenbaum, 1976:115). Wiezenbaum expressed the fear that such developers could lose touch with reality, and come to believe that all human problems could be solved by means of technology. They could, he feared, become sidetracked from addressing some critical issues facing humanity, issues such as world peace, love and morality. These, Weizenbaum claimed, only humans, interacting with other humans, could resolve.

To Weizenbaum, the potential loss of touch with reality on the part of the developers of the technology, coupled with an almost superstitious faith in the technology on the part of the public, were potential threats to the survival of the human race. Alluding specifically to AI, he wrote: "there are certain tasks a computer ought not to be made to do, independent of whether computers can be made to do them" (Weizenbaum, 1976:x)

Weizenbaum cannot be regarded as a lone renegade against the inexorable mainstream of progress. Other writers have identified similar trends. Brian Oakley, a former chairman of the British Computer Society, was reportedly sounding a warning note when he said that people "trust computers and the answers they give", that people "are used to systems which give definite answers according to the laws of mathematics" (Watts, 1988:32). Biram (1978:15-16) coined the word 'teknosis' to refer to what he considered the pathological state of the human condition brought on by technology. He wrote:

> Man's error is to assume he can manage anything reliably; to attempt to manage a planet that was running well before he got to grips with it is sheer arrogant folly (Biram, 1978:247).

Today, AI stands at the forefront of technology, mankind's tool for tampering with the planet.

In the area of instruction, one critic of ITSs has referred to such systems as "potentially seditious", in that they can deskill teachers' jobs and pupils' tasks, directing attention away from human-to-human interaction, and focusing instead on technical mastery (Ridgeway, 1988:28). Clancey (1988:58) warned of the possibility of people losing their ability to use articulation and abstraction in solving problems, thus having the core of their knowledge usurped by the systems.

Defenders of AI and associated computer technology have been quick to counter some of the claims made against the technology. Writing specifically in reaction to Weizenbaum's warnings, Berry (1983:31) argued that any attempt to suppress a technology such as AI would only serve to drive it underground, where its development would continue, possibly in ways more detrimental to mankind than before.

Other writers have referred to the positive, and even empowering[5], effects that AI and related technologies can have on human activities. Zuboff (1988:57) pointed out that, instead of the oft-predicted loss of skills resulting from the use of computer technology (particularly AI-based computer technology), some industries are recording a trend towards reskilling[6] as certain workers achieve mastery of new productivity tools.

In another defence of AI technol[illegible] Ferguson (1988:78) quoted Weyer, of the multinational [illegible]computer giant corporation Apple, who claimed that using AI meant "giving someone an assistant or tool. We're talking about empowering the human."

In the midst of this controversy, what direction is to be taken? Does one reject the use of AI and its associated technologies as unethical, a threat to human empowerment, or even potentially dangerous to the very existence of mankind? Or does one adopt a more pragmatic approach, shrug off the threats as being exaggerated or inevitable, and focus one's attention upon how best to make use of these technologies? In the case of the present study, the latter approach was adopted. However, as the colloquial saying goes, "the jury is still out", and some doubts did and still do exist in my mind about the ethical acceptability of the technology.

2.3 Instructional Design

In this section, ID concepts and literature relevant to this study are examined under the following headings:

2.3.1 Background to the ISD Model
2.3.2 Description of the ISD Model
2.3.3 Components of the ISD Model Relevant to this Study
2.3.4 A Critique of the ISD Model.

2.3.1 Background to the ISD Model

According to Eisner (1985:15), it was Franklin Bobbit who, acting as a consultant in curriculum design to Los Angeles schools in the 1920s, initiated a systematic approach to ID. Bobbit (1924) promoted application of the procedures of science to the building of a curriculum. He stressed the importance of task analysis as a means by which the curriculum builder could assemble the objectives of the instruction. These objectives were to be stated in what would later be referred to as behavioural or performance based terms.

Bobbit's approach was adopted by Tyler (1950), among others, some twenty years later. Tyler was credited by Eisner (1985:24) as having raised the issue of determining whether the purposes of the instruction (ie the objectives) had been attained. This introduced the concept of evaluation into the 'science' of curriculum building, which became known as the systems or ISD model of ID (Sredl and Rothwell, 1987:VI:362).

Some years later, attempts were made to classify instructional objectives into categories, ie to formulate taxonomies of objectives. Much credit for the early development of taxonomies has been attributed to Bloom et al (1956) (see Geber, 1990:107; Romiszowski, 1981:35). More recently, Bloom's taxonomies of instructional objectives were reported to have been largely superceded by the work of Gagne (Gagne and Briggs, 1974) and of Merrill (Merrill and Wood (1974) (see Geber, 1990:108).

The ISD model has proved to be particularly popular over the past three decades for the design of Programmed Instruction (PI), and its successor, CBT (O'Shea and Self, 1983:77). Today the ISD model, in one form or another, is almost invariably prescribed for TBT or CBT design by writers on the subject (Alessi and Trollip, 1985:271; Chambers and Sprecher, 1983:146; Hudson, 1984:107).

The links between PI (and therefore CBT) and ISD are more than fortuitous. Both have been said to be firmly founded in behaviouristic psychology, with its firm commitment to an objective, positivist, behaviour based approach to the understanding and changing of human behaviour (Sredl and Rothwell, 1987:VII:23; Park, 1983:69; Romiszowski, 1981:166).

One of the most prolific advocates of the ISD approach in recent years has been Romiszowski (1981, 1984). Many of the

ideas used in the Bank's approach to ID, and in the ES knowledge bases described in the present study, were based on his work.

According to Blank (1982:7), variations on the ISD model include Mager and Pipe's Criterion Referenced Instruction (CKI) (Mager and Pipe, 1970), Clark and Clark's adaptation of Merrill's Content/Performance Matrix approach (Clark and Clark, 1986), and Blank's own Competency Based Training model (Blank, 1982). All of the above adaptations of the ISD model have been used in South Africa, with many of the large mining houses such as Anglo-American, Goldfields, and JCI having used the CRI approach, the Standard Bank having used an eclectic combination of Clark's and Blank's approaches, and organisations such as South African Airways, South African Transport Services and Wesbank having used Blank's Competency Based Training approach. Among others, the Department of Manpower has also adopted a competency based approach for the design of training for artisan apprentices (Opperman et al, 1989).

2.3.2 Description of the ISD Model

The basic assumption underlying the ISD model is that the ID process can be treated as a system, as "a set of connected things or parts that form a whole or work together" (see Chapter 1, p1.14). Romiszowski (1981:5-9) described a system as being composed of four major components (see Figure 2.2 below), namely:

1. An input component.
2. A "black box" where this input is processed.
3. An output component.
4. "Corrective feedback", derived from a comparison of the desired output with the actual output delivered from the "black box."

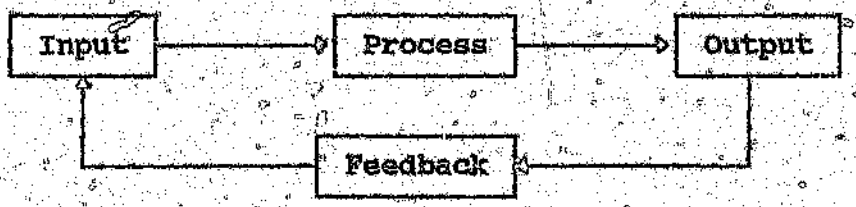

Figure 2.2: The Four Components of a System

The system operation is initiated when input is fed into the processing component (the "black box", so-called because it is assumed that specific details of its own operation can be bypassed as not essential to an understanding of the operation of the system as a whole) to produce an output. Information relating to the performance of the system, in the form of feedback, is returned as input for further processing, initiating a repetition or iteration of a further cycle of input, processing, output and feedback.

In ID, this "set of connected things or parts" consists of activities, grouped together into stages or phases, commonly referred to as the analysis, design, development, implementation and evaluation phases of the ID process (Romiszowski, 1981; Alessi and Trollip, 1985; Rosenberg, 1982; Sredl and Rothwell, 1987:VII).

In general the ISD model begins with the analysis phase and ends with the evaluation phase, although the process is seldom linear (Rushby, 1987:20), there being a great deal of interaction between the phases. One example of this interaction is that the feedback into the entire system provided via evaluation can, and does, occur throughout the ID process, and can result in the re-examination and revision of aspects of any other phase.

Figure 2.3 shows these main phases of the ISD model as depicted by Rosenberg, (1982).

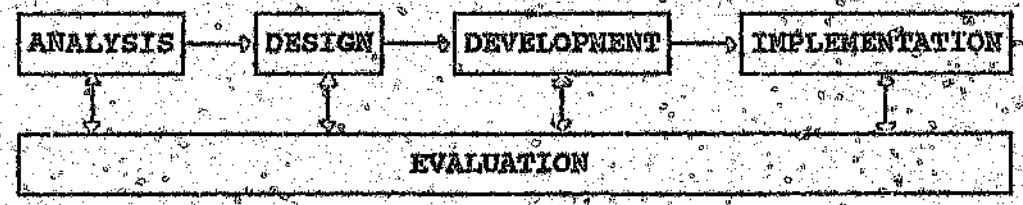

Figure 2.3: Phases of the ISD Model

Each of the phases shown above can be broken down into a number of steps, although the exact number of these steps can differ from one variation of the model to another. In the Bank's adaptation of the ISD model, the phases are broken down as follows:

1. The analysis phase consists of:
   * A training needs analysis (referred to simply as the needs analysis).
   * A target learner population analysis.
   * A task analysis (ie, an analysis of ideal and actual job-related behaviour for which the training is intended).

2. The design phase consists of:
   * The identification of the competencies (skills, knowledge and/or attitudes) which are presumed to be needed in order to perform the required tasks).
   * The setting and sequencing of instructional objectives.
   * The selection of instructional methods (referred to as method selection), instructional media (referred to as media selection) and learner assessment strategies.

3. The development phase consists of:
   * The collection of suitable content for lessons.
   * The sequencing of individual lessons.
   * The writing of lesson materials such as videoscripts, CBT storyboards, workbooks and lecture notes.
   * The initial production of draft lesson materials.

   During this phase, the draft materials and lessons developed are pilot tested and subjected to formative evaluation (see below).

4. During the implementation phase the finished lesson materials are produced and distributed, and the lessons are presented, or delivered in other ways, to learners.

5. As noted above, the evaluation phase, although referred to last, in fact permeates the entire process, from beginning to end. Scriven (1971), distinguished between two broad types of evaluation, namely formative and summative:
   * Formative evaluation is conducted throughout the entire ID process. It provides feedback to designers on how to make adjustments to their original designs to match the demands of reality, such as changing needs of learners and of the organisation. One reason that Scriven advanced for drawing attention to formative evaluation as a separate process was that he had noticed that once a curriculum had been put into its final form, there was considerable resistance to efforts to improve upon it. By including formative evaluation as a formal step in the development phase of an

instructional programme, the programme could be improved upon prior to its general release and implementation.

Samson (1987:100) pointed out that formative evaluation is a "creative and ongoing process." It is not something that happens only once. At any point in the ID process, revised information can be fed back into the system.

Summative evaluation generally occurs at the end of the ID cycle, and provides information about the overall validity and effectiveness of the instruction.

2.3.3 Components of the ISD Model Relevant to this Study

In this study, the focus of attention was upon certain selected components of the first two phases of the ISD model, namely the analysis and the design phases. The three components were:

1. Needs analysis
2. Method selection
3. Media selection

1. Needs Analysis

This component has been described as "the single most important step" in the ID process (Sredl and Rothwell, 1987:VII:5). Whether a needs analysis has been conducted, how accurate and comprehensive its findings are, and whether these findings are interpreted and applied correctly, can influence not only many other aspects of the ID process, but also the outcome and value of any instruction produced.

A single definition covering the wide variety of activities that fall under the umbrella term 'needs analysis' would be difficult to find. Activities range from organisation-wide "performance audits" (Rummler, 1976), to the more learner-centred determination of individual learners needs advocated by Knowles (1980), or of the needs of a community (Freire, 1970).

A further complication is that some approaches to ID include the analysis of tasks and of learner population characteristics in the needs analysis itself (eg Blank, 1982), while others (eg Clark and Clark, 1986) treat task and learner population analysis as separate components of the ID process.

Despite this lack of uniformity, for the purposes of this study the term was taken to refer to "the analysis of a performance problem or deficiency in an organisation, with a view to determining whether training can form part of the solution to the problem." Implicit in this definition is a focus on job performance, and on how this impacts on the organisation, rather than on the needs and feelings of the individual learner. Also implicit is a readiness to focus on training as a solution to the problem.

In order to conduct such a needs analysis, answers to a number of questions must be sought. One list of such questions was produced by Mager and Pipe (1970), and was derived from the work on "Performance Problem Analysis" by Thomas Gilbert (1967) (see Romiszowski, 1981:97).

Figure 2.4 depicts a flowchart of Mager and Pipe's questions. The initial questions seek to ascertain whether a behavioural deficiency exists, is important or not, and, if so, whether it is the result of a skill deficiency. If it is, further questions seek to

ascertain whether the deficiency results from a lack of training, or from some other source. The behaviourist bias in such an approach is clear, with the focus on 'performance problems' and 'behavioural deficiencies'.

Somewhat similar models of needs analyses, in the form of flowcharts, tables or questionnaires, and differing mainly in the finer details, have been produced by Laird (1985), Sredl and Rothwell (1987:VII), Rummler (1976) and Romiszowski (1981).

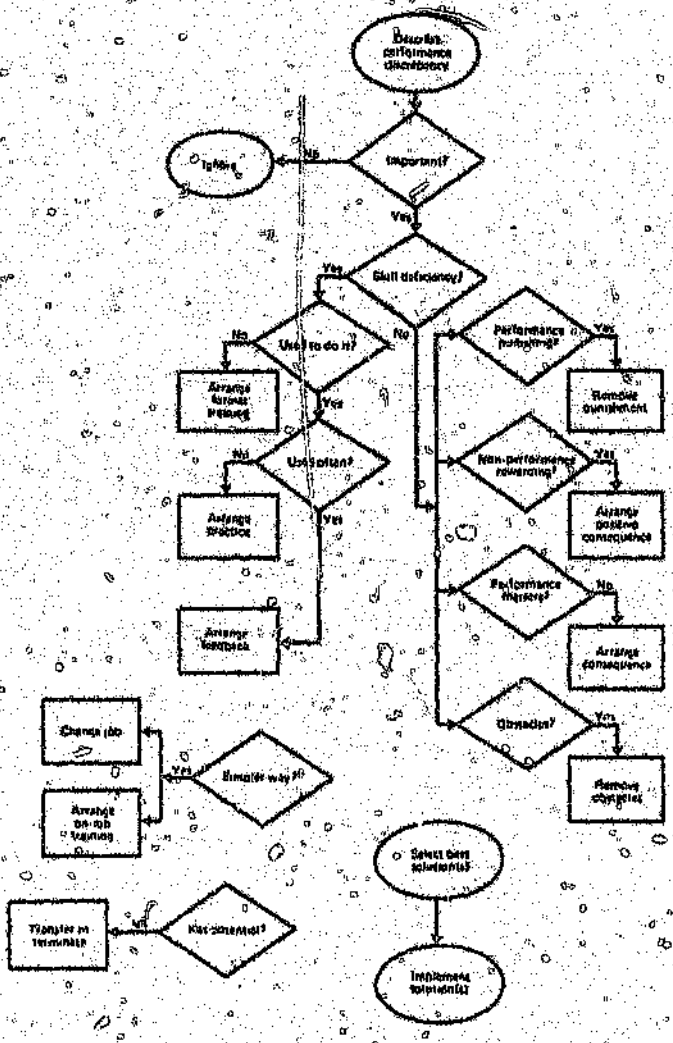

Figure 2.4: Mager and Pipe's Needs Analysis Process

The Needs Analysis knowledge base developed in the present study was derived in part from Mager and Pipe's flowchart. However, the focus was shifted away from purely behavioural deficiencies, to include the analysis of knowledge and attitudinal deficiencies (see Chapter 3 for more details).

2. Method Selection

Some writers on ID have treated the term 'instructional methods' as problematical. Although he did use the term, Romiszowski (1981:276), for example, defined instructional methods simply as "ways of doing something", and indicated a preference for more specific terms, such as instructional 'strategies', 'plans', 'tactics' and 'exercises'.

The decision was made to adhere to use of the term 'methods' in this study, since this was the term most commonly used by trainers in the Bank. In the Instructional Design Workshop, methods were defined simply as "techniques to facilitate learning." In the present study, then, method selection is defined as the process of choosing techniques to facilitate learning for particular instructional objectives.

In the design and development of curriculum-wide instruction, method selection decisions can be made at several levels of the decision making process. On what Romiszowski (1981:165) referred to as the "macro", or strategic level of decision making, one of the decisions to be taken could be whether to adopt an expositive or a discovery based approach. Essentially, an expositive approach to learning involves presenting the learning content to learners prior to them being required to

practice or apply this information. A leading proponent of this approach was Ausubel (1968). A discovery approach involves devising learning situations in which learners first experience particular instances of the learning content and then come to develop their own cognitive interpretations of the overall learning content. A leading proponent of the discovery learning approach was Bruner (1966).

Pure expositive and discovery learning approaches can be regarded as lying at the opposite extremes of a continuum. Numerous other approaches lie between these extremes, such as Gagne's "guided discovery" approach (Gagne, 1965), in which a learner is subtly led towards the discovery of learning content by means of clues built into the learning environment. Binstead (1987:30) made the point that most instruction contains elements of both the discovery and the expositive approach.

Another approach to method selection, perhaps undertaken at a more specific level of design and development, involves the separation of instructional objectives into three domains, namely skills, knowledge and attitudes. Methods are then assigned according to the learning domain under consideration (Binstead, 1987:28-30). The classification of objectives into three domains can be traced back to the taxonomy of instructional objectives derived by Bloom et al (1956), in which three domains, ie cognitive, affective and psychomotor, were identified. Binstead (1987:28) argued that a method appropriate to one domain was unlikely to be appropriate to another, although in my own experience this is not always the case.

Yet another approach to method selection was advocated by Clark and Clark (1986), and was derived in turn from the

work of Merrill (1983). In this approach, learning content is classified into types and levels of application, and then located in a "Content/Performance Matrix" (see Table 2.1). The learning content is separated into the categories of fact, concept, process, procedure and principle. Performance requirements of the content (how the content is to be used) are separated into two further categories, use and remember. A number of instructional methods (referred to as "information displays" and "practice methods" by Clark and Clark) are then recommended for each particular cell in the matrix (see Table 2.2).

Table 2.1: Clark and Clark's Content/Performance Matrix

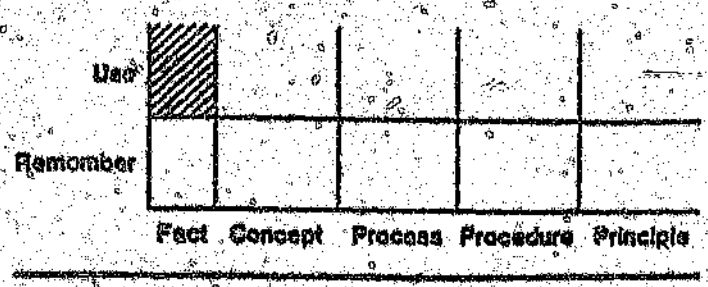

Table 2.2: Clark and Clark's Instructional Method Selection Chart

I. Informational Displays Recommended To Communicate Content Types.

FACTS	CONCEPTS	PROCESSES	PROCEDURES	PRINCIPLES
Statements	Definitions	Stage Table	Action Table	Rule
Lists	Examples	Flow Diagram	Decision Table	Example
Tables	Nonexamples	Analogies	Demonstrations	Analogies
Tree Charts	Analogies	Examples	Examples	Modeling
Diagrams/ Illustrations	Diagrams/ Illustrations	Diagrams/ Illustrations	Modeling	

II. Practice Methods Recommended To Achieve Performance Levels

USE		Classify New Examples	Solve Problems	Hands-On Practice Role Play	Solve Case Study Prediction Problems Role Play
REMEMBER	Mnemonics; Recall and Organizations Meaningful Rewording Chunking and Sequencing Rehearsal				
	FACT	CONCEPT	PROCESS	PROCEDURE	PRINCIPLE

Romiszowski (1981:308) presented an approach to method selection that combined many elements of the approaches outlined above. Figure 2.5 displays this approach.

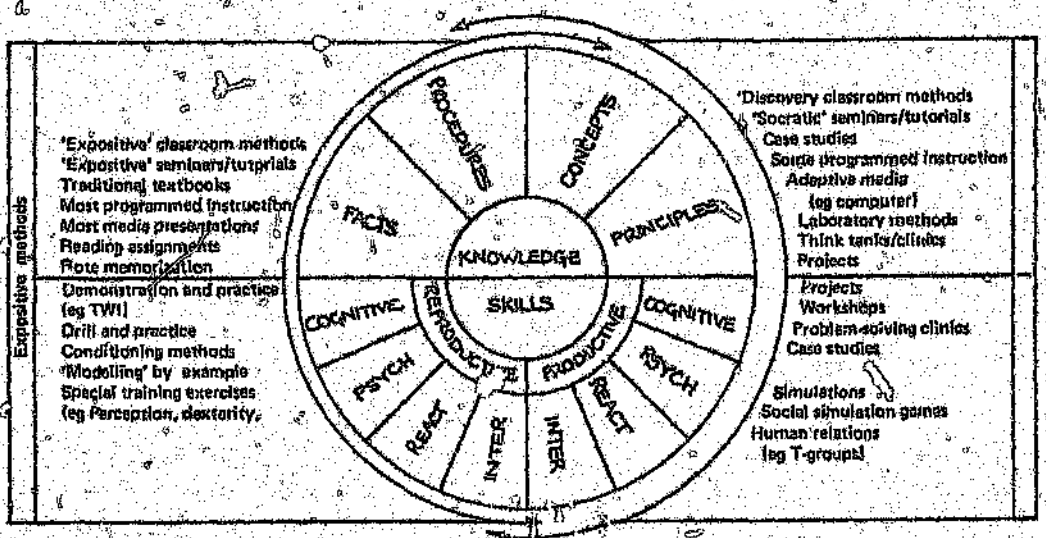

Figure 2.5: Romiszowski's Schema for Method Selection

Working from the centre of Figure 2.5 outwards, it can be seen that:

* The first decision to be made is whether the required learning falls into the knowledge or the skills domain (Romiszowski blended attitudes into the skills domain as "reactive skills").
* If the learning is in the knowledge domain, the behaviour is classified into one of four types, ie facts, concepts, procedures or principles. This is based on Merril's classification noted above.
* A variety of methods is then recommended for each pair of types (some overlap is evident).
* Similarly, if the learning is in the skills domain, it is classified into one of two types, productive and reproductive, depending on whether the

behaviour calls for a degree of planning or not (if so, it falls into the productive category).

* The behaviour is then further classified into one of four categories, cognitive, psychomotor, reactive (ie "dealing with oneself") or interactive (ie "dealing with others") (Romiszowski,1981:253).
* Again, depending on the classification of the behaviour, a number of instructional methods are recommended.

The method selection knowledge base for the present study was based to a large extent on Romiszowski's approach (see Chapter 3).

A method selection decision often overlooked by designers of instruction is the possible use of job aids as alternatives to instruction. Lineberry (1977:89-90) outlined some of the advantages of using job aids, such as that:

* They are usually cheaper to produce and maintain than are training programmes.
* They can help to reduce the time required to master certain skills or knowledge.
* They can help overcome the need for learners to memorise many job-related details.

On the other hand, job aids may not always be suitable, since they can suffer from disadvantages such as:

* They can be lost or overlooked.
* They may not be understood or appreciated.
* They can interfere with the fluent performance of certain tasks.

Despite these disadvantages, however, job aids were considered important enough to be included in the

ES method selection component in the present study.

3. Media Selection

Media selection involves selection of the vehicle via which instructional content is conveyed to the learner. Media can range from the simple and relatively unsophisticated, such as the human voice, blackboard and chalk, or the printed word, to highly complex and sophisticated electronic equipment, such as CBT and optical disc technology.

One approach to media selection is based on Bruner's proposal (Bruner, 1966) that a learner's knowledge can be internally represented in one of three different ways:

* Enactive (based on the learner's actions).
* Iconic (based on a pictorial representation of knowledge).
* Symbolic (based on the use of language and symbols).

Following on from these three means of representation, Dale (1969) classified learning content presentation into twelve forms, namely:

1. Direct purposeful experiences
2. Contrived experiences
3. Dramatised experiences
4. Observation of demonstrations
5. Viewing of real situation/s
6. Exhibits of reality
7. Mediated reality (eg video)
8. Edited mediated reality (eg motion pictures)
9. Still pictures
10. Recordings (eg cassettes) and radio
11. Visual symbols
12. Verbal symbols.

Dale's twelve forms of representation follow Bruner's classification in a narrowing "cone of experience", with forms 1 to 3 being regarded as enactive, forms 4 to 9 iconic, and forms 10 to 12 enactive (Park 1983:56). The identification of which type of internal representation of knowledge a learner requires provides a guide to the medium needed to deliver the instruction.

One advocate of the use of Dale's cone of experience as a guide to materials (ie media) selection was Knowles (1980:244). Since one would not expect the learner to be able to decide into which category of internal knowledge representation his or her learning would fit, the media selection decision would, presumably, be left up to an expert in ID. This, I would suggest, is somewhat at odds with Knowles' criticism of the use of mechanistic and prescriptive techniques in the design of instruction for adult learners (see pp2.4-2.5).

Another approach to media selection was adopted by Gagne and Briggs (1974). They proposed that the nature of the stimuli to be found within a lesson implied the use of a particular type of medium for that lesson. For example, if the lesson contained printed words, the media options included books, programmed instruction, handouts, charts and checklists. On the other hand, if the lesson contained spoken words, the media options included teacher, tape recordings and video.

In another approach to media selection, Schramm (1967) advocated that an early distinction be drawn between what he referred to as "big" (ie mass) media and "little" (ie face-to-face) media. Building upon Schramm's distinction, Romiszowski (1981:345) produced

a "schema for initial media selection decisions", upon which the media selection component of the ES in the present study was originally based. This schema is represented in Figure 2:6. Working from the inside of the diagram outwards, the initial selection to be made is between "big" and "little" media. Then, depending on whether the message to be transmitted involves information (one-way communication) or instruction (two-way communication), and whether a fixed or a flexible presentation is required, a variety of media options are provided, as indicated in the diagram.

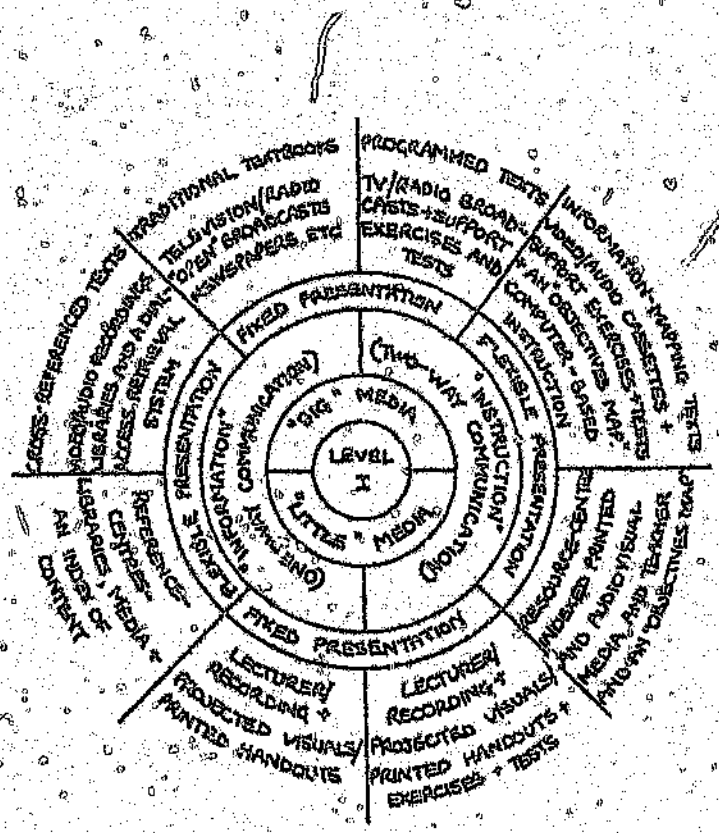

Figure 2:6: Romiszowski's Schema for Initial Media Selection Decisions

A pragmatic approach to media selection has been proposed by Clark and Clark (1986). The approach was based on the assumption that, given sufficient resources (time, expertise, finance etc), almost any medium, within certain bounds of reason, could be used to deliver almost any form of instruction. This leaves the designer of instruction free to select media more in terms of factors such as resources available, numbers and distribution of the learner population, and learner preferences. Many aspects of this approach were incorporated into the media selection knowledge base in the present study.

2.3.4 A Critique of the ISD Model

Two common criticisms of the ISD model have been singled out for attention. These relate to the model's alleged tendencies towards:

1. Prescriptiveness
2. The Stifling of Creativity.

1. Prescriptiveness

It has been argued that the ISD model adopted in the present study represents a prescriptive approach to adult learning. For example Gery (1990:40) has criticised the ISD model on the grounds that it involves assumptions that:

* The learning audience can always be specifically defined in terms of needs, entry knowledge, skills and motivation.
* Specialists can independently determine what people need or want to know.
* The judgment of these specialists is superior to the judgment of the learners themselves.

Similarly, Brookfield (1986:231) criticised the ISD model (which he refers to as "the institutional model") on the grounds that:

* The model is too simplistic - it fails to take account of the complexity of real life outside the training situation.
* There is too much reliance on "prespecified objectives", implying that the professional educator knows best what must go into the learning situation.

Nadler (1982:6) distinguished between what he referred to as open and closed approaches to the design of instruction. An open approach tends to acknowledge explicitly the existence of external influences (such as the individual learner's wants and needs) on the design process, influences beyond the direct control of the designer. A closed approach is based on the assumption that all influences can be identified and controlled by the designer, during the design process.

According to Nadler, the ISD model is an example of a closed approach. An assumption underlying its use is that the designer of the instruction possesses all that is required for successful design, without having to turn to, for example, the learner, for any additional inputs. Again, the issue of prescriptiveness is highlighted, with the implication that this leads to the exclusion of the learner from the ID process.

2. The Stifling of Creativity

Brookfield (1986:206-209) criticised the ISD model on the grounds that once objectives have been "prespecified", they tended to become reified and inflexible, thus inhibiting unplanned or spontaneous learning events from taking place.

A similar criticism was forthcoming from Eisner (1985:32-37). Eisner was, however, careful to differentiate between instructional objectives - normally specified during the ID process, and appropriate for skills training - and what he referred to as expressive objectives - not initially specified, but emerging from the individual training encounter, and appropriate for broader, less-focused adult learning activities.

In summary, a number of writers in the field of adult learning, have aired concerns about the issues of prescriptiveness and the stifling of creativity in the ISD model, and the possible effects of these issues on adult learning. An attempt to examine the implications of these concerns will be made later in this report.

In this chapter, a review of some of the concepts and the literature relevant to the present study was undertaken. Chapter 3 describes the methodological approach adopted in this study.

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CHAPTER 3 - METHOD

This chapter will begin with an overview of the research methodology and data collection and analysis techniques employed in this study. This will be followed by a detailed description of the development and evaluation of the ES.

3.1 Research Methodology

The investigation consisted of a case study of the development and subsequent qualitative evaluation of the ES. Lessons learned from the development and evaluation of prototypes of the ES were applied in subsequent development, in a cyclical, iterative process reminiscent of the process of formative evaluation common to the development of instruction (see Chapter 2). In this section, the following topics will be examined:

- 3.1.1 The Methodological Approach
- 3.1.2 Outline of the Research Process
- 3.1.3 The Research Design
- 3.1.4 Prototyping

3.1.1 The Methodological Approach

The overall methodological approach adopted in this study tended towards the qualitative end of what Patton (1978) described as a continuum between the extremes of qualitative and quantitative approaches to research and evaluation.

It has been claimed that the two extremes of this continuum are founded on two quite different paradigms (Kuhn, 1970;

Guba and Lincoln, 1983:315-317; Carr and Kemmis, 1986:89; Patton, 1980:223).

During the 1970s, Patton (1978) described the "natural sciences" paradigm as being dominant in research. This paradigm involves a hypothetico-deductive methodology and "assumes quantitative measurement, experimental design, and multivariate, parametric statistical analysis to be the epitome of "good science" (Patton, 1980:219). An obvious similarity exists between this paradigm and the structural/functionalist paradigm described in Chapter 2 of this report.

An alternative paradigm described by Patton (1978) was the "holistic-inductive" paradigm. This paradigm assumes a less rigidly controlled methodology, and seeks to provide a more descriptive, subjective, and holistic picture of the phenomena being studied, often sacrificing tighter experimental control and justification (Eisner, 1985:183; Patton, 1980:225). A parallel can be drawn between this paradigm and the interpretive paradigm described in Chapter 2 of this report.

In the present study the approach deriving from the natural sciences paradigm is referred to as a quantitative approach, and that deriving from a holistic inductive paradigm as a qualitative one.

Since a more qualitatively oriented approach was adopted in this study, the reader can expect a more context-oriented, subjective and descriptive style of presentation (examples include the use of the personal pronouns "I" and "me" to describe the writer, and frequent reference to the individual comments, interpretations and feelings of members of test groups used in the study). This is what Eisner (1985:112) described as a "thick" research presentation style, which he contrasts with the more economical,

impersonal and objective, "thin" style more typical of a quantitative approach.

The reader can also expect less attention to be paid to the identification, experimental manipulation and control of dependent and independent variables, to sample selection techniques, and to quantitative, numerical measurement, recording and analysis of data. The study can be expected to focus more on emergent, unanticipated and unquantifiable events and outcomes.

One reason for adopting a qualitatively oriented approach in the present study was my belief that the subject of the study was of an exploratory, [illegible]ative and emergent nature. Several proponents of a qualitative approach have pointed out the value of this approach to research of this nature (Eisner, 1985:184; Guba and Lincoln, 1983:318-220).

A further reason for adopting a more qualitatively oriented approach in this study concerned the characteristics of the sample of potential users of [illegible]S. The limited numbers and availability of sample ES[illegible] users made sample selection by means of random selection or matching awkward. The data derived from samples of users was, therefore, not considered acceptable for the production of meaningful inferential statistics, in terms of criteria of random selection and sample size and composition (Huysamen 1981:225-227).

A phenomenon noted in qualitative studies has been the gradual emergence of focus, a narrowing-down of the field of study from the general towards the more specific, and even, at times, a shift towards a more quantitative methodology (Bogdan and Biklen, 1982:59; Britan, 1978:231). It was expected that the present study would follow a similar pattern, moving from a broad, poorly-defined area of

investigation and relatively unstructured methodology towards a more specific area of investigation and a more structured methodology.

3.1.2 Outline of the Research Process

The research process can be regarded as consisting of two separate but intertwined components, namely development and evaluation:

1. The Development Component

A cyclical, iterative approach was followed during the development of the three ES prototypes and the completed ES. Figure 3.1 presents an outline of this approach

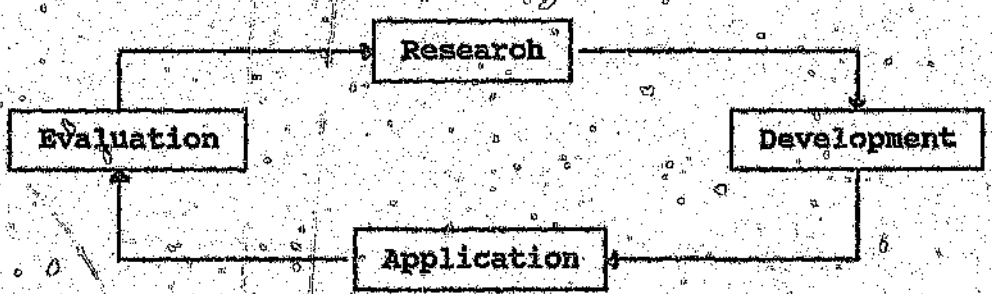

Figure 3.1: Outline of the Development Process

Briefly, the first step in the process involved research into the ES technology and into the subject-matter (various aspects of the ID process) of the knowledge domains selected. This was followed by development of a particular ES knowledge domain prototype, and its application and evaluation, using a sample of users. The results of the evaluation were then used as feedback for the following iteration of the development cycle. This process was repeated for each ES prototype. The cycle was then repeated using all three prototypes combined into a complete ES.

2. The Evaluation Component

Within the development component, another process was taking place. Figure 3.2 presents a graphical outline of this process.

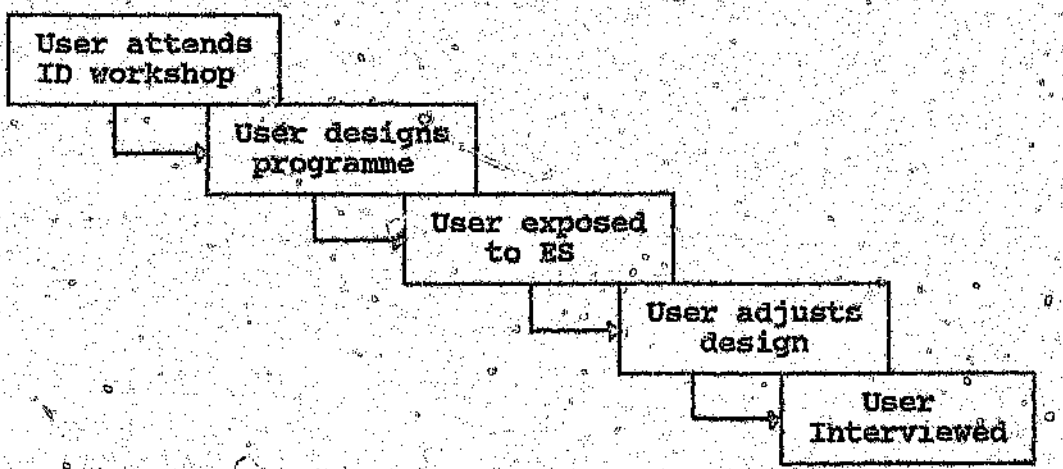

Figure 3.2: Outline of the Evaluation Process

Briefly, each user was selected from a class of bank trainers attending an ID workshop. As an individual exercise in the workshop, the user was required to design a training programme, using the ID document (see Appendix B). No more than fourteen days after attending the workshop, the user was exposed to the ES (or one of its prototypes) under observation, and invited to make alterations to his or her original programme design if desired. The user was then interviewed, and his or her reactions to, and suggestions about, the ES were noted.

3.1.3 The Research Design

The investigation was modeled on a case study approach. The design employed was an iterative derivation of what has been referred to as the "One-Shot Case Study" design (Hatch and

Farhady, 1982:19-20; Huysamen, 1981:96-97), in which "a single group of individuals is subjected to the treatment of interest" (Huysamen, 1981:96).

The case study approach has been described as being a "nonexperimental" (Huysamen, 1981:96; McGuigan, 1968:57) or "pre-experimental" (Hatch and Farhady, 1982:19) research design. In this approach, there is less-than-ideal control over intervening variables[1] such as:

* Historic events occuring at the same time as the research.
* Spontaneous changes to the experimental variables.
* Subjects' awareness of being participants in the research, the so-called "Hawthorne effect" (Huysamen, 1981:97).

This approach is therefore open to criticisms relating to lack of experimental control, reliability, validity and generalisability.

The case study approach has also been referred to as the "clinical method" or the "life-history method" (McGuigan, 1968:57). In the present study, the life-history that was traced and described was that of the ES, ie its development and evaluation.

In compensation for its lack of experimental control, the case study approach has been claimed to be "insight-stimulating" (Selltiz et al, 1965:59-60), particularly useful for the subsequent generation of more formal hypotheses. In the present study, it was this stimulation of insight that I felt was required in order to approach the emergent and complex field that I had chosen to investigate.

To help counteract at least some of the effects of a lack of

experimental control in the present study, the principle of triangulation (see section 3.2.5 later) was practised wherever possible.

A somewhat more experimental approach to the research design was introduced during the evaluation of the ES and its prototypes. Here, a primitive form of Before-after design[2] was employed to isolate some of the effects of the ES on users' instructional designs. At that juncture in the study, the dependent variable, ie the instructional designs produced by users of the ES, were examined both before and after exposure to the independent variable, which was the ES (see Figure 3.3).

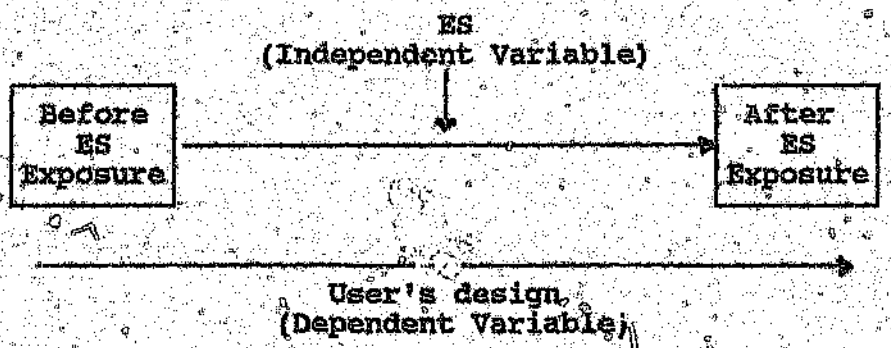

Figure 3.3: Outline of Before-after Research Design to Ascertain Effects of ES on Users' Instructional Designs

As regards the sample selection techniques employed in this study, as already stated in section 3.1.1 above, the limited size and availability of potential users of the system resulted in an "as and when available" approach having to be adopted. Since no attempt was made to select subjects either via randomization or matching procedures, this again lays the study open to criticism regarding lack of experimental control.

3.1.4 Prototyping

Prototyping is frequently encountered in the literature for use in the development and testing of computer software such as an ES (Ellis, 1990). This technique consists of creating one or more unfinished, but operational, models or prototypes of either the entire ES, or of only a part of it, for testing and demonstration purposes.

Some benefits of prototyping include:

* A prototype can be created and tested with relatively limited initial commitment of development resources (ie time, expertise, software and hardware).
* A version of the ES can be developed in a relatively brief period of time to demonstrate progress to the sponsors of the development project (ie management, in the present study).
* Lessons learned during the development and evaluation of each prototype can be incorporated in the development of the final version of the ES.

3.2. Techniques Used in Data Collection and Analysis

In this study, the following data collection and analysis techniques were used, and will be discussed below:

3.2.1 Field Notes (The Logbook)
3.2.2 Unstructured Observation
3.2.3 Focused Interviewing
3.2.4 Content Analysis
3.2.5 Triangulation.

3.2.1 Field Notes (The Logbook)

Field notes, in the form of a logbook, were maintained throughout the course of the study. This logbook contained a record of all events and occurrences considered relevant to the study.

According to Bogdan and Biklen (1982:84), the content of field notes can be classified into two distinct categories: descriptive items of information, and reflective items. Descriptive items are manifest, observable events in the study, external to the researcher. Reflective items of information involve the thoughts and feelings experienced by the researcher.

Descriptive events in the present study included:

* Transcripts of interviews and discussions with people who became involved with the ES.
* Observations of the behaviour of users of the ES.
* A record of the actual development and evaluation process of the ES.

Reflective aspects of the field notes included:

* An account of my own thoughts, feelings and experiences during the development and evaluation of the ES.
* A record of the decisions that I made as sole developer and interpreter of evaluation information in the study, and my reasons for making these decisions at that particular time.

3.2.2 Unstructured Observation

During the evaluation of the prototypes and final version of the ES, the reactions of users to the ES were noted by means

of unstructured observation. According to Selltiz et al (1965:221), observation can be termed unstructured when the observer does not use predetermined categories of behaviour in order to focus the observations. In this way, unstructured observation can be distinguished from a more structured type of observation, where the occurrence of an explicitly defined set of events might be sought and their frequencies of occurrence recorded.

Selltiz et al (1965:207) noted that unstructured observation was often used as an exploratory technique in research. It was because of the tentative, exploratory nature of the present study that this technique was considered to be appropriate.

One potential problem with the recording of unstructured observations involved deciding which observations to record and which to omit. This selective recording can be regarded as a form of sampling bias, and will be discussed, together with the issue of investigator bias, in Chapter 5.

3.2.3. Focused Interviewing

Focused interviewing can be described as lying intermediately between structured interviewing and unstructured interviewing (Selltiz et al, 1965:263).

Unlike structured interviewing, focused interviewing does not depend on a predetermined set of questions to be presented to the interviewee in a predetermined pattern. Instead, the interview becomes open-ended in its format, following a different path upon each specific instance.

However, rather that being completely unstructured, interviews conducted with users of the ES in this present study contained a number of focus questions prepared beforehand (see Appendix E). I sought satisfactory answers to these questions during the course of the interview with users of the ES by asking further, probing questions where I deemed this to be necessary.

Although the primary purpose of the interviews was to gather data for this study, another purpose was to debrief users of the ES, by answering any questions they wished to raise about the system and by allaying any residual anxieties or doubts they may have been experiencing about the system.

3.2.4 Content Analysis

The content analysis process is described in section 3.3.9 of this chapter.

3.2.5 Triangulation

A particular problem associated with qualitative investigations is the lack of credibility that tends to be associated with a non-quantitive approach (Guba and Lincoln, 1983:327). One means of enhancing the credibility of the findings is by triangulation of sources of information.

Triangulation has been described by Zuboff (1988:128) as "a continual juxtaposition and comparison of data culled from distinct sources that purport to describe the same phenomenon." The assumption underlying this technique appears to be that the more sources of information used to derive and confirm the findings of a study, the greater the accuracy and credibility of those findings.

To achieve triangulation in the present study, information was gathered from a variety of sources, ranging from field and observation notes and interview transcripts, to computer printouts of the results of ES consultations and the instructional design documentation of Bank trainers.

3.3 Development and Evaluation of the ES

The development and evaluation of the ES will be described under the following headings:

- 3.3.1 From AI-Based System to ES
- 3.3.2 Selecting the ES Software
- 3.3.3 Defining the Knowledge Domain
- 3.3.4 Deriving the Knowledge Base Rules
- 3.3.5 Populating and Testing the ES
- 3.3.6 The Evaluation Samples and the ID Workshop
- 3.3.7 The ES Consultation Sessions
- 3.3.8 Ensuring Triangulation
- 3.3.9 The Content Analysis Process.

3.3.1 From AI-Based System to ES

My original intention was to produce a comprehensive, computerised AI-based ID system to guide users through the analysis and design of a programme of instruction. My early attempts to produce such a system by programming it in various computer languages drove home to me the difficulty of doing so without a considerable investment in time and expertise, neither of which I had at my disposal. Instead, therefore, of producing a completely original system, I developed a limited-domain ES, using pre-programmed ES software. A detailed description of this development process is provided in Chapter 4 of this report, while Appendix C contains a description of the ES concepts and procedures covered in this section.

3.3.2 Selecting the ES Software

My first attempt at developing ES software was based on guidelines provided by Schildt (1987:104-114) for an ES shell written in the C computer language. I subsequently attempted to produce an ES shell in the BASIC computer language, based on a program by Leithauser (1987:200-204). I found that neither of the two rather primitive shells that I produced were suited to my requirements. Once created, the knowledge base of the C-based ES proved extremely difficult to edit, while the BASIC ES's operation was slow and cumbersome, and the ES had a very limited capacity to provide textual information to a user.

I subsequently acquired the commercially produced Level 5 ES software package, produced by Information Builders Inc. of California, USA. Since this software possessed its own supporting computer language (called PRL for "Production Rule Language"), I hoped to produce an ES that could be adapted to suit both my initial requirements and those expected to emerge during the course of the study. My specific reasons for choosing the Level 5 ES software are outlined in Appendix C.

3.3.3 Defining the Knowledge Domain

The process of defining the knowledge domain (as described in Appendix C) is discussed under three headings:

1. Identifying an Appropriate Knowledge Domain
2. Defining the Overall Goal of the ES
3. Establishing the Scope and Content of the Knowledge Domain.

1. Identifying an Appropriate Knowledge Domain

To ensure that ID as a topic would lend itself to an ES application, I examined two sets of criteria:

a. Whether the knowledge bases would include the performance of either synthesis or analysis functions (see Appendix C).

b. Rich's (1983) criteria for an appropriate knowledge domain (see Appendix C).

a. As regards the requirement for either analysis or synthesis functions to be performed to justify the use of an ES (Siegel, 1989:18), I concluded that a competent instructional designer would need to perform both. Activities such as needs analysis, target learner population analysis and task analysis can be cited as examples of analyses. The formulation of instructional objectives, and the creation of tutorial material using an appropriate blend of content, methods and media, are examples of syntheses. In terms of Siegel's criteria, therefore, the domain of ID appeared to be suited to an ES application.

b. Rich (1983:38) has listed several criteria for determining whether a knowledge domain was suited to an ES application:

* Bounded domain - the overall ISD process would be difficult to restrict to a neat and bounded domain. The process of designing effective instruction could involve accessing and applying information from many other fields of knowledge. Media selection, for example, might require expertise in video production or CBT technology, and a needs analysis could call for a specific understanding of the managerial style prevalent in a particular part of an organisation. To overcome the difficulty of a poorly bounded knowledge

domain, severe limitations upon the scope of the ES were imposed, and as already noted, the final ES was limited to only three ID components. Later in this report it will be seen that even within the three areas chosen, the scope had to be clearly defined and severely bounded.

* Decomposable problems - from my experience in ID, I considered that the issues and problems likely to be encountered within the domain of the ES would indeed be decomposable into a series of production rules (see Appendix C for an explanation of the terms 'decomposable' and 'production rules'). In support of my own beliefs in this regard, a number of writers, upon whose work I based much of the ES knowledge bases, presented aspects of the ID process in terms of conditions and decisions that could be reduced to production rules (see, for example, Chapter 2, section 2.3.3).
* Non-rigorous solutions to problems - again, based upon my experience and reading in the field of ID, I concluded that any recommendations that the ES proposed would have to be based on the demands of each specific training situation, and that there would be no room for simplistic, generalised or inevitable solutions to problems.
* Uncertainty of relationships and data - the wide range of possible training problems and possible solutions to these problems, plus the fact that ultimately ID was intended to address the needs of individual human beings, left me in little doubt that the knowledge bases would have to cater for uncertainty in regard to relationships and data.
* Information subject to a high rate of change - the field of ID is forever undergoing changes. In the area of media selection, for example, rapid technological changes call for constant reviews of the media available.

Therefore, in terms of Rich's criteria, the domain of ID seemed be suited to an ES application, provided the domain boundaries were clearly defined and delimited.

2. Defining the Overall Goal of the ES

The overall goal of the system developed in the present study was subjected to a number of changes over time. The original intention was to guide a trainer, inexperienced in ID, through the entire ID process. However, as is described in Chapter 4, it became evident during the early stages of development that this goal was too ambitious. The result was a decision to restrict the goal of the system to providing assistance to the user in only three areas of ID: needs analysis, method selection and media selection.

The formal goal definition that emerged from the study was that spelled out to users on the introduction screen of the complete ES, namely:

> This system has been designed to help you go about designing an instructional programme. It will ask you a series of questions about the programme, and then it will provide a number of recommendations about the need in the organisation for the programme, some possible instructional methods you could use, and one or more instructional media that you might wish to use to deliver the programme.

3. Establishing the Scope and Content of the Knowledge Domain

The scope of the knowledge domain was established by mapping the main concepts of each of the three ID areas (ie needs analysis, method selection and media selection). Using single key words to represent them, the main concepts to be included in each area were noted in the form of spider diagrams (see Appendix C).

As with many other aspects of the ES development, establishing the scope of the ES was an iterative process. The scope was adapted as my experience with both the ES development process and the specific topics in the ID process grew, over a period of several months.

To help me decide what information to include in, or exclude from each area of the ES, I relied both on the literature about that area, and on my own experience. The resulting spider diagrams contained a miscellany of concepts from a variety of sources, as outlined below:

a. Needs Analysis - Figure 3.4 on page 3.18 shows a spider diagram of the main concepts of the needs analysis domain. As can be seen, a primary distinction is made between training related and non-training related aspects of an organisational performance problem.

The non-training-related aspects are further subdivided into those arising from problems in the work and personal situation, such as:

* Job definition issues
* Recruitment practices
* Working conditions
* Management or organisational issues
* Reward or recognition practices
* Marriage or other domestic issues
* Substance abuse
* Travelling to work
* Personality adjustment problems.

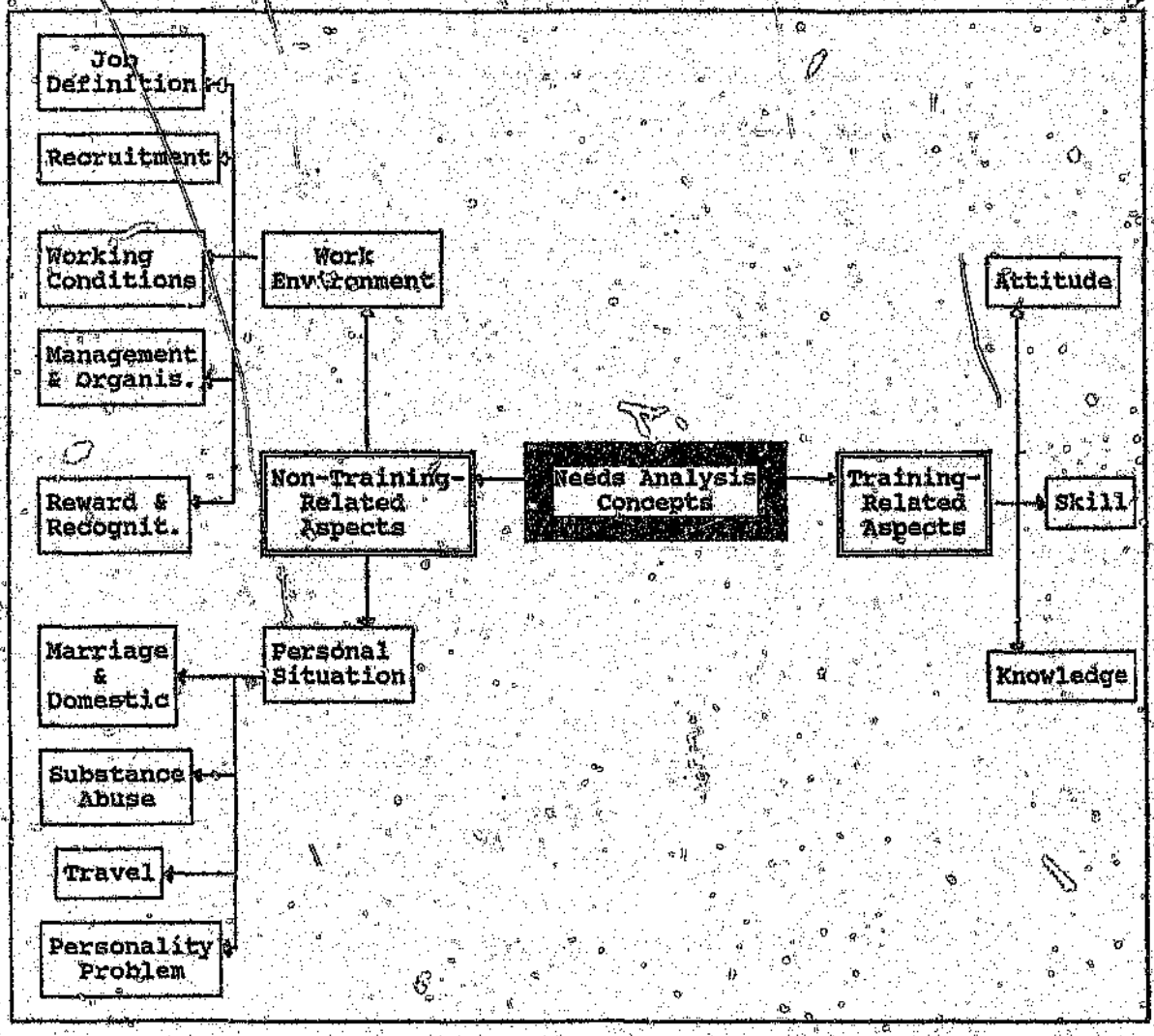

Figure 3.4: Needs Analysis Knowledge Base Spider Diagram

The training-related aspects of an organisational performance problem were treated as having arisen from deficiencies of skills, knowledge, or attitudes relating to the performance of a job or task.

As noted in Chapter 2, the needs analysis knowledge base was based on the work of Mager and Pipe (1970). For the ES, however, more emphasis was placed on the distinction between issues that could be addressed by means of training and those that could not. One reason for my emphasising this distinction was that, in many cases in the past, I had been requested to design and develop training for performance problems that could have been better addressed by some non-training related intervention.

In addition, a clear distinction was drawn between training related problems resulting from a lack of skills, of knowledge, or of appropriate attitudes, while Mager and Pipe's focus appears to be on the identification of skills deficiencies only.

b. Method Selection - Figure 3.5 on page 3.20 shows a spider diagram of the main concepts of the method selection domain.

As can be seen, a basic distinction is drawn between the type of instructional strategy to be adopted (expositive, discovery or use of a job aid - see Chapter 2). Each of these strategies is accompanied by keywords denoting criteria for the selection of a particular strategy type. Another basic distinction made is between three learning domains (skills, knowledge or attitudes).

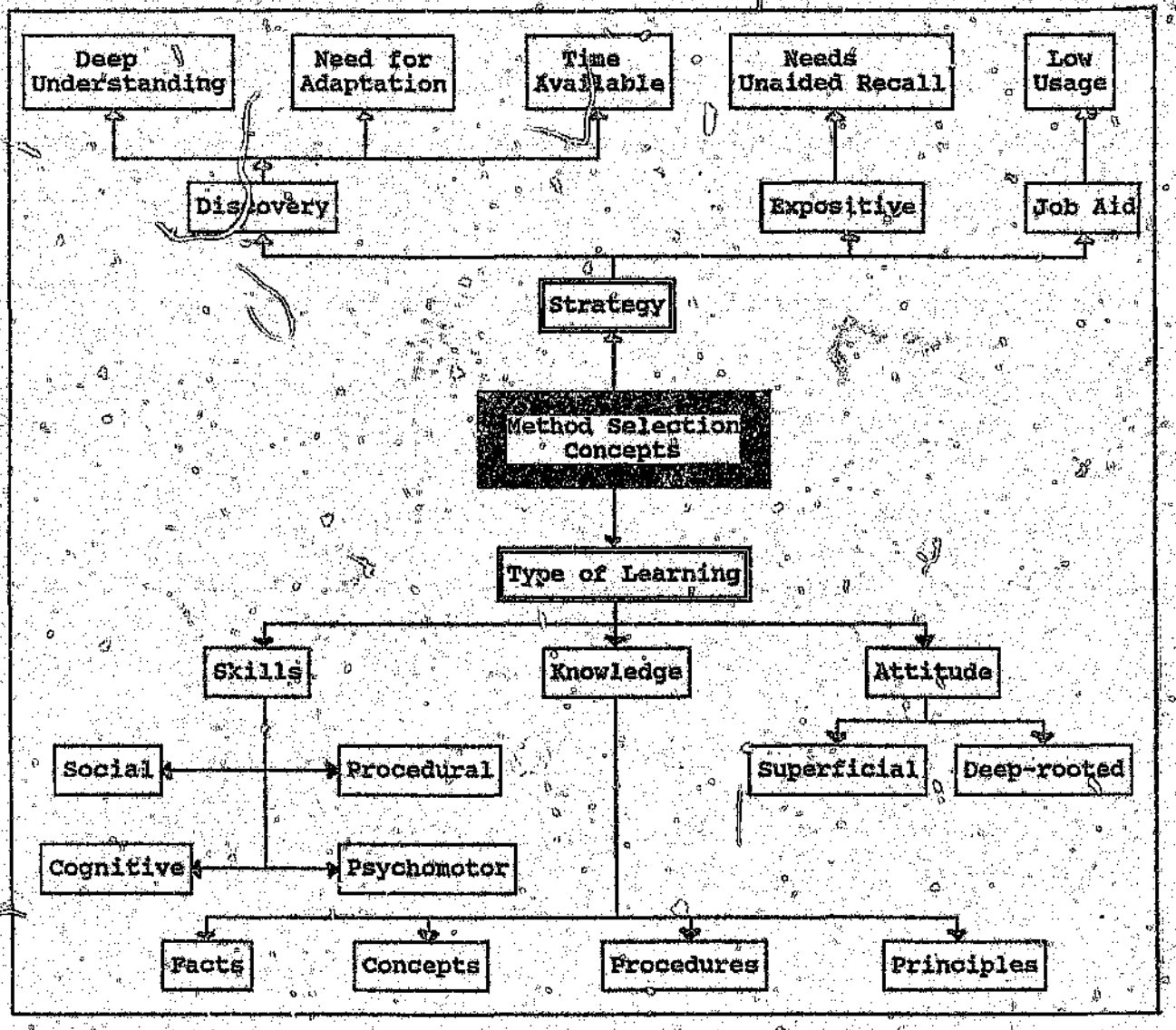

Figure 3.5: Method Selection Knowledge Base Spider Diagram

Both of the distinctions described above, as well as the categorisation of skills into four types (social, procedural, cognitive or psychomotor) and the categorisation of knowledge into four types (facts, concepts, procedures and principles), are in keeping with the method selection schema produced by Romiszowski (1981:308).

What I did add to the ES method selection domain that did not conform to Romiszowski's schema was a category for attitudes, subdivided into superficial attitudes and deep-rooted ones. This addition was to allow the method selection knowledge base to conform to the teachings in the ID workshop, where a distinction was drawn between methods suited for teaching skills, knowledge or attitudes, as advocated, inter alia, by Binstead (1987:28).

c. Media Selection - Figure 3.6 on page 3.22 shows a spider diagram of the main concepts of the media selection domain.

As can be seen, Schramm's distinction between "big" (mass) media, and "little" (face-to-face) media (Schramm, 1967) was preserved. "Big" media were subdivided into types, including:

* Mass lecture
* Video
* Workbook
* Other.

"Little" media were subdivided into:

* Distance learning media, including technology based media, and non-technology based media.
* Classroom based media, involving local trainers, visiting trainers employed by the Bank, or external consultants.

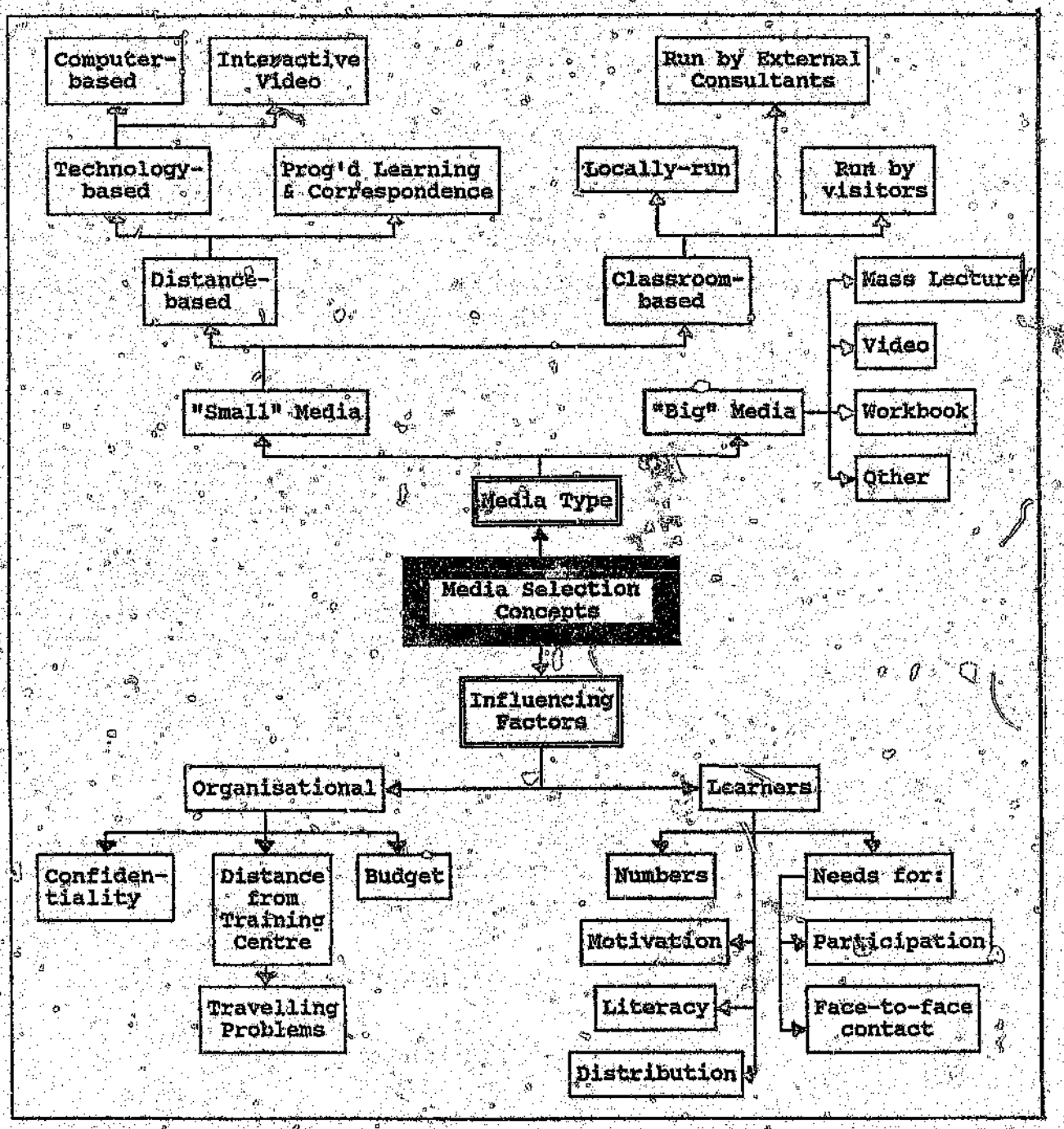

Figure 3.6: Media Selection Knowledge Base Structure Diagram

Also included in the media selection spider diagram are a number of factors that I believed needed to be considered in media selection decisions, including:

* Organisational factors, such as the need for confidentiality (important in the competitive and security-conscious banking environment), distance of learner from nearest training centre, and funds available for training
* Learner factors, such as number of learners, their motivation level, literacy level, physical distribution around the country, and needs both to participate in the training process and for face-to-face contact with the trainer.

3.3.4 Deriving the Knowledge Base Rules

I decided to adopt a production rule-based approach to knowledge representation because of the particular advantages enjoyed by this approach, as described in Appendix C, pages C.20 to C.21:

* Rules are usually explicit and thus relatively easily understood by non-experts in AI technology.
* The structure of rules appears to be a natural way for human beings to express knowledge.
* Rules are usually modular, allowing for relative ease of adding, editing and removing of individual rules.

To arrive at a set of production rules, I first created a series of process charts (see Appendix Q), based on the spider diagrams. The process charts were created by repeatedly examining each spider diagram, to determine possible decision paths linking various concepts in each of the spider diagrams. Simplified versions of the process charts for the three areas of the ID process are presented in Figures 3.7, 3.8 and 3.9.

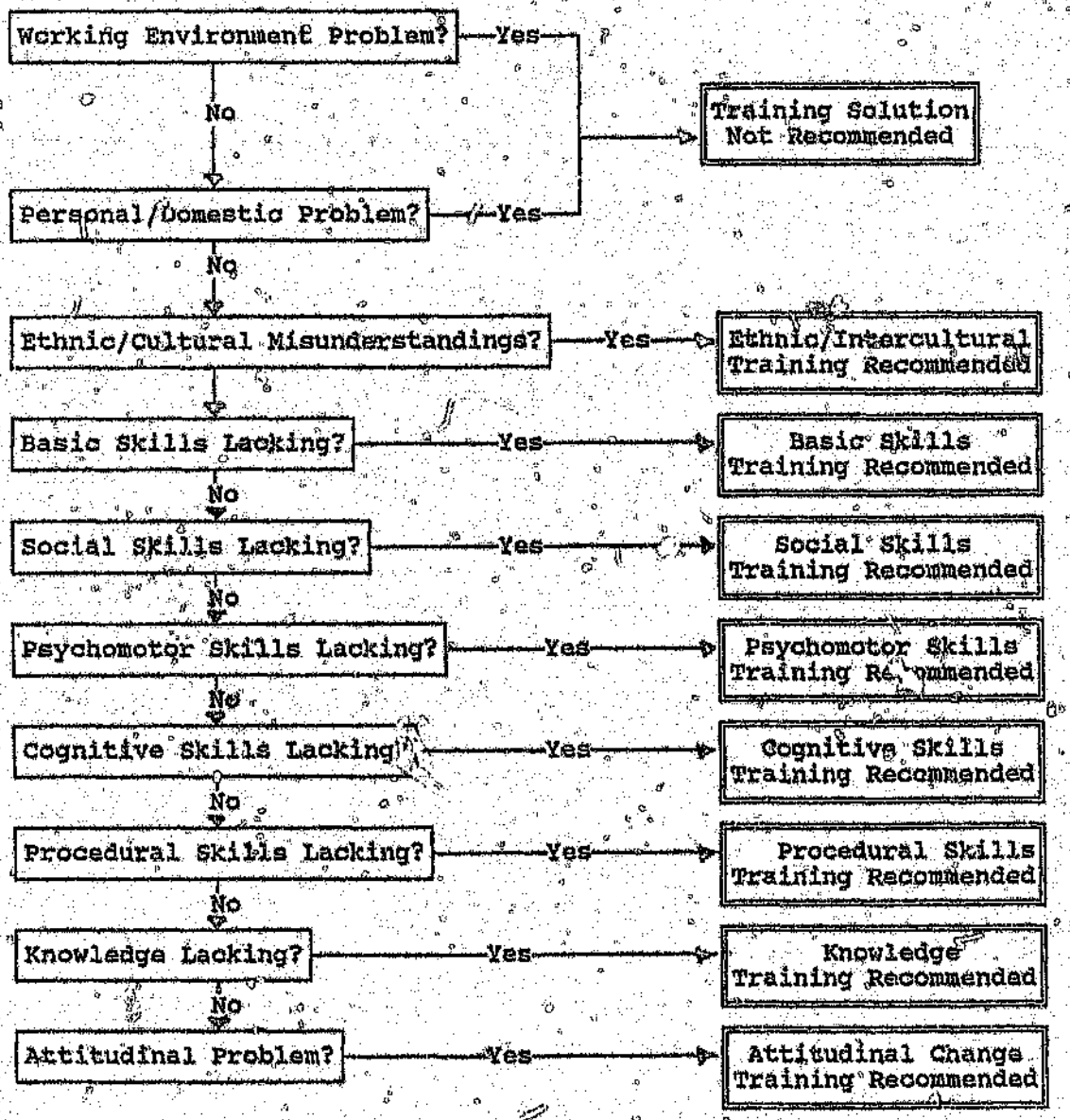

Figure 3.7: Needs Analysis Process Chart

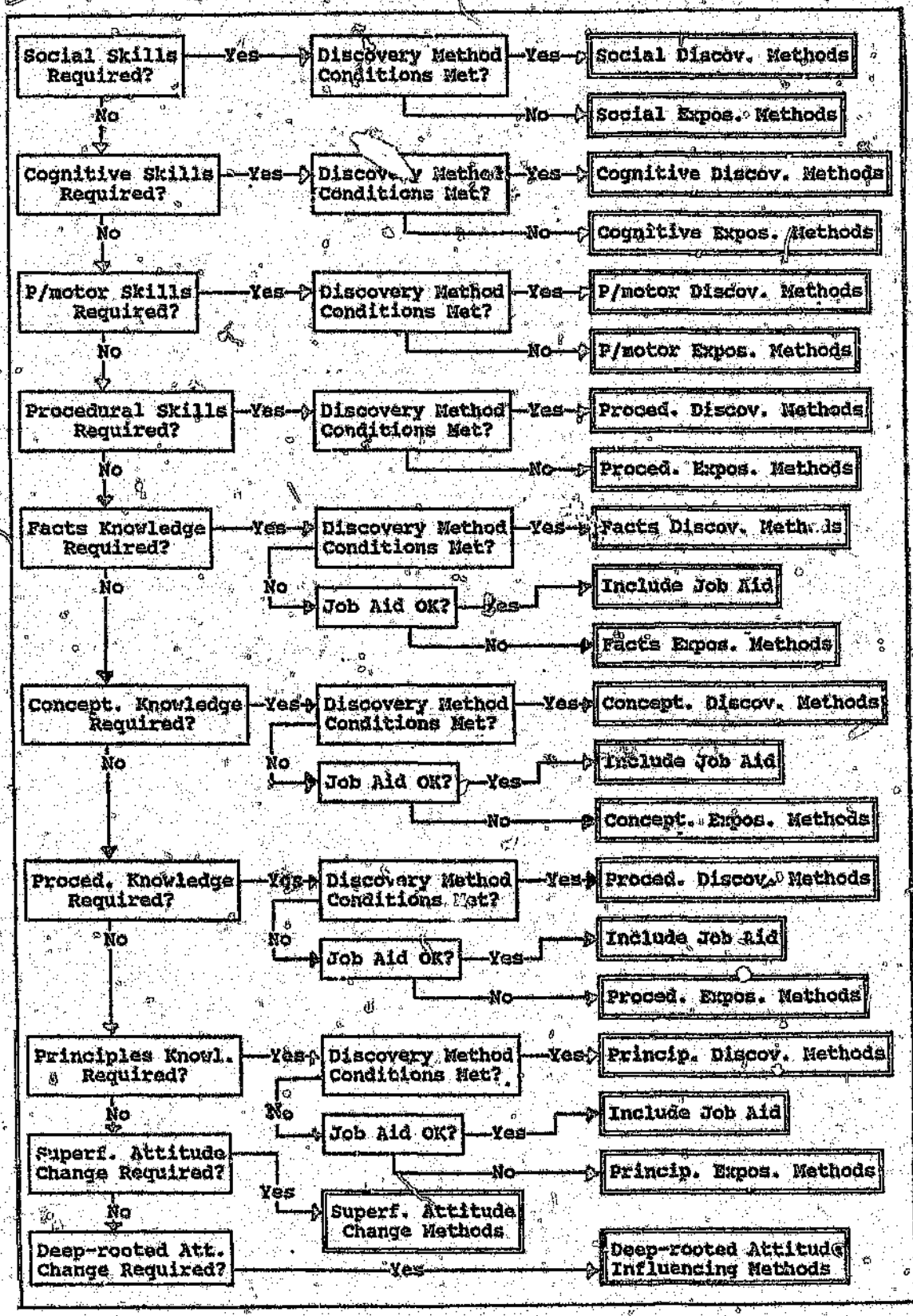

Figure 3.8: Method Selection Process Chart

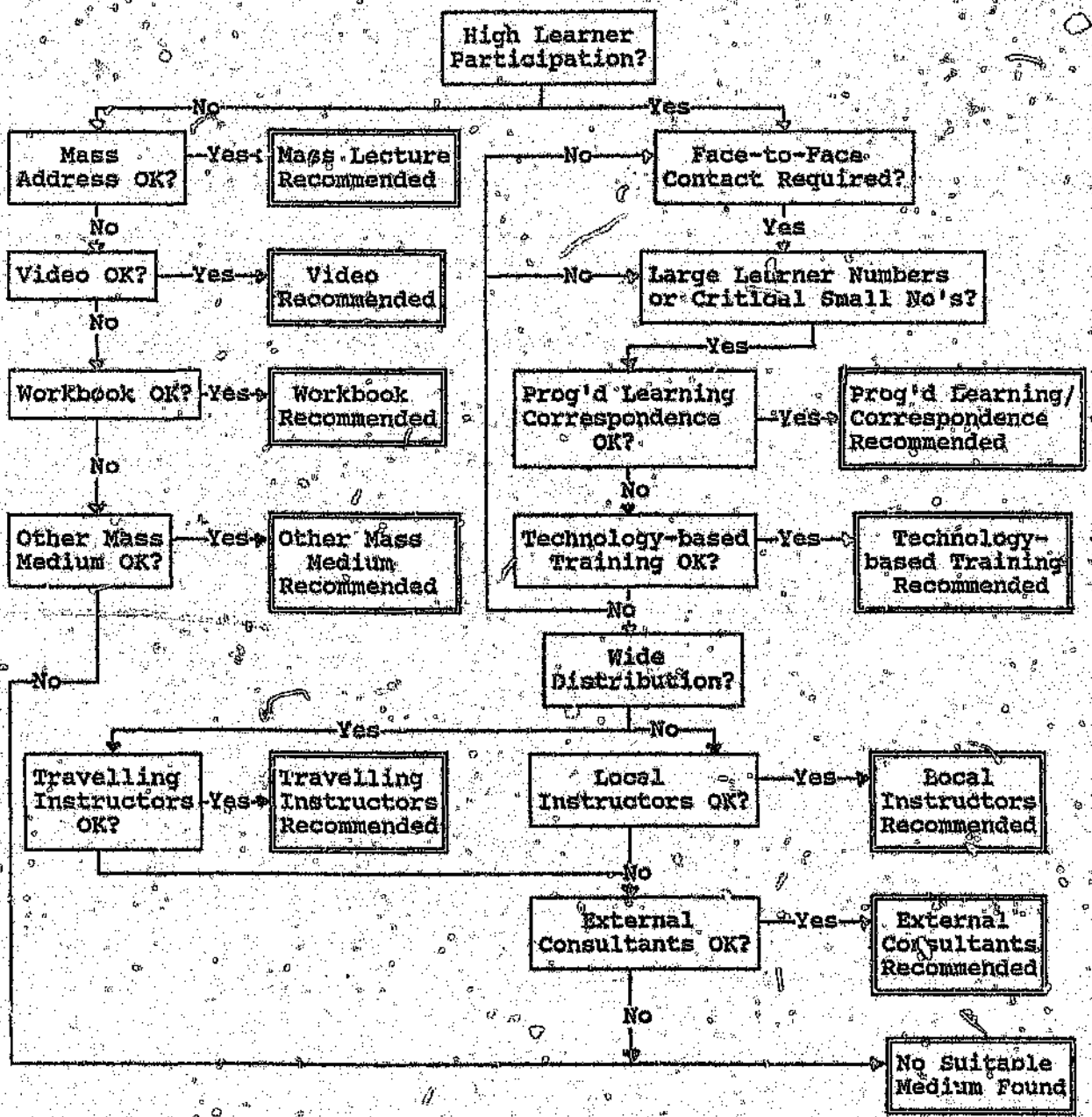

Figure 3.9: Media Selection Process Chart

In the needs analysis process chart (Figure 3.7), the process involved checking whether the problem being addressed was (mainly) due to the working environment, and if not, whether it was due to an individual's personal or domestic situation. If it was not, other possible causes of the performance problem were checked in turn, including ethnic/cultural misunderstandings, lack of basic, social, pyschomotor, cognitive or procedural skills, a lack of knowledge, or some attitude-related problem.

In the method selection process chart, (Figure 3.8) the process involved checking in turn whether the learning fell (mainly) into the social, cognitive, psychomotor or procedural skills domains, into the knowledge domain, either as facts, concepts, procedural knowledge or knowledge of principles, or into the domain of attitudes, either deep-rooted or superficial. If a domain was located, in most cases the next step was to establish whether the learning was more suited to discovery learning methods, use of a job aid (for the knowledge domain), or expositive learning methods.

In the media selection process chart (Figure 3.9), the process involved checking the need for high learner participation. If there was a low need, the suitability (in terms of conditions such as availability of resources etc) of various mass media was checked in turn (mass address video, workbook, other). If, on the other hand, a high need for learner participation was found, the need for direct, face-to-face contact was checked. If the need was low, the number of learners, or alternatively the degree to which the learning was critical to the organisation, was established, to check whether PI, correspondence or TBT were viable alternatives. If either the need for direct face-to face contact was high, or the numbers or amount of significance of the training to the organisation's survival were low, the viability of a number of face-to-face class-room media was

investigated, dependent to a large extent on the development and delivery resources available.

Once determined, each decision path was then translated into one or more production rules, declaring that IF certain conditions were found to apply, THEN a particular solution would be presented. As discussed in detail in Appendix C, a confidence factor ranging from zero to one hundred percent, representing the extent of my own confidence in the 'truth' of each rule statement, was also assigned to each rule.

In this way, a hierarchy of production rules was created. Initially, these rules tended to be sparse and roughly phrased. As each knowledge base developed, however, a noticeable increase occurred in the number of rules, the degree of sophistication of the wording in which the rules were phrased, and the intricacy of the relationships between conditions and actions. Appendix D contains a printout of these rules in their final form.

3.3.5 Populating and Testing the ES

Once sufficient rules for a particular knowledge base had been assembled, the next task was to create a prototype ES for that knowledge base, using the Level 5 ES software. Once a prototype had been created, I tested its operation by running through a series of dummy consultation sessions, providing varied fictitious answers to questions that the system required me to answer. In this way, numerous errors and omissions in the prototype came to light and were attended to.

The process of testing continued until I was satisfied that the particular prototype was ready for evaluation by representatives of the intended user population.

3.3.6 The Evaluation Samples and the ID Workshop

Groups of four Bank trainers were used to pilot test each of the prototype systems (one prototype each for the needs analysis, method selection, and media selection knowledge bases). A group of eight trainers was then used to test the complete ES, which consisted of a combination of all three knowledge bases.

The trainers had all attended one of a series of four four-day ID workshops, not more than two weeks prior to the evaluation session. The only criteria for selection as members of a particular ES test group were attendance at a workshop, and the criteria for attendance at that workshop itself, which were:

* That the delegate be a practising Bank trainer.
* That he or she have previously attended a five-day Basic Instructor's Workshop, run by the Bank, which provided an overview of the training function and a number of practical training techniques.
* That he or she have been assigned to design and develop some form of instructional programme for Bank staff.

Table 3.1 contains a list of selected details of the members of each of the evaluation groups. From this table, it can be seen that, of the twenty delegates:

* Ages ranged from twenty two to thirty four years.
* There were fourteen females and six males.
* Education levels ranged from Standard Ten to a Masters degree in Clinical Psychology.
* Amount of training experience ranged from none to over nine years (one hundred and eleven months).
* Amount of exposure to computers ranged from none to over two years (twenty seven months).
* Eleven delegates had previously been involved in some form of ID.

* The programmes that delegates were already designing or were about to begin designing varied enormously, ranging from clerical skills programmes to programmes intended to address intercultural diversity.
* Although all trainers of some sort, the jobs being performed by delegates ranged from middle management of a training unit to junior lecturer.

Table 3.1: Individual Details of Sample Users

Name	Age (years)	Gender Male=m Female=f	Highest Education Achieved	Experience (months) with:			Focus Area for ID Process
				Computers	Training	ID	
DD	32	f	MA (Clinical Psychology)	0	21	0	Intercultural Communications
SA	34	m	Standard 10	6	73	3	Clerical Skills (Forex)
SS	22	f	BA (Hons) (Psychology)	3	10	3	Interviewing Skills
TW	27	m	BA (Economics)	4	2	0	Planning Skills for Supervisors
KS	29	f	BA (Hons)	5	74	18	Clerical Skills (Credit Laws)
PH	28	m	Standard 10 + CAIB (x)	27	53	15	'Introduction to CBT' lesson
GA	31	m	Standard 10	14	12	4	Operation of microcomputer
IS	30	f	BA (Hons) + H.E.D.	0	98	16	Intercultural Communications
MJ	23	f	Standard 10	6	0	0	CBT computer orientation
RB	31	f	BA (English) + H.E.D.	0	111	2	Writing Skills
NB	22	f	BA (Social) + H.D.E.	0	5	0	New Employee Induction
IP	32	m	BA (Social Work)	14	87	23	Management Development
LA	26	f	B Comm.	1	6	0	Clerical Skills (Credit)
VS	28	f	Standard 10	12	21	5	Clerical Skills (Ledgers)
JN	34	f	Standard 10	18	27	34	Marketing Product Knolwldge
AE	27	f	BA (Hons) (English)	0	0	49	Basic Trainers' Workshop
CK	28	m	B. Comm.	1	13	0	Understanding Balance Sheets
ZM	34	f	Standard 10	15	3	0	Computerised Payroll System
GD	26	f	Standard 10	0	2	0	New Employee Induction
SE	31	f	Standard 10	2	51	0	Clerical Skills (Credit)

ID workshop delegates were used to evaluate the ES because the system was intended for use by Bank trainers who lacked experience in designing and developing instruction, but who could at least recognise the ID concepts referred to by the system, such as "needs analysis", "media", and "social skills training". Most of these concepts were not explained by the system itself. A modicum of theoretical knowledge of common concepts used in the ID process adopted by the Bank was therefore a prerequisite for using the system.

The stated terminal objective[3] of the ID workshops was:

> Upon successful completion of the workshop the learner will be able to analyse a performance problem, design an appropriate training solution, and develop at least one module of relevant instruction for that solution under the guidance of an experienced instructional designer.

It was intended that the final phrase of the above objective (underlined) could be replaced in time with "with the assistance of the Bank's Instructional Design Expert System."

One of the enabling objectives[4] of the ID workshops was that, upon successful completion of the workshop, each delegate would be able to complete an ID document (see Appendix A), to the satisfaction of the workshop facilitator (myself). This document consisted of a series of forms onto which the delegate had to enter information pertinent to the analysis and design of an instructional programme. The ID document requested information on the following:

* Needs analysis
* Target population analysis
* Job/task analysis
* Instructional objectives
* Method selection
* Media selection
* Testing strategies

During the ID workshops, delegates received instruction and performed exercises on the Bank's approach to ID, learning how to complete the ID document. At the end of the workshop, delegates were requested to use the document in the analysis and design of the instructional programme they had been assigned to produce. Dates were established with each individual delegate for a follow-up consultation session with myself, between five and fourteen days after completion of the workshops.

3.3.7 The ES Consultation Sessions

In this study, an ES consultation session is taken to mean an individual session during which a user employed the ES to arrive at one or more recommendations regarding a specific ID issue. The consultation session itself consisted of three phases:

1. Preparation
2. Consultation
3. Post-consultation Interview.

1. Preparation

Preparation involved ensuring that the facilities (testing location, hardware and software) were ready, as well as briefing and otherwise preparing users for the ES consultation session.

All consultation sessions were conducted in a private office at the Bank's headquarters in Johannesburg. The office was situated in a quiet area, insulated against external noises and interruptions. The ES was loaded, and ready to run, on an IBM-compatible personal computer. The two swivel chairs in the office were arranged so that the user sat facing the computer during

the session, but at other times could swivel around to where I would be sitting, one metre behind and slightly to the left of the user's chair, positioned so that I, too, could see the computer screen.

At the begining of a consultation session, after welcoming and seating the user, I read out the following instructions:

> During the first part of this session you will be asked to help us test a new computer program, to see whether it can help you to check out the instructional design that you have brought along with you....
> It is very important to keep in mind that we are testing the program and not you ... and we need your help to make sure that the program works properly and does what it should...
> I will be sitting in the chair just behind you all the time. I want you to try to run through the program on your own but if you really get stuck or don't understand what to do next, I will be here to help you. I will be making notes as you go through the program.
> After the program is finished we will discuss how it went, together with your experiences with the design exercise.
> To help us to test the program, we need you to do the following ...
> Make sure that you have a completed copy of your design document in front of you.
> Keeping the SAME PROBLEM or ISSUE in mind that you were looking to solve with your training program, answer the questions that the computer will ask you.
> Make a note of any problems or difficulties you might experience with the program's operation, instructions, language, logic or anything else.
> Feel free to make any alterations or additions you wish to your copy of the design document as you work through the program, but please use the GREEN PEN provided.
> Once you have worked through ALL sections in the program, I will tell you what to do next. DO NOT SIGN OFF from the computer program.
> To run the program, all you need to do is follow the instructions on the screen. The computer will tell you what to do next.
> Would you like me to read these instructions over again?
> Do you have any questions before you begin?

If requested to do so, I would repeat instructions, and attempt to answer any questions asked and allay any apparent anxieties. The user would then turn to the computer and the actual ES consultation session would begin.

2. Consultation

The first computer screen that the user saw was a standard Level 5 Software title screen. The user was requested on the screen to press the ENTER key on the computer keyboard to continue.

The following screen then displayed:

* The title of the ES, which was 'EXPERT ASSISTANT'.
* A brief explanation of the purpose of the ES and an overview of the consultation process that was to follow.
* A request that the user work through the consultation session with a specific ID issue in mind, and answer the questions posed by the system as they pertained to that issue.
* A note explaining how to answer the questions that the system asked, by using the SPACEBAR or ARROW keys to indicate their estimated percentage level of confidence in an answer, and then pressing the ENTER key.
* The instruction to press the F3 function key on the computer keyboard to begin the session.

Appendix D contains a printout of the instructions presented to users.

The following screen displayed the first of a series of questions that the user was required to answer, indicating his or her level of confidence in the replies. At the base of this and all subsequent screens

the following keypress options were shown:

F2 - "UNKN" - If the answer to a question posed by the system was unknown to the user, he or she could press Function Key 2 to skip the question and continue.

F3 - "STRT" - The user could press Function Key 3 to START an ES consultation session.

F6 - "WHY?" - If the user pressed Function Key 5, an explanation of why a question was being asked by the system (ie, what production rule or series of rules the system was attempting to process) would be shown on the screen.

F8 - "MENU" - By pressing Function Key 8, the user could exit the program to the main menu of the Level 5 software program. This allowed the user to restart the consultation session.

F9 - "HELP" - Pressing Function Key 9 would display a help screen explaining the effects of each of the keypresses currently being described in this report.

F10 - "EXIT" - The user could exit from the program by pressing Function Key 10.

Once the user had answered sufficient questions for the ES to provide a recommendation, that recommendation was presented on the screen. After reading this recommendation, the user could continue answering questions in order to seek further recommendations, until the end of the session.

When the user had finished a session, I created screen printouts of all recommendations that the ES had provided to the user. I then asked the user to exit the system by pressing Function Key 10.

During the consultation session (which usually lasted from between ten and forty-five minutes), I observed and,

where I believed appropriate, recorded the process taking place.

The actual process of observation was conducted according to guidelines spelled out by Allessi and Trollip (1985:386-389) for the observation of learners during the pilot testing of CBT programmes. Seated one metre behind the user, and trying to be as unobtrusive as possible, I observed and recorded any user behaviours or other events that I considered significant to the study, such as:

* Indications of hesitation or bewilderment.
* Reports of difficulties experienced.
* Signs of frustration, or of apparent misunderstanding of questions or recommendations provided by the system.
* Any positive reactions, such as the expression of excitement or of satisfaction with the system or with the user's own performance on the system.

At times I also recorded any thoughts or reactions of my own, if these struck me as being relevant to the study.

Upon completion of the consultation session, I invited users to make any alterations they wished to their ID documents, using a green pen that I had provided. I encouraged them to take time to reflect, and make any notes they wanted to about the ES and the effects of the ES on the ID process. Once the user had indicated that he or she was ready, I began the interview.

3. Post-Consultation Interview

At the beginning of the interview, I advised the user that the purpose of the interview was to discuss his or her feelings about, and reactions, to the ES. I mentioned that I would be making notes during the discussion and requested permission to tape record the interview. After obtaining permission (invariably

granted) I switched on the tape recorder and began asking open-ended questions, as indicated in the sample interview in Appendix E. The actual sequence of questions, and their precise wording, varied from one interview to the next, depending on how the interview developed.

During the course of the interview, I made brief notes about users' replies to questions. Where I felt that more information, clarification, or an example was called for, I asked probing questions, as recommended by Bogdan and Biklen (1982:135).

The interview continued until I felt that I had obtained a satisfactory description of the user's experience of the ES, the so-called "data saturation point" (Bogdan and Biklen, 1982:64).

The interview was then concluded with a debriefing session. During this session, I attempted to allay any residual anxieties or doubts that the user might have experienced about the ES or about the ID process.

To close off the interview, I thanked the user for his or her assistance with the development of the ES, and escorted him or her out of the office. As soon as possible after each interview, I wrote as full a transcript of the interview as possible. A copy of such a transcript is included in Appendix E.

3.3.8 Ensuring Triangulation

In order to achieve the effect of triangulation, numerous sources of information were used, including:

* The logbook of field notes.
* The notes that I had made during observation of users.

* Transcripts of the post-evaluation interviews conducted.
* Computer printouts of ES recommendations.
* Users' original ID documents.

Information from the above sources of information was collected and used for the content analysis process.

3.3.9 The Content Analysis Process

Berelson (1952) defined content analysis as "a research technique for the objective, systematic and quantitative description of the manifest content of communication." The content analysis process used in the present study can be described with reference to this definition:

* The "content of communication" in the present study included all the sources of information listed in Section 3.3.8 above. The reason for this multiplicity of sources of information was, in terms of Berelson's description, to enhance the "objectivity" of the study via triangulation.
* The process of analysis was "systematic" in that relat[illegible]ems of information from various sources were collected and grouped together into categories. These categories were then tabulated and analysed.
* The various sources of information listed in section 3.3.8 above could all be described as "manifest content of communication".

One possible point of difference between Berelson's description of content analysis and the process as it was conducted in the present study was that the word "quantitive" in Berelson's description would have to be replaced by the word "qualitative."

In this chapter, the various research methods used in the present study were described. The findings derived by the use of these methods are presented in the next chapter.

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CHAPTER 4 - RESULTS

In this Chapter, the findings of the study are presented under the following headings:

4.1 Record of ES Development Process
4.2 User Reactions to the ES
4.3 Comparisons of Users' Own Decisions and ES Recommendations.

4.1 Record of ES Development Process

The primary source of information for the record of the ES development process was the logbook containing the field notes maintained throughout the development and evaluation of the ES.

Table 4.1 on p4.2 lists, in chronological order, the major milestone events that occurred during the development and evaluation of the ES. These events are described under the following two headings:

4.1.1 ES Shell Development and Testing
4.1.2 Knowledge Base Development and Evaluation.

4.1.1 ES Shell Development and Testing

My attempts to program my own AI-based ID system lasted from June, 1989 until February 1990, when I finally conceded that a pre-programmed ES software system would be more suited to my needs (see Chapter 3).

Table 4.1: Chart indicating Milestone Events in the Development and Evaluation of the ES.

	Jun	Start learning C programming language
	Jul	Start programming C-based ES shell
	Aug	Start selecting knowledge base topics
1989	Sep	Complete C-based ES shell
	Oct	Start programming BASIC ES shell
	Nov	Start needs analysis knowledge base
	Dec	Complete BASIC ES shell
	Jan	System test BASIC ES shell with 30 rules
	Feb	Switch to Level 5 ES software
	Mar	Start needs analysis ES
1990	Apr	Start method selection ES
	May	Start media selection ES
	Jun	Complete/pilot test needs analysis ES
	Jul	Complete/pilot test methods selection ES
	Aug	Revise knowledge acquisition methodology
	Sep	Complete/pilot test media selection ES
	Oct	Evaluate complete ES

Before my first attempt to program an AI system, I decided to learn the C programming language. To do so, I studied two books on the subject of C programming (namely Schildt, 1985 and Schildt 1987), and also attended a five-day C-programming workshop run by a private company, Information Services Management, during June, 1989. In July of that year, I began programming the first ES shell, based on a program listing provided by Schildt (1987:104-114). I completed the shell in late September, 1989, but, due to my dissatisfaction with it (see Chapter 3, p3.13 of this report), I never applied the shell in practice.

In October, 1989, I abandoned the C-based shell and began programming a shell in the BASIC programming language, based on a program by Leithauser (1987:200-214). I completed the programming of this shell in late December, 1989.

In January, 1990, I entered thirty rules, derived somewhat arbitrarily from Mager's flowchart of the steps in a need analysis (Mager, 1970 - see Chapter 3), into the BASIC shell. I tested the resulting ES by conducting eight dummy consultation sessions, with myself as user. The results of this test revealed a number of limitations to the BASIC ES shell (see Chapter 3, p3.13).

In February, 1990, I acquired the Level 5 ES software, and immediately set about learning how to make use of it from its accompanying manuals and sample programs.

4.1.2 Knowledge Base Development and Evaluation

The development and evaluation of each of the three knowledge bases, as well as of the [illegible] knowledge base, which combined all three com[illegible] described below:

1. Needs Analysis

Although I had begun research on the needs analysis knowledge base in August, 1989, it was only in March, 1990, that I began in earnest to create the needs analysis ES. I completed and pilot-tested this ES in June, 1990.

My initial research into the area of needs analysis included a literature survey of the field (see Chapter 2). I also discussed the topic with a number of individuals from the Bank's training function, beginning with BS, manager of the Organisation Development (OD) Department and head of a team of training consultants.

BS's department was responsible for conducting in-depth analyses of training and training-related needs in various divisions in the Bank. BS welcomed the idea of an ES-based needs analysis tool that could be used by non-specialist training staff. He stressed, however, that much of the effort involved in conducting a needs analysis went into the data gathering stage. Both BS and I agreed that there was little that the ES could do to alleviate the workload in the data gathering process, and that the ES should, therefore, focus on providing assistance to users who were already in possession of sufficient information about a particular performance problem.

Three other members of the training function that I consulted were JO, LK and AZ. All three were involved in the design of training programmes, ranging from management and marketing training to a workshop on intercultural communications, and all three appeared favourably disposed towards a needs analysis ES:

* JO claimed that it was necessary to find some way to speed up the needs analysis process, saying "I can't afford to wait for the OD department to get around to doing a needs analysis in my area - they have too many other things to do before."
* AZ told me that often a need for marketing training was identified just before the release of a new Bank product or service. She said: "There is a crying need for some sort of instant needs analysis."
* LH told me that she had been delaying the design and development of a management training programme for some six months, waiting for assistance in conducting a needs analysis.

Thus reassured that an attempt to create a needs analysis ES could be of at least some use, I sought out a suitable model upon which to base it. In the end, as noted in section 4.1.1 above, I used Mager's flowchart (Mager, 1970).

I soon discovered, however, that Mager's model required extensive adaptation. For example, the USA-based model did not address problems arising from cultural and ethnic differences, some of which were peculiar to the South African situation. I had to include additional rules to address issues such as:

* Excessive travelling requirements.
* Inter-ethnic group friction in the workplace.
* Domestic and workplace disruption arising from the prevailing 'unrest'[1] in the country.

In my fieldnotes I recorded that:

> One can stare forever at the work of American experts such as Gilbert (ie Gilbert, 1967) and Mager (ie Mager, 1970) and NEVER find a mention of the unique problems found in South Africa.

Another unanticipated event that occurred during the development of the needs analysis knowledge base was the rapidity with which I encountered the phenomenon of combinatorial explosions (see Appendix C). Each time a new concept or process was included in the knowledge base, the need to relate this concept or process to others resulted in a host of new rules being added to the knowledge base.

My first encounter with this phenomenon was when I attempted to include an analysis of the intended target learner population in the needs analysis knowledge base. The resulting proliferation of rules soon persuaded me that such an inclusion would be too ambitious for my

aims. Combinatorial explosions continued to plague me throughout the ES development process.

2. Method Selection

An early dilemma recorded in my field notes was my attempt to define the scope of the method selection knowledge base. The problem was to decide between an in-depth approach to method selection (specifying each instructional method individually and in detail) and what Romiszowski (1981:31) referred to as a macro approach, limited to outlining broad instructional strategies. To avoid the problems associated with combinatorial explosions noted above, I was loath to address both approaches in the same knowledge base. In the end I decided to adopt a more macro-oriented approach, focusing on whether a discovery learning or an expositive learning approach was to be recommended by the ES (see Chapter 3).

During development of the method selection knowledge base, I noted how the production of rules for the ES seemed to highlight hidden flaws and assumptions in the sources consulted. For example, attempts to arrive at a clear decision between an expositive and a discovery learning approach proved to be extremely difficult in practice, since at times either approach would have had its own merits. I recorded that I was "somewhat unhappy" with the resulting knowledge base, and that "at times I am forced to choose rather blindly between two contradictory methods and just hope for the best."

I also noted my frustration at being unable to integrate diverging theoretical approaches. I would have liked to integrate the more mechanistic approach to ID, favoured by writers such as Mager (1970) and Clark and Clark (1984), with more humanistic elements, to be found in the

work of writers such as Knowles (1980) and Houle (1976). At the time, however, I feared that the dangers of a combinatorial explosion would negate any potential benefits that could be derived from bringing such divergent approaches together.

Perhaps my experience of producing the methods selection component of the ES is best summed up by the words I wrote after the pilot testing phase: "I feel quite dissatisfied with the results of my efforts to develop this part of the ES."

3. Media Selection

It was during the development of the media selection knowledge base that I recorded one of the more dramatic lessons that this study revealed to me. I began to realise that something was missing from my approach, namely, a lack of interaction between the knowledge engineer and the source of expertise. By basing my knowledge base rules so extensively on theoretical concepts and principles derived from the literature, I was, in fact, overlooking, and therefore sacrificing, my own practical expertise in the field of ID.

This realisation (which I described as a "revelation of sorts" in my field notes) led me to alter my entire approach to the process of knowledge acquisition. I began to collect knowledge by simulating an interview with myself. Adopting both the role of ID consultant and of client, I pretended that I was consulting myself about a variety of media selection issues. I recorded how the consultant went about selecting media for a wide range of learning topics, under varying circumstances. Only after I had built up a substantial range of media selection

procedures did I look for verification of these procedures in the literature.

My notes indicate that I felt far more satisfied with the results of this revised approach to knowledge acquisition than I had felt prior to my "revelation."

4.2 User Reactions to the ES

As noted in Chapter 3, a record was maintained of users' observed and reported reactions to the ES. Tables 4.2 to 4.4 present summaries of these reactions, divided into three broad areas:

4.2.1 User Difficulties with the ES
4.2.2 User Reactions to the Applicability of the ES
4.2.3 User Suggestions for Improvements to the ES.

The three broad areas were, in turn, divided into a number of specific items, numbered from 1 to 24. A detailed description of each area and its related items is presented below.

4.2.1 User Difficulties with the ES

Table 4.2 lists the frequency of users who reported or were observed to be experiencing difficulties with the ES.

Item 1 - Difficulty using computer - Two users, out of a total of twenty, reported some difficulty with the operation of the computer:

* DD admitted that she felt "threatened by computers", and frequently requested my assistance about the location of various keys on the keyboard, such as the function keys and the ESCAPE key.

Table 4.2: Frequency of Users Who Experienced Difficulties with the ES

Item Desciption	Group A		Group B		Group C		Group D	
	f	Users	f	Users	f	Users	f	Users
1. Difficulty using computer	1	DD					1	SE
2. Difficulty following instructions	2	DD+SA	1	IS	1	MJ	1	VS
3. Difficulty answering questions	1	SS			1	MJ	2	VS+JN
4. Difficulty with location in ES					1	MJ		
5. Difficulty with vocabulary/concepts used			1	GA	1	MJ	2	AE+SE
6. ES text misleading or ambiguous	2	TW+SS	2	KS+GA	3	RB+NB +MJ	4	VS+JN CK+AE
7. Spelling/grammar errors	1	DD	1	IS				
8. Disagreed with accuracy/relevance of questions	1	TW	2	IS+GA				
9. Disagreed with accuracy/relevance of recommendations	3	DD+SA +SS	4	PH+GA KS+IS	2	RB+MJ	3	JN+LA +SE

Key: Group A: Needs analysis only, Group B: Method selection only, Group C: Media selection only, Group D: Complete ES. f = Frequency of users.

* SE complained of difficulty reading the computer screen. However, she did mention that the specific colours and clarity of the screen were "no worse than any other" computer applications she had encountered.

Item 2 - Difficulty following instructions - Five users reported or were observed to be having difficulty following

instructions provided by the ES:

* DD was seen pressing inappropriate keys on the computer keyboard, contrary to instructions provided on the screen.
* SA reported that "the up-front objective of the system should be made clearer." Both SA and MJ started their sessions by providing what struck me as inappropriate responses to questions asked by the system. I eventually suggested that they abandon the sessions and start again, which they did. Both users were more successful on their second attempts.
* RS reported that she would have preferred some way of returning to the introduction to the ES during the session, to check whether she was "still on track."
* VS said "Initially I did not understand what exactly I was supposed to do", but added that as she worked through the session, the purpose became clearer.

Item 3 - Difficulty answering questions - Four users reported or were observed to be having difficulty answering questions posed by the ES. In all four cases, the difficulty appeared to involve having to use the Space Bar on the computer keyboard to set the user's level of confidence when answering a question[2]:

* SS said that she wished that the ES was "simpler to use, so that you can just type in a number to show your confidence instead of messing around with the Space Bar."

Item 4 - Difficulty with location in ES - Only one user was observed to be having difficulty navigating through the ES:

* MJ appeared to have difficulty [illegible]ing her position within the ES. When she reach[illegible] end of the session, at which point the ES made a series of recommendations, she attempted to provide answers to the recommendations, before finally turning to me for assistance.

Item 5 - Difficulty with vocabulary and/or concepts used - Four users reported, or were observed to be having, difficulties in this respect:

* CA complained that he found the references to expositive and discovery learning confusing.
* MJ was observed to be having difficulty with a number of the concepts in the ES. She appeared to follow blind alleys, providing inappropriate answers to questions posed by the ES. On checking with her, I gathered that she was confused by terms such as `internal communications' and `viable possibility.'
* AE stated that she felt uncomfortable with references to the term `attitude', and that she would have preferred a precise definition of the term.
* JN expressed difficulty associating the term `social skills' with her own particular area of interest, which she described as involving "marketing and sales skills."

Item 6 - ES text misleading/ambiguous - A total of eleven users were recorded as finding questions or recommendations provided by the ES misleading or ambiguous:

* Of this number, eight (ie TW, SS, KS, GA, RB, NB, JN and AE) expressed confusion about having to assign a low rate of confidence to a negatively-posed question (thereby creating a double-negative effect). As SS said: "Some questions were difficult to unravel because of the double negatives. I had to read them more than once, and sometimes I even just guessed the answer in the end."
* The remaining three users reported being confused by the use of the word `or' in a question. All three claimed that, for them, this meant that if <u>any</u> of the alternatives separated by the word did <u>not</u> apply, then <u>no</u> alternative applied. My intention in using `or' to separate alternatives had been to indicate that <u>any one</u> of the alternatives <u>could</u> apply.

Item 7 - Spelling/grammatical errors - Two users reported spelling or grammatical errors in the ES:

* Both DD and IS handed me with lists of spelling and grammatical errors after their consultation sessions.

Item 8 - Disagreement with accuracy/relevance of questions - Three users disagreed with the accuracy or relevance of questions asked by the ES:

* TW reported that no specific questions had been asked about planning skills in the needs analysis.
* IS reported feeling that many of the questions asked by the ES were irrelevant to the selection of methods for her particular target learner population.
* GA initially questioned the relevance of any of the ES questions to the process of method selection.

Item 9 - Disagreement with accuracy/relevance of recommendations - A total of twelve users questioned the accuracy or relevance of recommendations supplied by the ES. This item is described further in section 4.3.

4.2.2 User Reactions to the Applicability of the ES

Table 4.3 on p4.13 lists the frequency of users who demonstrated reactions to the applicability of the ES in the ID process.

Item 10 - Reported impact on user's approach to ID - Eight users reported that the ES had made an impact on their approach to the ID process:

* SS claimed that, after using the needs analysis component of the ES, she realised the need to gather far more information about her focus area than she already had available.
* MJ said of the media selection component of the ES: "It helped me structure my thoughts."

Table 4.3: Frequency of Users Who Reacted to the Applicability of the ES

Category and Description	Group A		Group B		Group C		Group D	
	f	Users	f	Users	f	Users	f	Users
10. Reported impact on user's approach to ID	1	SS	1	PH	2	MJ+RB	4	LA+GD CK+AE
11. Altered ID document	1	SA+TW +SS	3	PH+KS +IS	2	MJ+PB	7	JN+AE GD+SE LA+VS +CK
12. Intention to use ES in actual work situation	3	SA+SS +TW	3	PH+KS +IS	3	RB+NB +IP	5	LA+VS GD+SE +CK
13. Used ES within six months of consultation			1	PH	3	MJ+NB +IP	2	VS+GD
14. Would recommend ES	1	SA	1	PH	1	IP		
15. Did recommend ES within six months	1	SA	1	PH	1	IP		
16. Said ES of little/no use in own job area			1	IS	1	IP	2	JN+ZM

Key: Group A: Needs analysis only, Group B: Method selection only, Group C: Media selection only, Group D: Complete ES. f = Frequency of users.

* RB, PH, LA, GD, AE and CK all commented on how the ES had helped them to expand their range of ideas about the ID process in some way. AE commented about the programme she was designing: "I've never thought about the course in such detail before." CK's comment was that the ES "made useful recommendations, especially pointing out things that you were aware of but did not think of at the time."

Item 11 - Altered ID Document - Fifteen users made one or more alterations to their ID documents following ES consultation sessions. The extent and significance of these alterations is presented in section 4.3.

Item 12 - Stated intention to use the ES in actual work situation - Fourteen users stated their intention to use the ES in their actual work situations when required to design instruction:

* When asked for more specific details on how they would use the ES, six of the users indicated that they would use it more as a guide to their own designs than as the sole basis for making ID decisions.
* None of the users stated that they intended using the ES as the sole basis for making ID decisions.

Item 13 - Used ES within six months of consultation - Six users were found to have made use of the ES within six months of their consultation sessions:

* Of the six, PH and IP used the ES on more than one occasion during this period. PH used it four times, and IP twice.

Item 14 - Stated would recommend ES - Three of the users (SA, PH and IP) said that they would recommend the ES to other potential users.

Item 15 - Recommended ES to others within six months of consultation - Three users (SA, PH and IP) were recorded as having recommended the ES to other potential users within six months of their consultation sessions.

Item 16 - Said ES of little or no use in own job area - Four users claimed that they saw little or no use for the ES in their own particular areas of interest:

* IS said that she felt that the ES had not added much to assist her in the design of an intercultural communications course. "In some ways" she said "it wasted more time than it saved", and seemed "more suited to skills-based training."
* IP expressed the suspicion that he had chosen too broad a field of inquiry (a management training

curriculum) for the ES to cope with.

* JN claimed that, with her (considerable) experience in ID, the ES seemed to be "a bit of a waste of time" for experienced instructional designers.
* ZM stated that the ES was "of no use whatsoever" to her in the design of a training course intended for Bank customers.

4.2.3 User Suggestions for Improvements to the ES

Table 4.4 lists the frequency of users who offered suggestions for improvements to the ES.

Item 17 - Spell out purpose of ES more clearly - Three users suggested that the purpose of the ES should have been spelled out more clearly:

* GA and VS requested more clarification about what was expected of a user.
* KS suggested that users be provided with a printed copy of the introductory screens of the ES to refer to during the consultation session.

Item 18 - Provide on-screen help for the user - One user, VS, suggested that on-screen help be made available to users during a consultation session, to be accessed by means of a selected keypress. She said that the help already automatically provided by the Level 5 software was "inadequate" and "not specific enough to be of much use."

Item 19 - Improve clarity of ES wording - Seven users suggested that improvements be made to the clarity of wording used in the ES:

* Six users suggested that the double negative phenomenon already described (see Item 6 above) should be eliminated.

Table 4.4: Frequency of Users' Suggestions for Improvements to the ES

Category and Description	Group A		Group B		Group C		Group D	
	f	Users	f	Users	f	Users	f	Users
17. Spell out purpose of ES more clearly			2	KS+GA			1	VS
18. Provide on-screen help for user							1	VS
19. Improve clarity of ES wording	2	SS+TW	1	IS	2	RB+NB	2	JN+AE
20. Widen ES scope to embrace more types of instruction	2	DD+TW	1	IS	2	RB+IP	1	JN
21. Provide demonstration lesson	1	SA					2	VS+AE
22. Include ES in future ID workshops			1	PH			1	JN
23. Encourage staff involved in ID to use ES	4	DD+SS TW+SA	3	KS+IS +PH	3	MJ+RB +NB	7	LA+VS JN+GD SE+CK +GD
24. Scrap the ES			1	GA				

Key: Group A: Needs analysis only, Group B: Method selection only, Group C: Media selection only, Group D: Complete ES.
f = Frequency of users.

* TW recommended that the questions relating to cognitive skills should specifically include planning skills.
* JN requested that the relationship between the term 'social skills' and her focus area, ie selling and marketing skills, be spelled out more clearly.

Item 20 - Widen ES scope to embrace more types of instruction - Six users suggested that the scope of the ES

be widened to include additional types of instruction:

* DD, IS and RB said that they would have preferred more attention being paid by the ES to educational, as opposed to training, issues. When asked to be more specific, they mentioned intercultural communication (DD and IS) and writing skills (RB) as being more related to education than to training, and claimed that these topics warranted attention in the ES.
* TW, as already noted, suggested that planning skills be included under the umbrella concept of cognitive skills.
* IP suggested that the focus of the ES be expanded to embrace the concept of "management development", which he indicated involved far more than training, and included issues such as career-path planning and an analysis of learner potential.
* JN, as already mentioned, wanted the term 'social skills' to include selling and marketing skills.

Item 21 - Provide demonstration lesson to familiarise users - Three users recommended a demonstration lesson to familiarise users with the ES prior to their exposure to a formal consultation session:

* AE claimed that she would have preferred a "dry run" through the system before starting her consultation session.
* Both SA and VS suggested that some form of CBT lesson or simulation should accompany the ES.

Item 22 - Include ES in future ID workshops - Two users advocated the use of the ES in all future ID workshops:

* JN said that this would help reinforce concepts and procedures covered in the workshop, and added that the ES "could be a very useful tool for training junior or new trainers."
* PH insisted that the ES "should be made compulsory, as a part of the Instructional Design workshop."

Item 23 - Encourage staff involved in ID to use ES - Seventeen of the users advocated the use of the ES by all staff involved in the design of instruction in the Bank:

* When probed, eleven of these users recommended that the ES be used more as a guide, to help designers confirm their own designs and to provide additional and alternative ideas to designers, than as a system that would blindly determine design decisions without allowing the designer discretion.

Item 24 - Scrap the ES - One user (GA) said that the ES should "be scrapped, because it wastes more time than it's worth."

4.3 Comparisons of Users' Own Decisions and ES Recommendations

Tables 4.5 to 4.8 present comparisons between:

* The frequency of users' unaided ID decisions and the recommendations presented by the ES.
* The frequency with which novel (ie not proposed originally by the user) ES recommendations were adopted by each user.
* The frequency of ES recommendations specifically rejected by each user.
* The frequency of possible solutions that I perceived the ES to have missed, ie failed to propose in spite of these solutions being appropriate.

Notes on section 4.3:

* For the sake of brevity, both the ES recommendations and the users' unaided ID decisions are referred to from time to time as solutions.
* The information pertaining to the frequency of users' unaided decisions was derived from a content analysis of each user's ID document as it appeared prior to the

ES consultation session.

* The frequency of ES recommendations was obtained from a printout of the ES recommendations to each user.
* The frequency of novel ES solutions adopted and/or rejected by the user was derived from alterations made by users to their ID document following ES consultation sessions, and from a content analysis of transcripts of the post-consultation interviews I conducted with each user (see example in Appendix E).
* The frequency of user solutions missed by the ES was derived from the user's ID document, users' comments, and from my own observations.

4.3.1 ES/User Solutions Comparison for Needs Analysis Pilot Test Group

Table 4.5 presents the findings for Group A, ie the pilot test group for the needs analysis component of the ES.

From Table 4.5 it can be seen that DD listed two needs in her ID document:

* A need for social skills training.
* A need to address an attitude deficiency.

The same two needs were identified by the ES, resulting in a close concurrence between the user's and the ES's solutions.

SA identified the need for:

* Procedural skills training.

The ES identified needs for:

* A non-training related solution.
* Psychomotor skills trainning.
* Knowledge training.

The user adopted the suggestions relating to training, but rejected that regarding the need for a non-training related solution. The ES missed identification of a procedural skills deficiency.

Table 4.5: Frequencies of User and ES ID Solutions, of ES Solutions Adopted or Rejected by Users, and of Solutions Missed by the ES, for the Needs Analysis Pilot Test Group (Group A).

User	Frequency of User's Solutions	Frequency of ES Solutions	Frequency of ES Solutions Adopted	Frequency of ES Solutions Rejected	Frequency of Solutions ES Missed
DD	2	2	-	-	-
SA	1	3	2	1	1
SS	1	3	1	1	-
TW	1	2	1	-	1
TOTAL	5	10	4	2	2

SS identified the need for:

* Social skills training.

The ES identified needs for:

* Social skills training.
* A non-training-related solution.
* Knowledge training.

The user adopted the recommendation relating to the existence of a non-training related dimension to the problem, but rejected the knowledge training suggestion.

TW identified the need for:

* Cognitive skills training.

The ES identified needs for:

* Cognitive skills training.
* Knowledge training.

The user adopted the knowledge training suggestion. The ES missed identification of a procedural skills deficiency that I considered existed in this particular situation.

In summary, for Group A:

* Four solutions provided by both user and ES matched.
* Four additional, novel solutions proposed by the ES were adopted by users.
* Two ES solutions were specifically rejected by users.
* The ES missed two potential solutions.

4.3.2 ES/User Solutions Comparison for Method Selection Pilot Test Group

Table 4.6 presents the findings for Group B, ie the pilot test group for the method selection component of the ES.

From Table 4.6 it can be seen that KS selected two instructional methods:

* Games[3].
* Programmed Instruction (PI).

The ES recommended:

* PI.
* Behaviour modelling[4].
* Tutorials[5]
* Demonstration and practice[6].
* Job aids.

KS adopted the suggestions about behaviour modelling and job aids in her design, commenting that "The questions (in the ES consultation session) prompted me to think...I would never have thought of some of the suggested methods."
Both KS and I noted that the ES had missed making recommendations about methods for bringing about attitude change[7].

Table A.6: Frequencies of User and ES ID Solutions, of ES Solutions Adopted or Rejected by Users, and of Solutions Missed by the ES, for the Method Selection Pilot Test Group. (Group B).

User	Frequency of User's Solutions	Frequency of ES Solutions	Frequency of ES Solutions Adopted	Frequency of ES Solutions Rejected	Frequency of Solutions ES Missed
KS	2	5	2		1
PH	3	5	2	1	-
GA	3	1	-	1	-
IS	4	7	3	-	2
TOTAL	12	18	7	2	3

PH selected three instructional methods:

* Lectures.
* Group discussions.
* Non-participative demonstrations[8].

The ES recommended five different methods:

* PI.
* Tutorials.
* Examples and non-examples[9].
* Awareness-enhancement exercises to promote attitude change.
* Job aids.

PH incorporated the use of examples/nonexamples and awareness enhancement exercises in his design, but both he and I agreed that job aids would be inappropriate.

GA selected three instructional methods:

* Practical exercises.
* Lectures.
* Text readings[10].

The ES recommended only one method:

* Job aids.

Both GA and I agreed that the unsupported use of job aids would be inappropriate for his design.
I noted that GA was not answering the questions asked by the ES as I would have expected, and that he appeared to have misunderstood the purpose of the consultation.

IS selected four instructional methods:

* Tutorials.
* Group discussions.
* Games.
* Debates[11].

The ES recommended seven different methods:

* Behaviour modelling.
* Role plays[12].
* Think tanks[13].
* Case studies[14].
* Student projects[15].
* Simulations[16].
* An intensive, long-term attitude change programme.

IS incorporated three ES recommendations into her design: behaviour modelling, case studies, and a long-term attitude change programme, which she "hadn't thought of until now."
I noted that the ES missed recommending games and debates.

In summary, for Group B:

* A total of twelve instructional methods were selected by the four users prior to exposure to the ES.
* The ES recommended a total of eighteen methods, only one of which matched a method suggested by a user.
* Users adopted seven methods suggested by the ES.
* Users specifically rejected two ES recommendations.
* The ES missed three potential methods.

4.3.3 ES/User Solutions Comparison for Media Selection Pilot Test Group

Table 4.7 summarises the findings for Group C, ie the pilot test group for the media selection component of the ES.

Table 4.7: Frequencies of User and ES ID Solutions, of ES Solutions Adopted or Rejected by Users, and of Solutions Missed by the ES, for the Media Selection Pilot Test Group (Group C).

User	Frequency of User's Solutions	Frequency of ES Solutions	Frequency of ES Solutions Adopted	Frequency of ES Solutions Rejected	Frequency of Solutions ES Missed
MJ	3	3	1	-	1
RB	1	4	1	-	-
NB	2	1	-	-	-
IP	3	3	-	-	-
TOTAL	9	11	2	-	1

From Table 4.7 it can be seen that MJ selected three media:

* Video.
* Text-based workbook.
* Hands-on practice with authentic equipment.

The ES recommended three different media:

* TBT.
* PI or correspondence.
* Classroom-based delivery.

MJ incorporated TBT into her design, but I noted that the ES had missed recommending hands-on practice.

RB selected one medium:

* Classroom-based delivery.

The ES recommended:

* Classroom-based delivery.
* Video.

* Mass broadcast[17].
* The use of internal company communications devices[18]

RB incorporated the use of video into her design. I noted my dissatisfaction with the ES recommendations regarding the use of a mass broadcast and internal company communications.

NB selected two instructional media:

* Video.
* Classroom-based delivery.

The ES recommended:

* Classroom-based delivery.

The user decided <u>against</u> the use of video as a result of the ES consultation session, confessing that she had not considered the difficulties relating to the availability of video production resources prior to the session. She added: "The computer forced me to think."

IP selected three instructional media for his design:

* Classroom-based delivery.
* TBT.
* PI.

The ES recommended the same three media, demonstrating a close concurrence between the user's design and the ES recommendations.

In summary, for Group C:

* A total of nine instructional media were selected by the four users prior to exposure to the ES.
* The ES recommended a total of eleven media, five of which matched media suggested by a user.
* Users adopted two media suggested by the ES, and rejected none.
* The ES missed one potential medium recommendation.

4.3.4 ES/User Solutions Comparison for Complete ES Test Group

Table 4.8 summarises the findings for Group D, which was used to test the complete ES, covering all three of the ID areas.

Table 4.8: Frequencies of User and ES ID Solutions, of ES Solutions Adopted or Rejected by Users, and of Solutions Missed by the ES, for Complete ES Test Group (Group D).

User	Frequency of User's Solutions	Frequency of ES Solutions	Frequency of ES Solutions Adopted	Frequency of ES Solutions Rejected	Frequency of Solutions ES Missed
LA	4	10	4	-	1
VS	6	13	5	2	7
JN	5	8	4	1	2
AE	7	11	4	2	2
CK	7	8	3	-	2
ZM	6	8	-	1	1
GD	5	8	4	-	1
SE	7	11	6	-	3
TOTAL	47	77	30	3	12

From Table 4.8 it can be seen that prior to exposure to the ES, LA identified four relevant design items:

* A need for training arising from a procedural skills deficiency.
* Instructional methods comprising lectures and exercises.
* A classroom-based delivery medium.

The ES identified:

* Two different needs - the need for a non-training related solution and a knowledge deficiency.

* Six instructional methods - exercises, tutorials, demonstrations, text reading, examples and non-examples, and drill and practice.
* two delivery media - classroom-based delivery and PI.

LA incorporated four ES recommendations into her design:

* The existence of a non-training related problem.
* The existence of a knowledge deficiency.
* The use of drill and practice techniques.
* An adaptation of PI as a medium.

LA commented that the ES had "opened a window" on a whole range of ideas that she herself had not considered. I noted that the ES had missed identifying a probable procedural skills deficiency.

VS identified six relevant items in her design:

* A procedural skills deficiency.
* Instructional methods including lectures, demonstrations, group discussions and exercises.
* Classroom-based delivery as a medium.

The ES identified the following items:

* As needs - a procedural skills deficiency, a psychomotor skills deficiency, a knowledge deficiency and a non-training related issue.
* As methods - demonstrations, hands-on practice, tutorials, text readings, drill and practice, and examples and non-examples.
* As media - classroom-based delivery, PI or correspondence, and TBT.

VS incorporated the following ES recommendations into her design:

* The need to address psychomotor skills and knowledge deficiencies.
* The use of hands-on practice and examples and non-examples as instructional methods.
* TBT as a delivery medium.

VS rejected the ES recommendation that a non-training related problem existed, and both she and I questioned

whether PI or correspondence would be appropriate. After the ES consultation session, VS commented: "The computer was like an outside person, helping me to think of things I didn't think of." She claimed that "in real life, other people are too busy doing their own work to take time to offer advice and assistance."

Prior to the ES consultation, JN identified five relevant items:

* The existence of a knowledge deficiency.
* Instructional methods including demonstrations, tutorials and simulations.
* TBT as the appropriate delivery medium.

The ES identified:

* The existence of a knowledge deficiency and a social skills deficiency.
* As instructional methods - the use of demonstrations, behaviour modelling, text readings, and drill and practice.
* As delivery media - TBT, and PL or correspondence.

JN incorporated the following ES recommendations into her design:

* The need to address a social skills deficiency (although she disagreed with the use of the term 'social skills').
* Behaviour modelling.
* Demonstration.
* Drill and practice.

She rejected the suggestion about PI or correspondence. I noted that the ES missed recommending simulations or tutorials.

Prior to the ES consultation, AE identified five relevant items:

* As regards needs - a social skills deficiency.
* As instructional methods - lectures, group

discussions, behaviour modelling, practical exercises, and role plays.

* As media - classroom-based delivery.

The ES identified:

* As needs - a social skills deficiency, a procedural skills deficiency, a cognitive skills deficiency and an attitudinal problem.
* As methods - group discussions, demonstrations, case studies, projects, simulations, and some form of awareness enhancement programme to try to influence learner attitudes.
* As media - classroom-based delivery of instruction.

AE incorporated four ES recommendations into her design:

* The need to address procedural and cognitive skill deficiencies.
* The use of case studies and projects as methods.

AE rejected the ES recommendation regarding the need to address attitudinal issues, and the related recommendation about awareness enhancement. I noted that the ES missed suggestions about behaviour modelling and role plays. Following the ES consultation session, AE remarked that the ES had encouraged her to be "more analytical" in her approach, and added "I've never thought of the course (that she was designing) in such detail before."

Prior to the ES consultation session, CK identified seven relevant items:

* A need to address a procedural skills deficiency.
* As methods - group discussions, demonstrations, simulations, and text readings.
* As media - classroom-based delivery and TBT.

The ES identified:

* As needs - a procedural skills deficiency and a knowledge deficiency.
* As methods - demonstration, text reading, PI and the use of examples and non-examples.

* As media - classroom-based delivery, TBT, and PI.

CK incorporated into his design the ES recommendations regarding the knowledge deficiency and the use of PI, both as an instructional method and as a medium. He remarked that the ES "gave more ideas of what's what, and is good if you get stuck" and added that using the ES was "like brainstorming." I noted that the ES did not recommend simulations and group discussions as possible methods of instruction.

In her design prior to the ES consultation session, ZM identified six relevant items:

* The need to address deficiencies in both procedural skills and knowledge.
* As methods - tutorials, hands-on practice and text reading.
* As medium - classroom-based delivery.

The ES identified:

* As needs - a knowledge deficiency and a non-training related aspect to the problem being addressed.
* As methods - text readings, tutorials, drill and practice, and examples and non-examples.
* As medium - classroom-based delivery.

ZM did not incorporate any of the ES recommendations into her design, and specifically rejected the recommendation regarding the need to address a non-training aspect to the problem for which she was designing a solution. She commented that she "was not very turned-on" by the system. I noted that the ES had missed making a recommendation about a probable procedural skills deficiency.

GD identified four relevant items:

* A knowledge deficiency.
* Demonstrations as the sole instructional method.
* Classroom-based delivery and video as media.

The ES identified:

* As needs - a knowledge deficiency and an attitude problem.
* As methods - case studies, simulations, projects, group discussions, and attitude awareness enhancement exercises.
* As medium - classroom-based delivery.

GD incorporated four of the ES recommendations into her design, these being:

* The need to address an attitude problem.
* Group discussions, projects and awareness enhancement exercises as methods of instruction.

I noted that the ES had missed recommending video as a medium.

Finally, SE, prior to exposure to the ES, identified seven relevant items:

* A need to address a knowledge deficiency,
* Role plays, demonstrations, lectures, group discussions, and case studies as methods,
* As medium - classroom-based delivery.

The ES identified:

* As needs - a knowledge deficiency, a non-training related issue, a social skills deficiency, and a procedural skills deficiency.
* As methods - demonstrations, behaviour modelling, examples and non-examples, drill and practice, and text readings.
* As media - classroom-based delivery and TBT.

SE incorporated six ES recommendations into her design:

* The need to address a non-training related issues, as well as social and procedural skill deficiencies.
* The use of examples and non-examples, and of behaviour modelling as methods.
* TBT as an alternative delivery medium.

I noted that the ES had missed three methods - role plays, case studies, and group discussions.

In summary, for Group D:

* A total of forty seven relevant instructional items were selected by the eight users prior to exposure to the ES.
* The ES recommended a total of seventy seven items, of which twenty four matched users' items.
* Users adopted thirty recommendations suggested by the ES, and rejected six.
* I noted twelve potential recommendations as having been missed by the ES.

In Chapter 4, the findings derived from the ES development process and from the evaluation of the ES were presented. These consisted of the record of ES development process, the observed and reported user reactions to the ES, and a comparison of users' unaided instructional design decisions with recommendations provided by the ES. These findings are discussed in Chapter 5.

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CHAPTER 5 - DISCUSSION

In this chapter, the findings of the study are discussed in relation to the research questions posed in Chapter 1 of this report. Also provided in this chapter is a critical review of the study. The chapter is presented under the following headings:

5.1 The ES Development Process
5.2 User Reactions to the ES
5.3 Comparison of Users Own Decisions and ES Recommendations
5.4 A Critical Review of the Study
5.5 Guidelines for Future Bank AI-based Instructional Systems.

5.1 The ES Development Process

To answer research questions 1a, b and c, I turned to the record of the ES development process, reported in section 4.1 of Chapter 4.

Research Question 1a

What computer technology and expertise would be required to produce the system?

As can be seen from Table 4.1 (see Chapter 4), I spent several months attempting to program my own ES shell. My early attempts to do so using the C programming language and the BASIC programming language, failed to meet my need for a comprehensive, but flexible and user friendly system.

Once the switch was made to the Level 5 software, progress accelerated sharply, and I was able to concentrate on the development of the knowledge bases themselves, rather than having to struggle with error-prone computer code and logic.

Question 1a - Conclusions

At considerable cost, in terms of time and effort, I learned that would-be ES developers can spend a great deal of time and effort trying to program their own systems. Pre-programmed ES software, such as the Level 5 software, is readily available and may be quite adequate for the developers' needs.

Research Question 1b

How long would it take to develop the system?

From Table 4.1 in Chapter 4 is recorded that total ES development time extended over a period of some seventeen months.

However, ES development was not a full-time process. I was able to spend no more than two to four hours per day on the system. The development time-span cannot, therefore, be taken as a true reflection of the time that it would take to develop a similar ES on a full-time basis. To obtain a more accurate indication of time spent, I calculated the number of hours actually spent on development. At an estimation of fifty hours per month, this came to approximately 850 hours in total.

My lack of experience in ES development probably prolonged the duration of the development period. Time was taken up learning programming techniques and experimenting with various homemade ES options. My early reliance on external expertise, rather than my own knowledge of the ES content, may have also delayed development. A comparison of development time-spans for each successive knowledge base indicates that as my experience with the technology increased, the amount of development time required was reduced (see Table 4.1).

Question 1b - Conclusions

* Total ES development time for the ES was seventeen months, or about 850 development hours.
* I found that development time dropped considerably as I gained experience in using the ES technology.

Research Question 1c

What lessons would be learned about the scope, acquisition of content, and logic of the system?

1. Scope of the System

The way in which the scope of the system narrowed down from a comprehensive AI-based ID system to an ES focused on three areas of the ID process is discussed elsewhere in this report (see section 5.4.1).

The importance of establishing the scope and aims of the ES at an early stage in the development process was

highlighted during the development of the needs analysis knowledge base:

* From my discussions with BS, for example, I learned that the needs analysis should focus on helping the user to distinguish between training and non-training related issues, rather than on the task of data gathering. Data gathering could be handled without the assistance of the ES, for example by means of groupwork and interviews.
* From representatives of the potential target user population (JD, AZ and LK), I uncovered the need for a convenient need analysis tool. This tool could help trainers to identify needs without having to wait for a lengthy and detailed needs analysis to be provided, if ever, by the Bank's OD department.

The combinatorial explosion phenomenon (see Chapter 4 and Appendix C) occurred far more rapidly than expected, and became a problem that was to plague me throughout the development of the ES. Including a single additional factor in a knowledge base tended to increase the number and complexity of the rules quite disproportionately.

An early effect of this phenomenon was that the burgeoning size of the needs analysis knowledge base inhibited me from including in-depth analyses of the target learner population, the learning situation, or the availability of training resources. Such information would have been of considerable use in subsequent methods and media selection knowledge bases.

In both of the latter two knowledge bases, I was again forced to limit the number of factors to be examined, thereby reducing the specificity of recommendations that could be made by the ES. Thus, for example, I did not include a distinction between CBT and Interactive Video

Instruction (IVI)[1] in the media selection knowledge base, nor did I attempt to recommend optimal group size for classroom-based instruction.

Conclusions about the Scope of the System

* From my discussion with potential ES users and other interested parties, I learned the importance of establishing the specific requirements of potential users before beginning development of the system.
* I also learned that, for the inexperienced ES developer, combinatorial explosions are likely to occur, and tend to inhibit knowledge base development. They also tend to develop far more rapidly than expected.

2. Content Acquisition

One of the difficulties that I encountered with the acquisition of content was related to the limitations of the schemata[1] and flowcharts provided by writers in the field of ID.

To make the ES workable, I felt that I had to adapt these schemata and flowcharts. At times I included additional rules to cater for local requirements, such as ethnic and cultural factors (see Appendix D). At other times I simplified terminology, and even omitted complex concepts and principles, when I felt that such omissions would not affect the quality of ES recommendations.

My growing dissatisfaction with the knowledge bases being developed eventually led me to adopt a different approach to knowledge base development for the media selection

knowledge base. As described in Chapter 3, I began to simulate a dyadic consultation between an expert and a knowledge engineer. Although this revised process of knowledge acquisition was inevitably rather artificial, I recorded my increased satisfaction with it in my field notes (see Chapter 4).

Conclusions about Content Acquisition

* A lesson that I learned from the above was that, where a choice is possible, it is preferable to rely on live experts rather than on remote and theoretical expertise.

3. Logic of the System

One outcome of the knowledge base development process was that it tended to test the logic of the ID knowledge I was attempting to capture.

While constructing the ES rule bases, I found on several occasions that what appeared to be a clear, logical path, leading from one decision to the next, resulted in an exclusivity in ES recommendations that did not accord with reality. In the method selection knowledge base, for example, I initially distinguished clearly between instructional methods appropriate for knowledge and those appropriate for skills, in accordance with the schema provided by Romiszowski (1981:308). One of the rule statements read:

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IF Social Skills training required
OR Cognitive Skills training required
OR Psychomotor Skills training required
OR Procedural Skills training required
Then Skills Shortage (see Appendix D).
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The logic underlying this rule statement may appear difficult to fault. However, after selecting "Skills Shortage" as the solution, the system would produce this solution to the user, and then end the consultation session. The system would never take into consideration the existence of a knowledge shortage, which, as can be seen from Appendix D, forms part of a rule that occurs later in the knowledge base.

An examination of the text accompanying Romiszowski's schema makes it clear that no such simplistic 'either/or' distinction between knowledge and skill was intended. Romiszowski referred clearly to the role of knowledge as a prerequisite to skilled performance (Romiszowski, 1981:302-303). My attempt to translate Romiszowski's schema into ES rules resulted in a rule statement that forced a choice that was not intended.

I learned to minimise the effects of such forced exclusivity of ES solutions by assigning a level of confidence of less than 100 percent to rules. This allowed the system to display a solution, and then to continue seeking other solutions further on in the rule-base before ending the consultation session.

In trying to resolve problems such as the one described above, I was compelled to re-examine and clarify the flow of logic underlying the ID processes that I was attempting to automate.

This finding is in keeping with what Lippert (1989:14) referred to as "knowledge clarification". She quoted Singer and Perez (1986:60), who wrote that:

> The process has forced us to structure the knowledge available from field experiments and technical reports of validation studies. That structuring has shown where answers are needed and what variables are involved in obtaining the answers.

The process of knowledge clarification forms part of the rationale underlying the use of an ES as a tutee, as described in Chapter 2. The argument is that the inexorable logic required by the computer forces the learner to examine and clarify his or her own thinking about a knowledge domain.

Conclusions about the Logic of the System

* I discovered that, in an area of expertise such as ID, the ES must be able to deal with ambiguity, without forcing 'either/or' choices on the system developer.
* I also learned that the process of knowledge base development can force the developer to clarify his or her own thinking about aspects of the field of knowledge under consideration.

5.2 User Reactions to the ES

To answer research questions 2a, b and c, I turned to the records of the user reactions to the ES, reported in section 4.2 of Chapter 4.

Research Question 2a

Would the trainers encounter difficulties in using the system?

The ES user interface has been cited as an important factor in the success or failure of an ES project (Lipper (1987:407-413). Chorafas (1987:115) describes an ES

developed by British Telecom, the Dipmeter Advisor, that had fully forty two percent of its programming code[2] devoted to the user interface.

Table 4.2 in Chapter 4 lists the frequency of users who experienced various difficulties with the ES. Items 1 to 9 in this table are discussed below:

Item 1 - Difficulty using computer - I had expected more users to report difficulty in using the computer. One possible explanation for the incidence being lower than expected was that most users (fourteen of the total sample of twenty - see Table 3.1) had some prior exposure to computers. Another possible explanation was that my presence during the consultation session helped to reduce users' computerphobia[3], since users were not made to feel left alone with the system.

Of the two users who reported difficulties:

* From her reports of "feeling threatened by computers" I deduced that DD was suffering from a degree of computerphobia, made worse by her lack of familiarity with the computer keyboard.
* SE reported trouble reading the computer screen, but admitted that this was a problem that she had experienced before, with other computer applications. As noted, she reported that the ES was "no worse than any other" computer application she had encountered.

Item 2 - Difficulty following instructions - As noted, five out of a total of twenty users reported, or were observed to be experiencing, difficulties following instructions provided by the ES.

Initially I believed that these difficulties were related to users' lack of facility with the English language. The ES instructions were in English, and, of the five

who encountered difficulties, three were Asians, one was Black and one was an Afrikaans-speaking White. To these users, English may have been a second language. However, since I considered at least two of the Asian users, and the Black user, to have an excellent command of English, I was more inclined to regard the use of obscure vocabulary or grammar in the ES instructions as lying at the heart of the difficulties. Whenever such difficulties were noted, I re-examined the language used in the ES, making alterations where appropriate.

Item 3 - Difficulty answering questions - The need for users to press the Space Bar on the computer keyboard to set their level of confidence when answering an ES question was a feature built into the Level 5 software itself. I was unable to alter this, despite my suspicion that it made the ES more difficult to use than necessary.

To counter the problem, I could perhaps have allowed users to practice using the system, perhaps under expert guidance, or via a CBT lesson, prior to their commencing a consultation session. Another solution might have been to use ES software that operated on a different, simpler principle.

Item 4 - Difficulty with location in ES - Horn (1990:48-60) noted that difficulties can arise when users are required to find their way via computer through large bodies of information, such as reside in ES knowledge bases. He referred to the process of "navigating" through such large bodies of information.

Although, in the present study, users did not control the navigation process, since this was done by the ES itself, I would have preferred them to be aware of their position in the ES at all times. It concerned me, for example, that MJ could not seem to distinguish between a question

being asked by the ES and a recommendation made by it.

To counter the problem, I could have distinguished ES questions from recommendations, for example by using different colours, text fonts[4], text sizes or screen layouts. I also could have provided users with clear pre-consultation explanations and examples of what the questions and answers would look like.

Item 5 - Difficulty with vocabulary and/or concepts used - This item is related to the difficulties described under Item 2 above, except that for the present item the reference is to the vocabulary and concepts used in ES questions and recommendations, not those used in the operating instructions to the user.

As noted in Table 4.2, four out of twenty users reported, or were observed to be experiencing, difficulties with vocabulary and/or concepts used in the ES questions and recommendations. Whenever a user encountered such difficulties, I re-examined the language used in that part of the ES. Although I located, and altered, a number of words and concepts that might have been unfamiliar, or which were clearly incorrect, many of the difficulties seemed to relate to words and concepts that should have been defined and described in the ID workshops. My conclusion was that the source of many such difficulties lay in the content and delivery of this workshop, and not in the ES itself.

One way to counter the difficulties might have been to include some form of readily-available user help facility in the ES, containing an explanation of terms used.

Item 6 - ES text misleading or ambiguous - More than half of the users reported, or were observed to be experiencing, difficulties with misleading or ambiguous

questions or recommendations.

Most of the difficulties seemed to stem from two sources, namely from the 'double-negative' effect described in Chapter 4, and the confusion caused by use of the article 'or' in a question. I resolved to avoid both of these sources of difficulty in any similar developments I undertook in the future.

Item 7 - Spelling/grammatical errors - During the development and testing of the ES, it became clear to me that users could be most helpful in detecting errors or omissions in the ES at an early stage, and that the immediate rectification of such errors and ommissions was advisable to prevent later users from being exposed to them.

Item 8 - Disagreement with accuracy/relevance of questions - In two of the three cases where users disagreed with the accuracy or relevance of questions asked, the problem seemed to arise when the question was perceived to lack relevance to a particular user's area of interest.

This seemed to be the case with TW's interest in planning skills, and with IS's need to select methods for a specific target population. This led me to rework certain ES questions to avert a recurrence of the difficulties.

In the case of GA, it seemed to me that he was not reading the questions carefully enough before answering. I encouraged him to restart the consultation session, this time reading each question very carefully. After doing so, he reported no further difficulties.

Item 9 - Disagreement with accuracy/relevance of recommendations - A relatively large number (twelve) of users indicated disagreement with the accuracy or relevance of specific recommendations. Details of each user's specific disagreements will be discussed in section 5.3 of this chapter.

Question 2a - Conclusions

* From Item 1, I learned the need to try to overcome, or at least minimise, computerphobia in users. I should have provided a means for all users to become more familiar with the computer before beginning their ES consultation sessions.
* From Item 2, I discovered the need to:
  - Keep the language used in the ES as simple as possible.
  - Include ample introductory screens to explain ES instructions.
  - Make help screens or messages explaining instructions available to users at all times.
  - Encourage users to back out of a consultation session and start again if they encountered difficulties.
* The need for some form of practice in using the system was again shown by the difficulties that users encountered in using the Space Bar to set their level of confidence in a question answer, as I learned from Item 3.
* From Item 4, I discovered the need to help users to navigate through the mass of information available in the ES knowledge bases, for example by distinguishing clearly between questions posed by the ES and recommendations made by it.

* The need for some form of readily available user help facility, containing explanations of terms used in the ES, was revealed by Item 5.
* The lesson I learned from Item 6 was to avoid grammatical constructions using either a double negative or the word 'or' when posing questions or making recommendations to users.
* From Item 7 I learned that pilot test users can be a useful source of assistance in locating spelling and grammatical errors in an ES, and that it was best to rectify such errors immediately.
* The lesson reinforced by Item 8 was the importance of pilot testing in order to fine-tune the ES to cater for user diversity.

Research Question 2b

Would the trainers judge the system to be applicable to their ID requirements?

Many of the items in Table 4.3 in Chapter 4 can be grouped into pairs, consisting firstly of users' <u>perceptions or stated intentions</u> during the pilot test session, followed by their <u>actual behaviour</u> in the period following the ES consultation session. These pairs of items are discussed together below:

<u>Items 10 and 11 - Reported impact of ES on user's approach to ID, and - Altered ID document</u> - Eight users reported that the ES had made some impact. Almost twice as many users actually altered their ID documents in line with ES recommendations.

One could speculate that the disparity between the number of users who indicated that the ES had made an impact, and the number who altered their designs, was the result of some users being unwilling to give the ES too much credit for their designs. This supposition was not, however, supported by users' behaviour or comments in their interviews with me. I was unable to find any satisfactory reasons for the disparity between users' reports of the impact of the ES and their behaviour.

On examining interview transcripts, I found that users reported three major ways in which the ES had made an impact on their designs:

1. The ES encouraged a structured approach to ID.
2. The ES encouraged users to give more careful consideration to factors affecting ID decisions.
3. The ES provided users with fresh ideas for ID.

Points 1 and 2 above tend to support the argument that the ES assisted users to improve the quality of some of their ID decisions. Point 3 above tends to support the argument that the ES increased the quantity of options available to users. The twin issues of quality and quantity of ES recommendations are addressed in greater detail together with the concept of added value in section 5.3 of this chapter.

Items 12 and 13 - Stated intention to use the ES in the actual work situation, and - Used ES within six months of consultation - Fourteen users stated that they intended to use the ES in their work situations. Only five were found to have done so within six months of the consultation session.

Possible reasons for this disparity between stated intentions and actual behaviour may have included:

1. My not actively promoting subsequent use of the ES.
2. The lack of comp ter facilities to run the ES in the trainers' workplaces.
3. Users attributing little significance to the ES.
4. Users' hidden resistance to the technology.

Each of these possibilities is examined below:

1. For reasons discussed later in this report, I did not actively promote use of the ES outside the pilot testing situation. When approached by potential ES users, however, I did make arrangements for them to have access to the hardware and software needed to run the ES.

   That only five trainers made subsequent use of the ES within six months of helping to pilot test it is therefore not surprising. Many writers (eg Farrell and Broude, 1987:159:164; Gery, 1991:195-209) have drawn attention to the need to promote a computer system actively and persistently in order to have any chance of success in implementing it.

2. Of the fourteen users who had stated that they intended to use the ES in the actual work situation, all had reasonable access to personal computers suitable for running the ES. I do not, therefore, regard a lack of adequate computer facilities as a compelling explanation for the failure of many of these trainers to use the ES in their work situations.

3. From their comments during the pilot tests and subsequent interviews, most users seemed to display a relatively high regard for the usefulness of the ES. With a few exceptions (see Items 15 and 16

later), I do not consider that failure to use the ES was the result of users not perceiving it as being potentially useful to them in the work situation.

4. With the few exceptions noted above, users did not express any overt resistance to the ES. However, it is true that I did not specifically attempt to measure the extent of user resistance, and this must be considered an oversight in this study. I perhaps naively assumed that trainers would welcome any aid to their jobs. It is possible that users went along overtly with my encouragement of ES, but revealed their hidden resistance by not making use of the system once they returned to their workplaces.

Such resistance, if indeed it existed, could have arisen from:

* Users' fears of losing the human touch in dealing with the design of training - ie resistance to the ES because of it being perceived as mechanistic or impersonal.
* Users' fears of losing their jobs to, or being replaced by, a computer.
* User computerphobia.

Items 14 and 15 - Stated would recommend ES, and - Recommended ES to others within six months - No evidence was found in these items of any disparity between stated intentions and actual behaviour. Three users stated their intention to recommend the ES to others, and the same three users recommended the ES to others.

One could speculate that the act of making a verbal commitment to recommend the ES to others influenced the users to actually recommend the ES. If so, such a

commitment from all users might have served as a means of encouraging them to promote the system within the organisation. No attempt was made during this study to explore this possibility.

Item 16 - ES of little or no use in user's job area - As noted in Table 4.3, four users claimed that the ES would be of little or no use to them in their own jobs. Reasons for these claims seemed to differ in each case:

* IS's claim that the ES had not done much to assist her in the design of an intercultural communications course was contradicted to some extent by her incorporation of three ES recommendations into her design (see Section 5.3 later). Her opinion of the ES may have been clouded by her objections to the accuracy or relevance of ES questions and recommendations (Items 8 and 9), and by her perception that the ES was more suited to skills training than to her own topic.
* IP's focus, on a management training curriculum, was very broad, and probably beyond the scope of the ES. In addition, IP was a relatively experienced designer of instruction (see Table 3.1). It was to be expected that he would not benefit much from the ES recommendations, which were intended for less experienced users.
* Like IP, JN, as an experienced designer of instruction, was expected to derive less benefit from the ES than would an inexperienced designer. I took JN's comment that the ES was "a bit of a waste of time" for experienced instructional designers as confirmation that the ES was not intended for experienced designers, not as an indictment of the ES.
* ZM's remark that the ES had been "of no use whatsoever" to her in the design of her training

course was reinforced by the fact that she did not incorporate any ES recommendations into her design. Some three weeks after the pilot test, ZM left the field of training to return to a line position. Her lack of enthusiasm over the ES might have been a manifestation of her waning interest in training in general. On the other hand, one could also interpret her comments as being the most honest and clearly articulated of all. Since she was leaving training in any case, she may have felt that she had little to lose by speaking her mind. I believe that it would be unwise, therefore, to discount ZM's negative comments when evaluating the impact of the ES (see section 5.3 later in this chapter).

Question 2b - Conclusions

* From the examination of Items 10 and 11, I learned that both the quality and the quantity of decision-making seemed to have been positively influenced by the ES.
* A lesson learned from Items 12 and 13 was to try to assess user resistance to the technology in any similar future system development.
* Under Items 14 and 15 it was suggested that obtaining a verbal commitment from users to recommend the ES to other potential users could have served as a means to encourage use of the ES within the organisation.
* From Item 16, I learned that some users claimed that the ES would be of no use to them in their job situations, and that it was advisable not to discount such negative concerns.

Research Question 2c

What suggestions would the trainers make for improvements or alterations to the system?

Trainers' suggestions regarding the ES, shown in Table 4.4, were divided into two categories:

* Suggestions for improvements to the ES (Items 17 to 21).
* Suggestions for the application of the ES (Items 22 to 24).

Item 17 - Spell out purpose of ES more clearly - Since two of the three users who volunteered this suggestion were members of the method selection pilot test group, it struck me that the original introduction to this section of the ES was inadequate. I rewrote this introduction after the pilot test.

It will also be recalled that five users reported difficulties with the ES operating instructions (see Item 2). These reports, together with the occurrence of a number of related difficulties regarding answering questions (see Item 3) or location in the ES (see Item 4), were taken as further indications of the need to spell out the purpose of the ES more clearly.

Item 18 - Provide on-screen help for the user - The lack of specific on-screen help to users about the content of the ES knowledge base can be regarded as a significant criticism of the ES.

I had originally assumed that the help on operating the ES (for example, on which keys to press, and when to press them), provided automatically by the Level 5

software, would be adequate. However, VS's suggestions (see Table 4.3), and the nature of many of the difficulties that users experienced with the ES (Items 1 to 9 above), suggest that the help automatically provided was inadequate for the level of user for whom the ES was intended.

Item 19 - Improve clarity of ES wording - Six of the seven users who suggested improving the clarity of wording in the ES referred to the problem of double negatives already discussed (see Item 6 above). Not all my early attempts to eliminate this effect were successful, since even when the complete ES was being evaluated, two users still complained of the same effect.

In addition to the above, JN recommended that the description of the term 'social skills' be expanded to include selling and marketing skills. Since I considered that selling and marketing contained more than a social skills component (for example, a knowledge of facts and concepts of a product, plus certain procedural skills), I did not alter the knowledge base in response to JN's suggestion.

As regards TW's suggestion that the description of the term 'cognitive skills' be broadened to include planning skills, I subsequently included planning skills as one example of cognitive skills.

Item 20 - Widen ES scope to embrace more types of instruction - Of the six users who suggested that the scope of the ES be widened to embrace more types of instruction, the suggestions made by JN (to include selling and marketing skills), TW (to include planning under cognitive skills) and IP (to try to cover the overall area of management development) have already been discussed (see Items 16 and 19 above).

The remaining three users recommended that the ES be adapted to cater for broader educational topics, such as intercultural communication and writing skills, rather than being limited to training-related topics, such as procedural skills, psychomotor skills or product knowledge.

With the ever-present threat of a combinatorial explosion if more factors were added to the knowledge bases, I was reluctant to widen the ES's scope further. Perhaps what I could have done was to explain the scope of the ES more clearly in the introductory screens.

Item 21 - Provide demonstration lessons to familiarise users - The provision of some form of demonstration lesson for users prior to their consultation sessions might have helped to avert some of the difficulties that users experienced with the ES (see items 1 to 9 above).

With the CBT authoring facilities available to the Bank, a CBT demonstration lesson of the ES could have been created. My reasons for not producing such a lesson were that:

* The target population for which the ES was intended was relatively small, being estimated at about 35 trainers per annum, and the cost of CBT lesson development would have been difficult to justify.
* There was a shortage of time and of skilled human resources available to develop such a lesson.

AE's suggestion that she would have preferred a dry run with the ES prior to the actual consultation session, struck me as quite feasible. Had the suggestion not been made so late in the evaluation process, I would have encouraged all potential users of the system to undertake such a dry run.

Item 23 - Include ES in future ID workshops - As noted in Table 4.3, two of the more experienced instructional designers who evaluated the ES recommended that the ES be included as one of the activities in future ID workshops.

Item 23 - Encourage staff involved in ID to use ES - This item is related to Item 22 above. A final decision about whether to use the ES in the Bank's ID process has not yet been taken. A point in favour of using the ES is the large proportion of users (seventeen out of twenty) who suggested that the ES should be used by all staff designing instruction in the Bank.

Were the ES to be made available to designers of instruction, it would be offered only as an optional aid to design, and not forced upon any designer. The individual preferences, styles and needs of each designer would have to be taken into account, and enforcing uniformity of design procedures too rigidly could engender resistance (see section 5.4.2 of this chapter).

Item 24 - Scrap the ES - Perhaps as a result of the lack of ES recommendations that he found he could use, GA recommended that the ES be scrapped. The comment was in contrast to the large number of user suggestions advocating adoption of the ES thoughout the Bank for ID purposes (Item 23 above).

It would be unwise, however, to simply ignore reactions such as those displayed by GA and ZM (see Item 16). If use of the ES were to become widespread, this rejection by a minority of ten percent of users would represent a large number of potential users that could lead to a flurry of unfavourable reports that might threaten implementation of the system. I regret that I did not probe more deeply into the reasons why GA and ZM, by their own admissions, expressed rejection of the ES.

Question 2c - Conclusions

From the examination of items 17 to 24 I learned that:

* Care must be taken to ensure clarity of the introduction to an ES (Item 17).
* Users should preferably be given the opportunity to re-examine the introductory screens of the ES at any time during a consultation session (Item 17).
* The Level 5 software makes provision for the creation of content-specific help facilities. Such help should have been created and included with the ES (Item 18).
* The need to avoid double negatives was reinforced, as well as the need to use vocabulary and concepts that all users can relate to (Item 19).
* It is necessary to ensure that the scope and purpose of the ES are explained clearly in the introduction to the ES (Item 20).
* I should have included some means of allowing users to practice on the system, to enable them to become familiar with the system before their consultation sessions (Item 21).
* Despite some user recommendations to include the ES in future ID workshops, to date this has not been done (Item 22).
* The user recommendation to encourage other staff to use the ES has also, to date, not been put into effect (Item 23).
* The user recommendation to scrap the ES was not acted upon. On the other hand, this recommendation was taken as an indication that alternatives to the ES must be provided to designers of training, since the ES might not suit the needs of all designers under all circumstances (Item 24).

5.3 Comparison of Users' Own Decisions and ES Recommendations

In an attempt to answer research questions 3a, b and c, I turned to the comparison of users' own decisions and ES recommendations reported in section 4.3 of Chapter 4.

Research Question 3a

> Would the quality of any alterations made by trainers to their instructional designs after exposure to the system measure up to my personal standards of ID effectiveness?

As already noted, some fifteen out of the total twenty users in the study altered their designs following exposure to the ES (see Item 11 above). Barring the influence of uncontrolled intervening variables[5], it seems reasonable to assume that the alterations were made as a consequence of users' exposure to the ES.

In order to examine further the value of ES recommendations made, I borrowed the concept of added value from the world of business[6]. In the present study, added value was associated with both the quality and the quantity of ES recommendations, not originally in evidence in a design, that a user incorporated into the design and that, in my judgement, enhanced that design.

In so subjective an evaluation, I felt it was important to avoid the assumption that design alterations were inevitably improvements to that design, or that they were always the result of the ES consultation. It is conceivable that some alterations were prompted by recommendations of dubious value, or were made by users without, or despite, the influence of the ES.

With these reservations in mind, I assessed the added value for each of the four ES test groups as described below:

1. Added Value Assessment for the Needs Analysis Pilot Test Group (see Table 4.5)

All in all, I found considerable evidence of added value in the results for this group:

* SA adopted two of the ES recommendations, both dealing with what I considered to be significant aspects of his training design, namely the need to address the provision of both psychomotor skills training and knowledge training.
* The ES recommended that SS address a non-training related dimension (in effect a management problem) to the performance problem she was analysing. Following this recommendation, SS decided that the training that she had intended to develop would not solve the performance problem. The training was cancelled and replaced by a non-training related solution to the problem. I believe that the added value provided by the ES in this case was considerable, in that it helped to avert the production and presentation of a training programme that may not have addressed the performance problem identified. This was one of the clearest examples of the usefulness of the ES that I encountered during the study.
* TW's adoption of the need to address a knowledge deficiency in his training programme was also taken as evidence of added value.
* No direct evidence of added value could be derived from the results of DD's consultation session. However, the two needs that the ES recommended matched those that DD herself had identified. This may have served to reassure her that she was on the right track in her analysis.

Unfortunately I did not establish whether this was, in fact, the case.

2. Added Value Assessment for the Method Selection Pilot Test Group (see Table 4.6)

Upon reflection, the results for the method selection pilot test did not appear to be as disappointing as I had originally expected (see p4.7). I found evidence suggesting that ES recommendations had added value to the designs of three of the four pilot test users:

* Of four methods recommended by the ES, KS adopted two, behaviour modelling and the use of a job aid. On this basis, I attributed a limited amount of added value to the ES consultation. This was reinforced by KS's admission that she "would never have thought of the suggested methods" on her own.
* Of the two ES recommendations adopted by PH, I had little hesitation in judging the attitude change programme to be an enhancement to his design.
* Of the three ES recommendations adopted by IS, the long-term attitude change programme became a cornerstone of her intercultural communications programme. IS admitted that the use of such a programme had not occurred to her.
* No evidence of added value could be derived, however, from the results of GA's consultation session.

3. Added Value Assessment for the Media Selection Pilot Test Group (see Table 4.7)

In general, I was satisfied that there was considerable evidence of added value in the results

derived from this group:

* MJ's adoption of the ES recommendation to use TBT as the primary delivery medium represented a significant change in her design. It resulted in her training programme being distributed to learners throughout the country, rather than, as originally intended, only to those in the Johannesburg area.
* RB included the use of video for a small portion of her instructional programme. I believe that this added some variety to the programme.
* For NB, a form of reverse added value occurred. The ES recommendation appeared to convince NB not to select video as a delivery option, because of a lack of video production resources. This was an example of how, by simply working through the series of questions provided by the ES, the user was forced to reconsider the wisdom of a particular decision. The ES did not actually recommend that the user avoid video, but it did question the availability of video development resources. As NB said, "The computer forced me to think."
* Despite IP's request that the scope of the ES be extended (see section 5.2, Item 20), I noted that his selection of media closely matched the ES's recommendations. IP's several years of experience in the Bank's approach to ID was taken as evidence of the validity of the ES's recommendations. As was the case with DD (see point 1 above), IP may have derived reinforcement and support for his own choices of media from the ES, but I found no direct evidence of added value in the results of his consultation session.

4. Added Value Assessment for the Complete ES Test Group (see Table 4.8)

From the results of the test of the complete ES, I concluded that a considerable amount of added value had been provided by the ES. All but one user adopted ES recommendations which I judged to have enhanced their instructional designs. These indications of added value were supported by numerous positive comments made by the users themselves:

* LA adopted four ES recommendations, including the use of PI as a medium. This took the form of a self-study workbook, later reported to have been "most successful" by LA herself when used in the field.
* VS adopted five ES recommendations. Although the two skills deficiencies identified and the two methods recommended by the ES no doubt also influenced her design, for me the major impact of the ES came from its recommendation to use TBT as a medium. As was the case with MJ's programme (see point 3 above), this resulted in VS's training programme being distributed to a far wider learner population than originally intended.
* I found VS's comments that the ES was "like an outside person", and that people with whom she worked were often too busy to offer advice and assistance, to be of particular interest. Although I did not envisage the ES as a human surrogate, it seems that, in the absence of human assistance, the ES could assist a designer to generate alternative ID ideas, or to check the feasibility of a particular line of their own thought.
* Although JN incorporated four ES recommendations into her design, the changes that she made to her design were not extensive, consisting chiefly of the introduction of a number of additional

instructional methods. The relatively limited impact of the ES on her work was supported by her comment that the ES was "a bit of a waste of time" for experienced instructional designers. In JN's case, therefore, I judged the amount of added value provided by the ES to be relatively minor. However, since the ES was not intended for use by experienced instructional designers such as JN, I was not unduly concerned.

* Of the four ES recommendations that AE incorporated into her design, I considered two, namely those relating to the needs to address procedural skills and cognitive skills deficiencies, to be of critical importance to her training programme. This evidence of added value was supported by AE's comment that she "had never thought of the course (that she was designing) in such detail" before having been exposed to the ES.

* All three ES recommendations that CK incorporated into his design were taken as evidence of added value. His adoption of PI both as a method and as a medium, resulted in considerable, in my opinion positive, changes to his design. CK's comment that using the ES was "like brainstorming" was taken as a further indication that the ES had provided added value, serving as a source of ideas, or as a sounding board for his own ideas.

* The ES recommended numerous alternative instructional methods for GD, and indicated a potential attitude problem. Subsequent to these recommendations, GD made several alterations to her instructional design, in my opinion enriching it considerably in the process. A new dimension was added to her design when she took into account the learners' attitudes, and the range of instructional activities was enhanced by including group discussions and project work for learners.

* Of the six ES recommendations that SE incorporated, perhaps the clearest evidence of enhancement to her design was the incorporation of TBT as a medium. As in the case with MJ and VS (see above), use of this medium broadened the reach of the user's training programme significantly.
* No evidence of added value could be found for ZM. This was not entirely surprising, taking into account her negative stance towards the ES and, I believe, towards her role in training in general. As noted in section 5.2 above, ZM's rejection of the ES was cause for concern regarding the applicability of the ES to all designers of instruction under all circumstances.

Question 3a - Conclusions

* The majority of users in each test group altered their designs to some extent, in line with ES recommendations, following exposure to the ES.
* Some of the changes that followed ES recommendations had far-reaching implications on the users' designs and on their subsequent instructional programmes.
* In some cases, ES recommendations appeared to inhibit the adoption of a particular course of action in a users' design. Thus SS's instructional programme was aborted, and NB decided against using video.
* Comments by a number of users supported the notion that the ES served as a source of novel ideas for enhancements to the users' designs, or as a sounding board for the users' own ideas.
* One worrying outcome of the ES pilot test was the negative reactions of one of the users, ZM, to the system. This was taken as a warning that such systems may not appeal to all designers of instruction, and as a reminder that alternatives to the use of the system should be provided. Such alternatives could include a

written guidebook providing advice on ID, or one-on-one guidance by an experienced instructional designer, if available.

Research Question 3b

Would the trainers reject certain recommendations made by the system?

Those ES recommendations that were actively rejected (as opposed to being merely ignored) by users I counted as having been rejected.

Possible reasons why users rejected ES recommendations may have included:

* Resentment that they had not thought of an idea themselves.
* Lack of faith in the ES, or in technology in general.
* Fear of, or resistance to, the technology.
* The impression that their own specific ID circumstances and conditions were not being catered for by the ES.
* The possibility that the users simply did not understand certain recommendations.
* They genuinely rejected the recommendation.

Regrettably, I did not probe specifically to ascertain the reasons for users' rejections of ES recommendations. This was an oversight, since such information may have yielded valuable clues regarding the acceptability or otherwise of the technology, as well as to what could be done to make the ES more useful and relevant to potential users.

User rejections from each of the four ES test groups are examined in turn below:

1. Assessment of User Rejections for the Needs Analysis Pilot Test Group (see Table 4.5)

Two users rejected ES recommendations in this test group:

* SA's rejection of the ES's identification of a need to address a non-training related issue may have been justified. Even after examining the circumstances surrounding the problem SA was addressing, I was unable to determine whether such a need in fact existed.
* After examining the circumstances surrounding the problem that SS was addressing, I decided that a knowledge deficiency probably did exist. I do not, therefore, believe that SS's rejection of the knowledge deficiency identified by the ES was entirely justified. This was an example of where I could have probed for possible underlying reasons for user rejection of the ES.

2. Assessment of User Rejections for the Method Selection Pilot Test Group (see Table 4.6)

Again, two users rejected ES recommendations in this test group. In both cases, I believe the rejections were justified:

* Both PH and GA rejected the ES recommendations that a job aid be used, and I agreed with these rejections. In both cases a job aid seemed inappropriate, given the requirements of the situations being addressed. I discovered later that the ES had no rules to check for appropriate physical conditions in the workplace where the job aid was to be used. The ES was, therefore,

providing recommendations based on inadequate information.

3. Assessment of User Rejections for the Media Selection Pilot Test Group (see Table 4.7)

For this test group, no specific rejections of ES recommendations were reported. This positive finding is in keeping with my relatively greater satisfaction with the media selection knowledge base (see p4.8).

4. Assessment of User Rejections for the Complete ES Test Group (see Table 4.8)

Results for this test group indicated a limited number of specific rejections of ES recommendations. I concluded that some, but not all, of these rejections were justified:

* VS rejected the ES recommendation that PI could serve as a medium, saying that she believed that TBT would be more suited to her design and needs. She also rejected the ES recommendation regarding the possible existence of a non-training related need. After examining the problem that VS was addressing, I agreed that, if TBT was used, PI would have been redundant as a medium. However, I suspected that a non-training related need did exist. I concluded that VS's rejection of the ES recommendation regarding media selection was justified (if somewhat trivial), but that her rejection of the need to address additional needs was not entirely justified.
* I noted that JN rejected PI and correspondence as media options. After examining the problem that JN was addressing, I concluded that her rejection was probably justified.

* ZM specifically rejected the ES recommendation regarding the possible existence of a non-training related dimension to the problem she was addressing. After examining this problem, I concluded that a need to address a non-training related dimension did, in fact, exist, and that ZM's rejection was not entirely justified.

Question 3b - Conclusions

* A number of rejections were noted in all test groups other than the media selection pilot test group.
* In some cases I considered the rejections to be unjustified, particularly rejections of needs analysis recommendations. I believe that in many such cases the problem lay in users' lack of experience in detecting such needs.
* A lesson that I learned from the analysis of user rejections was that I ought to have probed for the reasons underlying these rejections.

Research Question 3c

Would the system fail to make certain recommendations that I would regard as valid?

When I noted that an apparently valid ID decision in a user's original design was absent from the list of recommendations made by the ES for that design, I recorded the decision as having been omitted by the ES. I also counted as omissions any recommendations that the ES failed to make that I myself would have made.

The omissions from each of the ES test groups in turn are examined below, together with a description of what action, if any, I took when an omission was detected:

1. Assessment of ES Omissions for the Needs Analysis Pilot Test Group (see Table 4.5)

* I regarded the ES's failure to detect a procedural skills deficiency in the problem being addressed by SA as a serious ommission. I immediately attended to the problem, which turned out to be a missing rule in the knowledge base.
* In TW's consultation session, the ES omitted to make a recommendation regarding the possible existence of a procedural skills deficiency. This led me to raise the probability of this recommendation being made by the ES in future sessions.

2. Assessment of ES Omissions for the Method Selection Pilot Test Group (see Table 4.6)

* Both KS and I agreed that the ES could have recommended some method for dealing with attitude change. I subsequently altered the ES so that it could generate recommendations regarding awareness enhancement and long-term attitude change programmes as possible methods (see rules in Appendix D). Although these recommendations were rather vague, they were subsequently adopted by later users of the ES (see discussion of research question 3a above).
* I noted that the ES had omitted to mention games and debates as possible methods in IS's design. I subsequently inserted these methods as options in the method selection knowledge base.

3. Assessment of ES Omissions for the Media Selection Pilot Test Group (see Table 4.7)

* I noted that the ES had not recommended hands-on training for MJ's design. I subsequently included hands-on training as a medium in the ES rule base.
* After examining the ES's recommendations to RB, I became dissatisfied that mass broadcasting and internal company communications had been recommended as media for her instructional programme. I subsequently lowered the probability of these media being recommended by the ES.

4. Assessment of ES Omissions for the Complete ES Test Group (see Table 4.8)

* I noted that the ES had missed making recommendations about:
  - A procedural skills deficiency in the problem that LA was addressing.
  - Simulations or tutorials for JN's design.
  - Behaviour modelling or role plays as methods for AR's design.
  - Simulations or group discussions as methods for CK's design.
  - The need to address a procedural skills deficiency in ZM's consultation session.
  - Video as a medium of instruction for GD's design.
  - Roles plays, case studies and group discussions for SE's design.

In each of the above cases, I re-examined the relevant knowledge bases to discover why the ES had failed to make the recommendations. In the majority of cases I succeeded in finding some logic

or probability problem, and readjusted the ES to produce the required recommendations in the future. However, in the cases of LA's, AE's and ZM's results, I could find no obvious problem with the ES, and eventually concluded that the omissions were probably the result of the users having provided inappropriate answers to questions posed by the ES.

Question 3c - Conclusions

* The ES failed to make a number of what I considered to be feasible recommendations to users. By failing to make these recommendations, the ES may have blinded users to the possibility of certain ID alternatives, thereby possibly reducing the richness and effectiveness of whatever instructional programme ensued from the users' designs.
* The examination of potential recommendations that the ES omitted proved to be a useful means of discovering gaps in the knowledge bases, as well as problems with logic and probability settings in the ES.

5.4 A Critical Review of this Study

In this section, the development and evaluation of the ES are critically reviewed under the following headings:

5.4.1 The Narrowing Scope
5.4.2 Precriptiveness and Creativity
5.4.3 The Research Methodology
5.4.4 The ES Development
5.4.5 Pilot Test Results

5.4.1 The Narrowing Scope

As noted in Chapters 3 and 4, the scope of the system changed over time. From being a broad and ambitious attempt to provide recommendations on a wide range of ID issues, it became more limited in scope, focusing on three very specific areas within the ISD model, namely needs analysis, method selection and media selection.

To some extent, the narrowing scope of the study can be regarded as a predictable outcome of much qualitative research into emergent phenomena. Stake (1983:288-289) noted a tendency for the scope of qualitative research to start out broad and ill-defined, becoming more focused as more is learned about a phenomenon.

The fact that the ES did not go into greater depths in terms of problem analysis can be regarded from a positive perspective. Romiszowski (1981:215) advised that it is unnecessary for designers of training to go any deeper than:

* The level of complexity the training problem warranted.
* The level that users of the training design would go to put the programme into effect.
* The level that users could afford to go in terms of time and/or resources.

Rummler (1976:14.2) warned that: "Organisations generally have a low tolerance for analysis of activities which they feel smack of "research"." For example, too much analysis might cause management of an organisation to regard analysis as the designer's attempt to look busy, rather than getting down to the job of creating instruction.

Viewed from a more critical perspective, it must be admitted that the final version fo the ES came nowhere close to the

"AI-supported Instructional Design System" originally proposed. Even the three ID areas of the ES that were included were severely restricted in their scope:

* The needs analysis dealt with only one of at least twelve possible steps in a more complete needs analysis procedure (Sredl and Rothwell, 1987:31), namely the interpretation of the needs analysis findings. In addition, the needs analysis took into serious consideration the values of only one of at least three possible sets of interested parties (Guba and Lincoln, 1982:58), in that it only catered for the values of the organisation (the Bank). Nowhere in the knowledge base was there any mention of a need to establish the values of learners, nor of the wider community in which the learning was to take place.
* The method selection knowledge base focused to a large extent on the broad strategic distinctions between expositive and discovery learning. Other factors influencing method selection, such as learner preferences and individual learning styles (Kolb, 1977) were omitted.
* The media selection knowledge base concentrated on the availability of resources for various media, overlooking individual learning styles and preferences as media selection factors.
* All three knowledge bases took little account of the principles and practices of adult learning espoused by educators such as Knowles (1970). For example, the needs analysis ignored Knowles' injunction to involve learners in the analysis of their own learning needs (Knowles, 1970:52-53), as well as his recommendation to negotiate learning contracts with learners (Knowles, 1980:245). Similarly, in both the method and media selection knowledge bases, there is little evidence of the need to consult with learners, involve them in the instructional process, or make the learning especially relevant to them.

My conclusions about the narrowing scope of the study can be summarised as follows:

* The narrowing of the scope was difficult to avoid, and was perhaps the natural outcome of a study focused on an emergent, poorly defined and evolving technology.
* On the other hand, it is possible that the narrowing of the scope placed limitations on the effectiveness of the ES, since many ID factors in the three knowledge bases were ultimately excluded.

5.4.2. Prescriptiveness and Creativity

Two potential criticisms of the ES, based as it was on the ISD model, are that:

1. It may have encouraged a prescriptive, mechanistic approach to the design of ins
2. It may have impeded user cre

The above two criticisms will now be examined in detail:

1. The ES as Prescriptive and Mechanistic

As noted in Chapter 2, Nadler (1982, 7-8) advocated the use of a closed system for the design of training (as opposed to education or development), because of the focused, performance-oriented approach demanded by training. The ISD model, upon which the ES knowledge base in this study was built, is such a closed system (see Chapter 2), and exclusive reliance on the expertise of the designer lay such an approach open to charges of it being prescriptive and mechanistic.

In the present study, the ES may have added another dimension to the issue of prescriptiveness. Since the ES involved a technology beyond the experience of the average Bank trainer, some users may have regarded it

as rather awe-inspiring and omniscient, precisely the effect of technological mystification that Weizenbaum (1976:10) warned about (see Chapter 2 of this report). It is conceivable that such users would accept any recommendation proposed by the ES without question. The fact that I failed to ascertain the specific reasons why fifteen out of a total of twenty users adopted ES recommendations (see section 5.3), can be regarded as an oversight of this study. For one thing, the degree to which any mystification effect was operating might have been revealed.

However, at least some of the users did display a capacity to resist the system's prescriptions. This is borne out by the number of ES recommendations (ten in all) specifically rejected by users (see Tables 4.5 to 4.8 and discussion in section 5.3). In addition, eleven of the twenty users indicated that the ES should be used more as a guide to help designers confirm their own designs rather than to determine design decisions without the designer's discretion (see Item 23, section 5.2).

My conclusion about the issue of prescriptiveness was that, although the potential for it existed using the ISD model in an ES knowledge base, some users countered this prescriptiveness with a display of healthy scepticism.

2. The ES and User Creativity

Related to the criticism regarding presciptiveness is the possibility that the ES may have interfered with the creative processes of the user.

It has been my experience that the successful design of instruction involves a strong measure of creativity. This is supported Bell and Putnam (1979:27), who wrote

that "the playground of the training designer is littered with both art and technique."

De Bono (1980:34-36) argued that analytical and creative modes of thought are incompatible, and cannot occur simultaneously. By implication, the ES, based on the ISD model (with its heavy emphasis on analysis of training needs, tasks, target population factors and learning domains), might be regarded as a threat to the creativity required of the designer.

My own experience is that the ID process can involve both analysis and creativity at different times. One often starts with an analytical approach, which I would regard as necessary for determining the parameters of an instructional programme. This is then followed by a more creative phase, during which a less rigorous approach is adopted for the generation of ideas for the methods and delivery media of the instruction.

I came to the conclusion that the needs analysis component of the ES tended, naturally enough, to encourage the analytical process, while the method and media selection components supported the subsequent idea-generation process.

* Use of the needs analysis component was followed by some users re-examining the problems for which they were designing solutions in greater depth. For example, SS re-investigated the situation for which she was designing a training programme, and found that, as the ES had recommended, there were other, non-training related forces at play that demanded priority attention (see p4.20).
* The large number and variety of methods and media recommendations produced by the ES and adopted by users into their designs demonstrated the

idea-generation process in action (see section 5.3).

The reactions of a number of users to the ES also seem to support this conclusion. For example, while AE claimed that the ES forced her to adopt a more analytical approach to the design of instruction (see p4.29), CK commented that using the ES was "like brainstorming" (p4.30), and LA remarked that the ES had "opened a window" on a whole range of ideas that she had not considered originally (p4.27).

It must be noted, however, that not all users expressed such positive views. Both IS and JN commented that the ES was, to some degree, a waste of time (p4.14), and ZM went as far as to say that the system had been "of no use whatsoever" (p4.15). These comments I took as indications that the ES had failed to stimulate the creative processes of these users.

My conclusions about the issue of user creativity and the ES were that:

* The method and media selection components of the ES appeared to have encouraged the idea-generation process, and therefore supported the production of more creative designs.
* I found no evidence that the ES actively impeded users' creativity, although in isolated cases users reported that it was a waste of time or of no use to them.

5.4.3 The Research Methodology

No apologies will be made in this section for the adoption of a qualitative approach to the research undertaken in this study, and few attempts will be made to critique the study

because of its lack of 'scientific' control over variables, validity or reliability. However, from within a qualitative, interpretive paradigm, certain aspects of the study warrant examination. Two interrelated aspects, namely the duration and the depth of the study, are discussed below:

1. Duration

One way of classifying research in terms of duration involves drawing a distinction between cross-sectional and longitudinal studies (Good, 1954:803-807). Briefly, a cross-sectional study is conducted around a fixed point in time, while a longitudinal study is conducted over a period of time. As with the distinction between qualitative and quantitative approaches to research (see Chapter 2), pure cross-sectional and pure longitudinal types can be regarded as opposing extremes of a continuum, with many studies lying between the two extremes.

I believe that the present study, although conducted over a considerable period of time, is best seen as lying closer to the cross-sectional end of the continuum, since the results of each user's interaction with the ES were gathered only once.

It could be argued that a more longitudinal research design would have yielded information missing from the present design. For example, I could have included a follow-up to the pilot tests to ascertain the longer-term impact of the system on users and their work. I could also have examined the actual training programmes resulting from users' designs, and the effect of these programmes on learners, possibly learning more about how the technology influenced the quality of the resulting learning experience on adult learners.

2. Depth

The depth of the study might also have been increased. By depth I mean the extent to which the study delved into underlying, hidden factors at play.

For example, more attention could have been paid to differences in users' preferences for a technology based approach to ID. Some form of pretest or questionnaire could have provided information about such preferences. This information might then have helped to explain the success or otherwise of a particular user's ES consultation session.

Many other such factors might have been revealed by deeper probing, including:

* The effects of users' previous ID experience on how they made use of the ES.
* The influence of a specific subject matter for which instruction was being designed on how the ES was used.
* The effects of the scale and scope of the instructional programme on the effectiveness of the ES.
* Possible side-effects of using the ES, such as incidental learning of the knowledge base content over time, as noted by Lippert (1989:14).

In conclusion, as regards research methodology, I believe that more benefit would have been derived from the present study if both the duration of the research period, and the depth of my analysis of the effects of the ES had been greater.

5.4.4 The ES Development

In this section, the following issues will be examined:

1. The Approach to ES Development
2. The Knowledge Acquisition Process
3. The ES Itself.

1. The Approach to ES Development

By and large, the approach to ES development adopted in the present study followed that advocated by a number of writers in the field of ES development (see Appendix C). I am satisfied that the progression, from domain definition, to process charting, to rule production, to prototype ES development, and finally to iterative testing, succeeded in helping to produce a usable ES.

2. The Knowledge Acquisition Process

My experiences of acquiring the expertise for the three knowledge bases, both from the writings of authorities in the field of ID, and by means of interviewing myself, have already been discussed (see section 5.1).

I believe that it would have been preferable to use separate individuals as knowledge engineer and as subject matter expert. The interaction between these two (or more) individuals may have enhanced the profundity and logical clarity of the resulting knowledge bases. In the knowledge acquisition process, the knowledge engineer asks the subject matter expert probing questions, encouraging the subject matter expert to continually revisit the same areas of expertise over and over again, and to explain the concepts and processes of his or her field of expertise in terms that the layperson can understand (see Appendix C). In the present study no such discipline and stimulation via interaction was

possible, since one person (myself) acted as both knowledge engineer and as subject matter expert simultaneously.

3. The ES itself

A significant criticism of the ES is centred around its user interface. I was concerned at the number of users who seemed to experience difficulties in understanding the operation of the ES, or its function in the ID process (see section 4.2.1). From the suggestions of some of the users (see section 4.2.3), from my own observations and reflections, and from an examination of the literature (eg Eary, 1987:94), it now seems clear that I should have included:

* Some form of introductory exercise for users, possibly in the form of a CBT simulation of the ES.
* More extensive help facilities for users to call upon during the ES consultations.

Another criticism of the ES was the lack of integration between the three knowledge bases, resulting in a certain amount of duplication of effort for the user. In the needs analysis knowledge base, for example, there was a check for the existence of various types of skills or knowledge deficiencies in a performance problem situation. Later, in the methods selection knowledge base, the same check was repeated. By combining the rules of the two knowledge bases, such duplication could have been averted.

My conclusions from the above critical examination of the ES development process in this study were:

* The standard approach to ES development, advocated by many writers in the field, succeeded in producing a usable ES.
* I believe that the knowledge acquisition process would

have been enhanced if separate individuals had served as knowledge engineer and as subject matter expert.

* ES users would have benefited from an introductory exercise in using the ES, as well as from more extensive help facilities.
* The three ES knowledge bases should have been more integrated to prevent duplication of effort by users.

5.4.5 Pilot Test Results

In this section, the results of the pilot tests are critically examined under the following headings:

1. The Field Notes
2. User Reactions to the ES
3. Comparison of User Decisions and ES Recommendations.

1. The Field notes

The field notes revealed the large amount of time that I seemed to have lost attempting to design and program my own ES shell (see Table 4.1). Over a period of several months, the only obvious output was a series of rejected attempts to produce such a shell.

Less obvious developments, however, were taking place during this period. The scope of the intended "AI-supported Instructional Design System" was becoming honed down to cater for a system more feasible to produce within the available time frame, and with the limited resources and expertise at my disposal. In addition, I was learning many of the intricacies of AI and ES technology, from readings, discussions and from my practical experiences in trying to create the ES shells. I am, therefore, inclined to regard this period not as a waste of time, but as a period of intense learning and refinement of the parameters of the system that was

eventually produced. To quote from Chorafas (1987:194), ESs "cannot be learned through books and conferences. The only way to get experience is to work on the development of an expert system yourself."

2. User Reactions to the ES

The issue of researcher bias[9] in my interpretation of user reactions to the ES warrants critical examination:

* The effect of my presence on users may have influenced their interaction with the ES and their choice of words during the consultation sessions and interviews. However, some users, at least, did not seem to be too afraid to speak their minds. Thus ZM and GA were able to indicate that the ES had been of no use to them (pp4.15 and 4.18), and JN and IS were able to refer to the ES as a waste of time in their own circumstances (p4.14).
* Another source of bias may have arisen from my vested interest in the development and evaluation of the ES. This may have led me to employ selective perception[10] in my recording of information. For example, during the content analysis process, I may have unwittingly grouped findings in ways that presented the ES only in its best light.
* As noted by Eisner (1985:261), even the choice of research questions themselves can involve a degree of investigator bias, since the formulation of these questions may be in accordance with what the investigator expects to find, and not what might best be revealed by the study.

The effects of these uncontrolled factors upon the records of user reactions might have been considerable. Regrettably, no attempt was made in the present study to ascertain or control these effects.

One means of reducing the effects of researcher bias might have been to use one or more independent observers or interviewers, without vested interests in the success or failure of the ES. In the present study, however, it would have been difficult to locate individuals with the required skills to perform this task.

Similarly, the interpretation of the findings of the research could have been performed by an independent researcher. Again, however, this would have been difficult to arrange in practice.

3. Comparison of User Decisions and ES Recommendations

Another criticism that could be levelled at the present study was that little attempt was made to encourage users to make further use of the ES, as some had stated that they had intended to (see section 5.2).

The gap between intentions and actions noted in section 5.2 of this report might have been approached in the light of studies of attitudinal and behavioural change. For example Festinger's theory of cognitive dissonance (Festinger, 1957) proposed that if an individual perceives an inconsistency between his or her behaviour and attitudes, or between two beliefs, attitudes, or behaviours, the individual will experience a degree of discomfort. In order to reduce this discomfort, the individual will seek to reduce the inconsistency in some way, either by altering the beliefs, attitudes or behaviours, or by explaining away the inconsistency via rationalisation. In terms of this theory, one way in which to begin changing attitudes or behaviour would be to draw the individual's attention to inconsistencies between his or her various attitudes, beliefs or behaviours.

In the present study, I might have been able to encourage users to adopt the ES by devising some means of indicating to them the lack of consistency between their stated intentions (for example to use the ES) and their actions (for example to continue doing their jobs without using the ES).

My conclusions regarding the above critical examination of the pilot test results in the present study can be summarised as follows:

* As the field notes show, there was much that I had to learn about developing an ES, and I believe that such learning is best done in a hands-on, practical manner.
* Users' overt reactions to the ES, as well as other results of the study, may have been considerably influenced by investigator bias. It would have been preferable to use independent researchers to observe and interview users and to interpret the findings of the study.
* Pointing out to users the dissonance between their stated intentions and their behaviour as regards the adoption of the ES in their working lives may have encouraged greater use of the ES beyond the pilot testing situation.

5.5 Guidelines for Future Bank AI-based Instructional Systems

Research Question 4a

What guidelines for future development could be derived from an examination of the processes of development and evaluation of the system?

In attempting to answer research question 4a, I examined my conclusions regarding the preceding research questions and the critical review of the study already discussed in this chapter.

The guidelines below represent a distillation of the lessons I learned during the development and evaluation of the ES. They are intended for use in the development of other AI-based instructional systems in the Bank, on the assumption that such systems could bear a resemblance to the ES developed and evaluated in the present study. The guidelines are presented under the following headings:

1. Planning the System
2. Developing the System
3. Testing and Evaluating the System
4. Some Results the Developer can Expect
5. Implementing the System

The source of each of the guidelines is included in parentheses following the description of that guideline.

1. Planning the System

* There is much that a would-be developer has to learn about developing an AI-based instructional system, and such learning appears to be best done in a hands-on, practical manner (section 5.4.5 - part 1).
* Inexperienced would-be AI-based system developers can spend a great deal of time trying to program their own systems (section 5.4.5 - part 1). Pre-programmed ES software, such as the Level 5 software, is readily available and may be quite adequate for the developers' needs (Question 1a).
* Given prior experience with ES technology, total development time for a system similar to the one in the present study should be less than 850 hours (Question 1a).

* It is very important to establish the specific requirements of potential users before beginning development of the system (Question 1c - part 1).
* In an area of expertise such as ID, the system must be able to deal with ambiguity, without forcing 'either/or' choices on system developers (Question 1c - part 3).

2. Developing the System

* The standard approach to ES development, advocated by many writers in the field, can be used to produce a usable system (section 5.4.4 - part 1).
* It is preferable to enlist the help of live experts rather than relying exclusively on remote and theoretical expertise (Question 1c - part 2).
* The knowledge acquisition process can best be conducted if separate individuals serve as knowledge engineer and as subject matter expert (section 5.4.4 - part 2).
* Combinatorial explosions are likely to occur to the inexperienced ES developer, and tend to inhibit knowledge base development. They also tend to develop far more rapidly than expected (Question 1c - part 1).
* Developers can expect the process of knowledge base development to encourage them to clarify their own thinking about certain aspects of the field of knowledge under consideration (Question 1c - part 3).
* It may be necessary to try to overcome, or at least minimise, computerphobia in certain users. A means should be provided for all users to become more familiar with operation of the computer before beginning their consultation sessions (Question 2a - Items 1 and 3, Question 2c - Item 21).

* Care must to be taken to ensure clarity of the introduction to the system (Question 2c - Item 17).
* Ensure that the scope and purpose of the system are clearly spelled out in the introduction to the system (Question 2c - Item 20).
* Include ample information on introductory screens to explain system operating instructions (Question 2a - Item 2 and section 5.4.4 - part 3).
* Users must be given the opportunity to re-examine the system's introductory screens at any time during the consultation session (Question 2c - Item 17).
* Pre-programmed AI software (such as the Level 5 software used in the present study) generally makes provision for the creation of content-specific help facilities. Such help should be created and included with the system (Question 2c - Item 18).
* At all times make available help screens or messages explaining instructions on how to operate the system, terminology and concepts used (Question 2a - Items 2 and 5 and section 5.4.4 - part 3).
* Help users to navigate through the mass of information available in the system knowledge bases, for example by distinguishing clearly between ES questions and recommendations (Question 2a - Item 4).
* Avoid grammatical constructions involving either a double negative or the word 'or' when posing questions or making recommendations to users (Question 2a - Item 6, Question 2c - Item 19).
* Keep the language used in the system as simple as possible (Question 2a - Item 2).
* Try to use vocabulary and concepts that all users can relate to (Question 2c - Item 19).
* Where multiple knowledge bases are developed, developers should attempt to integrate these to

prevent duplication of effort by users (section 5.4.4 - part 3).

3. Testing and Evaluating the System

* Pilot testing is very important in order to fine-tune the system to cater for user diversity (Question 2a - Item 8).
* Encourage users to back out of a consultation session and start again if they encounter difficulties (Question 2a - Item 5).
* Pilot test users can be an invaluable source of assistance in locating spelling and grammatical errors in the system (Question 2a - Item 7).
* Developers should try to assess the degree of user resistance to the technology employed in the system (Question 2b - Items 12 and 13).
* When pilot testing the system, developers should probe for the underlying reasons for any user rejections of system recommendations (Question 3b).
* The examination of potential recommendations that the system omits can be a useful means of discovering gaps in the knowledge bases, as well as problems with logic and probability settings in the system (Question 3c).
* As regards system evaluation, developers need to pay attention to both the duration of the research period, and the depth of any analysis of the effects of the system (section 5.4.3).
* Users' overt reactions to the system, as well as other results of an evaluation of the system, may be considerably influenced by investigator bias. It may therefore be preferable to use independent researchers to observe and interview users after their consultation sessions and/or to interpret the findings of the study (section 5.4.5 - part 2).

4. Some Results the Developer can Expect

* Developers can expect the scope of the system to narrow during development, as a natural [illegible] of a system based on an emergent, poorly defined and evolving technology (section 5.4.1).
* The narrowing of the scope of the system may place limitations on its effectiveness, since many knowledge base factors may come to be excluded (section 5.4.1).
* The developer can expect the system to influence positively both the quality of user decision-making and the quantity of decisions made (Question 2b - Items 10 and 11 and Question 3a).
* The system can serve as a source of novel ideas for users, or as a sounding board for the users' own ideas (Question 3a, and section 5.4.2).
* In some cases, system recommendations may serve to prevent the adoption of a particular course of action previously decided upon by a user (Question 3a).
* Developers must be aware that, by failing to make certain recommendations, the system may blind users to the possibility of alternatives, thereby possibly reducing the richness and effectiveness of solutions to problems being addressed (Question 3c).
* Developers can expect that not all users will find the system to be of use to them in their job situations, and it is advisable not to discount such negative concerns. It may be desirable or even necessary to provide alternatives to the system, to cater for differing needs and preferences. Such alternatives could include a written guidebook or one-on-one guidance by an expert, if available. (Question 2b - Item 16, Question 2c - Item 24, Question 3a).

5. Implementing the System

* Obtaining a verbal commitment from users to recommend the system to other potential users might serve as a means of encouraging more widespread use of the system within the organisation (Question 2b - Items 14 and 15).
* Pointing out to users the dissonance between their stated intentions and their behaviour as regards adoption of the system in the workplace could promote use of the system beyond the pilot testing situation (section 5.4.5 - part 3).

In this chapter, the findings of the study were discussed in relation to the research questions posed in Chapter 1. A critical examination of some of the techniques and interpretations adopted in the study was also conducted. In Chapter 6, various conclusions about the aims of the study are drawn, and a number of recommendations for further research are proposed.

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CHAPTER 6 - CONCLUSION

In this final chapter an attempt is made to establish, in broad terms, what this study managed to accomplish. The overall aims of the study are briefly reviewed to examine to what extent they were met. This review is followed by a number of recommendations for future research.

6.1 Review of the Aims of This Study

As will be recalled from Chapter 1, there were four overall aims of the study. Each of these aims is examined in turn below:

Aim 1

To discover what would be learned from the development of an AI-based ID system intended for use by Bank trainers.

The lessons learned in this study have been spelled out in detail in the conclusions reached after each of the research questions discussed in Chapter 5. Many are also summarised in the guidelines to future AI-based instructional systems development spelled out in section 5.5 of Chapter 5.

In general terms, the large number and variety of lessons that I learned bear testimony to the fact that I had a lot to learn about AI technology and about the capturing and reproduction of ID expertise when I began the study. Some of the more significant lessons learned were the following:

* As regards the issue of software, I learned that it could be of great benefit to avoid programming one's

own AI software and instead to use pre-programmed software such as an ES shell, if at all possible. This is not to declare that all AI-based instructional systems would be amenable to such an approach. Some will no doubt require customised software to be produced. Where this turns out to be the case, I would recommend that unless the developer is an expert AI programmer, he or she employ the services of such a programmer. In this way, a lot of time, expense and effort might be saved.

* As regards the process of knowledge acquisition, I learned firstly not to rely too heavily on expertise taken directly from written authorities in a knowledge domain, and secondly to try to elicit the expertise in a dynamic interpersonal situation. In this way, the expertise can be questioned and made accessible and complete, both for the sake of the lay user of the system, and to cater for the logical demands imposed by the system itself. I also discovered that the inexorable logic demanded by the computer system helped me clarify my own thinking in specific knowledge domains.

Even from the above sample of lessons learned, I have concluded that the development process in this study yielded a wealth of valuable lessons. As such, I am satisfied that, to a large extent, Aim 1 of the study was achieved.

The second aim of the present study, stated in Chapter 1 of this report, was:

Aim 2

To determine the reactions of a sample of Bank trainers to the system.

Generally, a wide range of user reactions to the system were noted. In my opinion these reactions yielded valuable input to an understanding of the effect of the system on users, as well as providing numerous useful suggestions for the improvement and application of the system. Included amongst the highlights of the exercise in determining user reactions were the following:

* A number of invaluable lessons were learned about how to go about presenting the system to users - for example, introducing the purpose and operation of the system to users, encouraging them to practice using it, keeping the wording in the system clear and unambiguous, and making help facilities available to users at all times.
* Noticeable discrepancies between users' stated intentions regarding the system and their actual behaviour revealed a need for mechanisms to encourage users to follow up their intentions with actions. Failing such action, users' stated intentions would need to be re-examined in greater depth.
* Users provided a number of constructive suggestions for improving the operation, user-friendliness and application of the system.

All in all, I believe that the value of determing user reactions to the system was clearly demonstrated by the findings of this study.

The third aim of the present study, stated in Chapter 1 of this report, was:

> To assess the impact of the system on ID decisions made by the sample of Bank trainers

The findings of this study seem to indicate that the system had a considerable impact on users' decisions. In such a qualitatively-oriented study, with its lack of experimental control, no objective proof of the influence of the system could be established. However, there were strong indications that use of the system was followed by revisions of users decisions regarding the ID process, for example:

* Many system recommendations were incorporated into users' designs following consultation sessions.
* Some of the users' own ID decisions were <u>not</u> included in their final designs following system consultation sessions.

I regarded such indications as pointing to the system's potential for adding value to the ID process, by helping to generate new ideas and by helping users to clarify their own thinking about what they were attempting to achieve.

However, there was also evidence that users did not inevitably and blindly accept every recommendation proposed by the system. Some users rejected recommendations made by the system. In general, I took this scepticism to be a healthy sign that some users were retaining their ability to think critically and independently, and using the system as a guide, rather than as an all-knowing oracle.

The fact that the system was by no means omniscient was demonstrated by the number of potentially useful recommendations that the system failed to make.

The fourth aim of the present study, stated in Chapter 1 of this report, was:

To establish a set of guidelines for the development of future AI-based instructional systems in the Bank.

I was satisfied that the study yielded a wealth of guidelines for the prospective designer of AI-based instructional systems in the Bank (and elsewhere too, for that matter). Tips and hints from lessons learned in this study were found for system developers creating a system similar to that in the present study, when:-

* Planning the system
* Developing the system
* Testing and evaluating the system
* Implementing the system.

The study also provided indications about some of the results that a developer could expect from such a system.

However, although the guidelines derived from the present study were quite numerous, it would be a mistake to regard them as comprehensive. There are many specific aspects of AI-based system development, testing and application that I did not include in the guidelines, for example how to select an ES shell, how to conduct knowledge acquisition interviews, and much more besides. Such information would still have to be acquired by the system developer, or, perhaps better still, an experienced AI expert could be employed to assist in development.

All in all, I am satisfied that considerable benefit was derived from the exercise decribed in this report. However, as noted in Chapter 2, the technology of AI is an emergent one, as yet largely undefined and untested, and ultimately only time will tell whether it can be usefully applied to the field of adult education and training.

6.2 Recommendations for Future Research

As might be expected from a study of an emergent phenomenon such as AI, this study seems to have raised more questions than it managed to answer. A brief selection of recommendations for possible future research are listed below:

* Numerous aspects of the instructional design process that could form part of an ES knowledge base were left virtually untouched in the present study. For example, an ES could offer guidance and/or advice on the analysis of the learner population, the task analysis process, the determination of learning domains, the setting of instructional objectives, and the selection of testing strategies.

* Longer-term studies could be conducted to examine the effects of the ES on users' performance in the workplace, for example on the instructional programmes they design, and on the students participating in these programmes.

* Related to the above point, the present study did not concern itself in any detail with the implications of implementing the AI technology from an organisational change management point of view. The impact of change, techniques for dealing with resistance to change, and the issue of user empowerment were but a few of the issues that warrant further research.

* The effects of incidental learning (Eary, 1987:91) of the instructional design process by means of using the ES could be studied, as well as the effects of using the ES (and perhaps of learning something about instructional design in the process) on user perceptions of empowerment in the ID situation.

* The period following the inception of the present study has seen the widespread appearance of the concept of the electronic performance support system (EPSS) (Geary, 1991). Essentially, with an EPSS, the individual user is presented with an integrated range of performance-enhancing facilities, such as application software, database information, multimedia and computer based training, help facilities, productivity software (such as spreadsheets and wordprocessing packages), job aids and ESs. The aim of an EPSS is to deliver information, guidance and training to the individual on demand, in response to the needs and preferences of the individual user, usually at the workplace. The AI element is most apparent in providing advice and guidance, and in selecting and assigning training and information. To date, little research has been conducted into EPSSs, but their relation to the system developed and evaluated in the present study should be apparent. It is entirely possible that a fully-fledged EPSS could be produced to support the designer of instruction, and that some of the elements of the EPSS could be AI-based. As regards future research, therefore, the issues and concerns aired in the present study should bear a close relation to those that are likely to surface in research into EPSS technology.

* The present study left the important issue of cost justification of the ES untouched. An area for future research could involve a comparison between the costs-benefit ratios of using AI technology and the provision of equivalent human expertise.

* Finally, I believe that the wider implications of the use of AI and related technologies, on individuals, on

society and on the planet, need to be examined as a matter of urgency. As one example, an issue left untouched by the present study is that of the affordability and appropriateness of AI technology in a changing South Africa. AI technology seems to have enormous potential, but it has not been established whether this will be ultimately for the benefit or for the harm of humankind.

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CHAPTER NOTES

CHAPTER 1: INTRODUCTION

1. One study (Senbetta, 1991) has revealed informed estimates of the amount of time required to develop a standard CBT course ranging from between fifty and three hundred and sixty five hours of development time per hour of CBT ready for delivery. In the Bank, we work on a figure of about one hundred hours of development time per hour of CBT ready for delivery.

2. During the process of selling one product or service to a customer, the salesperson might identify a need for some related product or service. This is referred to as a "cross-selling opportunity."

3. When the skills and/or knowledge required by a job-holder to perform all or part of a job are reduced in some way (eg by reliance on an ES), that job can be referred to as having been deskilled. In discussing this phenomenon, Zuboff (1988:57) has noted the historical displacement of the human body and its know-how by automation in industry and even in commerce.

4. In order to avoid interrupting the flow of the present report, as well as for the sake of brevity, no distinction is usually drawn in the text between references to the completed version of the system and to its prototypes. The version of the ES being discussed at any point should be apparent to the reader from its context.

1. The humanistic approach to psychology adopts a personal and optimistic view of mankind. One of its basic assumptions is that every individual possesses the inherent potential for self-actualisation and personal psychological growth and health. This approach focuses on encouraging the individual to accept responsibility for his or her own self development (Hall and Lindzey, 1978:279-280).

2. The behaviourist approach to psychology is focused around the examination of observable behaviour. A central assumption of this approach is that human behaviour is for the greater part learned, and can therefore be modified (Brammer and Shostrom, 1968:52-53). A strictly behaviourist approach is characterised by a refusal to speculate about the unobservable dynamics of behaviour, ie about what occurs within the oganism, beyond the range of direct observation (Romiszowski, 1981:34).

3. Heuristic search techniques are essentially short-cuts taken by an AI-based system in the search for solutions, based on prior experience programmed into, or acquired by, the system (Rich, 1983:35; Townsend and Feucht, 1986:26-27).

4. A Rogerian counselling dialogue is a face-to-face encounter between a therapist and a client, during which the therapist encourages the client to acknowledge his or her own feelings, and take responsibility for his or her own personal psychological development. The therapist takes care to display unconditional positive regard (ie acceptance) towards the client. Such an approach is described as being client-centred (Hall and Lindzey, 1978:280)

5. What is meant here is that access to information provided by the computer was perceived by the workers as enhancing their control over their work situations. Empowerment in this case, then, is the perceived restoration of this control.

6. Reskilling refers to a process during which already skilled or semi-skilled workers are provided with skills they had never possessed before, skills considered more appropriate to the performance of their current jobs.

CHAPTER 3 METHODS

1. Townsend (1953:52) defined an independent variable as "that factor manipulated by the experimenter in his attempt to ascertain its relationship to an observed phenomenon", and a dependent variable as "that factor which appears, disappears, or varies as the experimenter introduces, removes, or varies the independent variable." Factors which interfere or otherwise intervene in the presumed cause-effect relationship between the independent and dependent variable are referred to as intervening or nuisance variables (Townsend, 1953:13; Huysamen, 1981:2). Essentially, the experimental method involves manipulation of the independent variable to study the effects of this variable on the dependent variable, while at the same time attempting to control for the influence of intervening or nuisance variables.

2. The Before-after research design involves measuring the dependent variable both before and after manipulation of the independent variable, in order to examine the influence of the independent variable on the dependent variable. The assumption is that if intervening or nuisance variables are effectively controlled, the

changes in the dependent variable will have resulted from changes in the independent variable (Selltiz et al, 1965:112-122; Huysamen, 1981:1-2).

3. In skills training, terminal objectives are statements that spell out the ultimate behaviours that learners should be able to perform following a training programme. In the Bank, a terminal objective is usually spelled out for each complete task that a learner is required to be able to perform following the training.

4. In the Bank, enabling objectives are defined as intermediate objectives that the trainer sets as milestones on the road towards mastery of a terminal objective. Enabling objectives are usually related to the achievement of learning along the way towards mastery of the terminal objective (Romiszowski, 1981:85).

CHAPTER 4 RESULTS

1. During the period in which this study was being conducted, the Republic of South Africa was continually racked by social and political upheaval, that disrupted the lives of millions of its inhabitants.

2. Instead of presenting questions to a user, the Level 5 system presented statements on the computer screen, to which users were required to indicate the extent of their agreement, from zero to one hundred percent. Instructions to the user were to press the Space Bar on the computer keyboard to set a pointer on a bar marked from zero to one hundred percent, situated below the statement. If the user caused the pointer to exceed one hundred percent, the pointer reverted to zero percent and the scaling process could be restarted. Users were

also instructed to press the Enter key once they were satisfied with their settings.

3. The objective of using a game as an instructional method is to promote learning. A game is an activity governed by a set of rules, and may be played by an individual learner, as in CBT games, or by a group of learners. There is often an element of competition between players, or between an individual player and the computer (Romiszowski, 1981:223). There may also be an element of repetition or drill involved in the game (Romiszowski, 1981:321).

4. The use of behaviour modelling as an instructional method involves the demonstration of exemplary behaviour, by the instructor, by a video or by some other means. The demonstration may be accompanied by definitions and explanations, although this is not always the case (Romiszowski, 1981:316). The demonstration is usually followed by an opportunity for learners to practice the behaviour modelled. Behaviour modelling is commonly used when teaching interpersonal skills.

5. The tutorial as an instructional method involves the initial exposure of learning information to the individual learner or to a group of learners. This may or may not be followed by interaction between the instructor (or instructional device in the case of CBT or PI) and learners, during which the instructor (or surrogate) may question learners, to ascertain their understanding or mastery of the topic, and to decide whether to move on to another topic or to present remedial or additional information on the current topic (Trollip, 1985:52).

6. The use of demonstration and practice as a composite instructional method involves first exposing learners to one or more examples of the subject of the learning content, and then allowing the learners to practice whatever is being taught. The demonstration may or may not be accompanied by an explanation.

7. In both the ID workshops and in the ES knowledge base, a distinction was drawn between those instructional methods suited to altering more superficial attitudes and opinions, and those suited to altering apparently more deep-rooted ones. Designers were advised to address superficial attitude and opinion changes by means of fairly common instructional techniques such as awareness enhancement, for example via provision of information or participation in exercises that led learners towards novel experiences that challenged their stereotyping tendencies. When it came to deep-rooted attitudes and opinions (defined as attitudes and opinions that appeared to arouse powerful emotions and strong resistance in learners), designers were cautioned about the difficulties of attempting to alter these attitudes and opinions. They were requested to seek expert advice, for example in the form of psychological counselling for learners, and to expect any process of change to involve a long-term programme of intervention.

8. Non-participative demonstration involves a one-way expositive demonstration (see 6 above) unaccompanied by the opportunity for interaction between the learner and the instructor or instructional device.

9. The recommendation to make use of examples and non-examples as an instructional strategy involves contrasting specific instances (examples) of the phenomena that relate to the content of learning with phenomena that do not relate to this content. The

intention of using examples and non-examples is to help the learner distinguish between these two classes of phenomena (Clark, 1989:68).

10. Text readings refer to any form of textual material which the learner is required to read. Text readings commonly used in training are reference manuals, workbook passages, student handouts, programmed learning texts, books and articles.

11. Debates are contrived discussions between two or more individuals or groups about some topic, usually of a controverial nature. Participants are encouraged to adopt opposing positions regarding the topic and then to present these positions as convincingly as possible. An element of competition between opposing factions is common, with each faction attempting to gain favour for their allocated position.

12. The use of role plays as an instructional strategy involves assigning specific roles to learners and requiring them to act out these roles, usually in some form of preplanned problem situation. The objective of using a role play may be to allow learners to experience a variety of situations, pressures or points of view, and/or to enable them to practice some form of behaviour. Role plays are commonly used in interpersonal skills training.

13. The term 'think tank' refers to some form of (often informal) small-group brainstorming session, used for the generation and/or refinement of ideas or solutions to a problem.

14. The case study instructional method involves the provision of a real-life or fictitious problem situation to an individual learner or a group of learners.

Learners are required to examine the situation and generate one or more solutions to the problems. Learners then commonly present their solutions to the class and/or the instructor for discussion and evaluation.

15. The use of student projects involves setting some problem or problems for learners (individually or in groups) to examine, conduct research upon and generate solutions for. Projects are often conducted outside the normal classroom environment. Once learners have produced their solutions, these are often presented to the class and/or the instructor for discussion and evaluation.

16. A simulation is a learning situation that is contrived to bear at least some resemblance to the real-life situation in which the learning may ultimately be applied. The objective is to expose the learner to a controlled version of the real-life situation, to allow learning and practice to occur without the potential risks or distractions of the real-life situation.

17. By the term `mass broadcast' I was referring to some unspecified form of one-way (see note 18 below) mass communication, mediated, for example, by means of direct human speech, text or via an electronic device such as video, television or radio.

18. By `internal company communication devices' I was referring to media such as company circulars, on-line electronic messages, bulletin boards, or newssheets. Like the mass broadcast, such a device would operate on a one-way basis, from sender to receiver without any opportunity for feedback from the receiver, to the sender.

CHAPTER 5 DISCUSSION

1. Schemata are concept maps used extensively by Romiszowski in the ID decision-making process "to visually present the principal factors and the ways in which they interact." (Romiszowski, 1981:x). Many of the ID processes used in the ES developed in the present study were derived from Romiszowski's schemata.

2. Computer programs such as an ES shell are commonly made up of a series of instructions represented in a computer language (such as BASIC or C). The series of instructions may be referred to as 'code'.

3. Computerphobia is the word I used in the present study to refer to a fear, possibly unreasonable and/or unarticulated, that a person may have of operating a computer. The fear is described as being possibly unreasonable when the person is unable to explain why he or she feels that way.

4. Text fonts are types of text that can be made to appear on a computer screen or in print. Fonts on many modern computers can be altered to suit the requirements of the computer user. Common computer fonts include helvetica, roman and terminal.

5. See note 2 for Chapter 3.

6. In commercial practice, 'added value' refers to additional worth provided to a product or service by a third party, ie by a party other than the initial producer or consumer. The process of Value Added Taxation (VAT) is based on the notion of added value.

7. The term 'validity' has a very specific meaning in experimental research in the social sciences. For

example, Selltiz et al (1965:155) define the validity of a measuring instrument used in the social sciences as:

> the extent to which differences in scores on it reflect true differences among individuals, groups, or situations in the charcteristic which it seeks to measure, or true differences in the same individual, group, or situation, from one occasion to another, rather than constant or random errors.

The term is used somewhat more loosely in the present study, to refer in a general way to the soundness of ES recommendations made, ie the extent to which these reflected the recommendations that an experienced designer of instruction might have made in the same situation.

8. The term 'creativity' is used to refer to the ability to either "bring into being from nothing"), or to "invest with a new character" (Patterson, 19__:83). I regarded the generation of novel ideas about some aspect of a particular user's instructional design as evidence of creativity.

9. Researcher bias is any form of unintentional misinterpretation or interference introduced into the research situation by the researcher, that could influence the research process.

10. In the present study the term 'selective perception' refers to the tendency for a person to take note (at least consciously) of only a part of the information in a particular situation. It has been noted (eg by Allport and Pettigrew, 1957) that what information is perceived may be influenced by the perceiver's state of mind or expectation set. Selective preception can be regarded as a possible source of bias (see note 9 above) in the research process.

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GLOSSARY OF TERMS

Adult - For the purposes of the present study, an adult was defined as a person who has either completed his or her secondary education, or has reached the age when the education would have been completed if uninterrupted in some way.

Adult education - The branch of education that is concerned with the education of adults.

Artificial Intelligence - "the branch of information science that focuses on developing computer programs able to perform functions normally associated with intelligent human behaviour" (Chorafas, 1987:42).

Attitude - An enduring mental state that includes a cognitive component (beliefs, opinions, facts), an affective component (positive and negative evaluations and emotions) and an action component (tendencies towards particular reactions and behaviours) (Freedman et al, 1970:246-248).

Cognitive skills - Abilities in the intellectual domain, such as problem-solving, planning, decision-making and learning.

Computer-Based Training (CBT) - training that is delivered and/or managed by means of a computer. The actual function of the computer can range from simple record-keeping, to learning resource allocation, to testing, to delivery of tutorial instruction, drill and practice or simulations (Alessi and Trollip, 1985).

Concepts - "A class of items that share common characteristics and are known by a common name" (Clark, 1989:87).

Confidence factor (or Certainty factor) - "A measure of the confidence or degree of belief in the information contained in the knowledge base or global data base of an expert system" (Biziarski and Lewand, 1988:319).

Cybernetics - "the study of regulation and control in complex systems both living and man-made'" (Romiszowski, 1981:184).

Discovery learning - A process of exploration and discovery during which learners seek and find out for themselves the learning content.

Education - "the deliberate, systematic and sustained effort to transmit, evoke, or acquire knowledge, attitudes, values or skills, as well as any outcomes of that effort" (Darkenwald and Merriam, 1982:2).

Expositive learning - A process during which learners are initially presented with the learning content in a consciously structured format, without being required to discover the learning content on their own.

Facts - Named individual specific items of individual specific associations between concepts (Clark, 1989:87).

Hardware - The physical components of a computer system (Chambers and Sprecher, 1983:201).

Intelligent tutoring - A process of using AI technology in conjunction with one or more theoretical models of learning in order to facilitate the learning process for an individual human learner.

Interactive Video Instruction (IVI) - A form of technology-based training delivered by means of an interactive combination of computer and video technology. The term IVI is usually applied when the video technology involved is analogue laser disk technology.

Instructional Design (ID) - The process of consciously and formally specifying procedures that facilitate the transfer of knowledge, skills and attitudes between people.

Instructional methods - techniques used to facilitate learning.

Instructional media - the vehicles via which instructional content is conveyed to the learner.

Instructional Systems Design (ISD) - An organised and integrated approach to the specification of procedures that facilitate the transfer of knowledge, skills or attitudes between people.

Job Aids - Performance aids that are designed to guide performance on the job, such as checklists, decision tables, charts, worksheets and other types of reference (Lineberry (1977:88).

Knowledge - "The facts or experiences known by a person or group of people" (McLeod, 1987:557).

Knowledge base - "The component of an expert system that contains the knowledge of the expert which it emulates" (Bielawski and Lewand, 1988:319).

Knowledge engineering - "The process of transferring knowledge from a human to an expert system" (Bielawski and Lewand, 1988:319).

Machine learning - A branch of AI concerned with the automated acquisition of new knowledge during the application of a computer program, and the subsequent storage and application of this new knowledge by the program.

Natural language processing - A branch of AI concerned with language translation, intelligent information retrieval, and the development of computer systems that can communicate in human languages (Townsend and Feucht, 1986:246)

Neural network technology - A branch of the study of AI that is concerned with the emulation of the functioning of the human brain, in particular with the inter-connectivity of various neurons in the brain and with the patterns of connections.

Pattern recognition - A branch of AI concerned with the identification and matching of patterns in data provided, taking into account possible variations in the dimensions of, or degrees of exact similarity between, various patterns.

Principles - Statements of cause-effect relationships "that result in a predictable outcome" (Clark, 1989:148). Principles are more generic in application than procedures, ie they can be applied in a wider variety of situations.

Procedures - Statements of "a series of clearly defined steps which result in the achievement of a job task" (Clark, 1989:42).

Procedural skill - The ability to perform a particular procedure.

Programmed Instruction - A technique of instruction that involves the controlled presentation of learning content. Learner progress is determined by the completion of drill and practice exercises and by mastery testing. Programmed instruction is founded on principles of learning theory derived from the Behaviourist school of Psychology (Hudson, 1984:11-13).

Psychomotor skill - The ability to perform a task that involves the coordination of physical and mental attributes.

Skill - The ability to perform a task.

Social skill - The ability to perform a task that involves successful interaction with other human beings.

Software - The computer instructions, programs and codes that enable the computer to function (Chambers and Sprecher, 1983:204).

Technology - The creative application of science to industrial (or any practical) purposes (Romiszowski, 1981:11).

Technology-Based Training (TBT) - training that is delivered and managed by means of electronic media such as computers, videotape players and videodisc players. Often a mixture of media technologies can be used interactively.

Training - The deliberate, systematic and sustained effort to transmit, evoke, or acquire a limited, specific and predetermined set of knowledge, attitudes, values or skills, as well as any outcomes of that effort. (Note: This definition has been adapted from the definition of education provided by Darkenwald and Merriam (1982:2)).

Training needs analysis - the analysis of a performance problem or deficiency in an organisation, with a view to determining whether training could form part of the solution to the problem.

User-friendly - "A description of a computer, computer component, or computer program that permits the user to interact in a natural, people-oriented manner" (Chambers and Sprecher, 1983:204).

User interface - "The portion of an expert system visible to the end user" (Bielawski and Lewand, 1988:319).

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APPENDIX A: OUTLINE OF THE INSTRUCTIONAL DESIGN WORKSHOP

Pages A.2 to A.3 contain a copy of the Table of Contents for the Bank's four-day Instructional Design workshop. The major topics covered in the workshop are listed in the order in which they are covered during the workshop.

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APPENDIX B: THE TRAINING DESIGN SUMMARY DOCUMENT B.2

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APPENDIX B: THE INSTRUCTIONAL DESIGN DOCUMENT

Pages B.2 to B.3 display a copy of the Bank's Instructional Design Document.

Page B.2 displays the summary of information from the needs analysis and the target population analysis. Page B.3 displays a sheet that summarises information from the task analysis (or goal analysis, in the case of a more abstract training progamme). Page B.3 also contains a breakdown of the skills, knowledge, attitudes or personal qualities required to perform each step in a task, and a record of instructional methods and media selected to facilitate the learning of each component emerging from the analysis.

Note that several copies of the task analysis sheet (page B.3) may accompany the design for a single training programme. When used for actual training design, this sheet is reproduced in A3 format to allow more room to work on.

TRAINING DESIGN SUMMARY

TRAINING NEEDS ANALYSIS

Problem/s Identified

Location of Problem

How Problem Identified

Date Identified

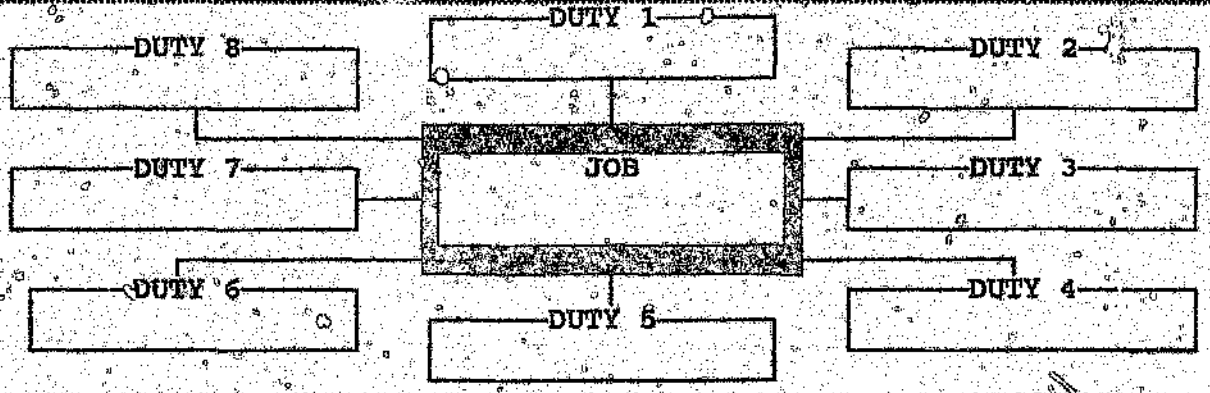
By Whom Identified

Recommended Solution/s

TARGET POPULATION ANALYSIS

Factor	Range
Job Title	
Job Grade	
Number	
Location	
Age Group	
Gender	
Education	
Experience	
Language	
Other	

TRAINING DESIGN SHEET Page ... of ...



TASK/GOAL LIST for DUTY No...

- *
- *
- *
- *
- *
- *
- *
- *

SELECTED TASK/GOAL DETAILS - ACTIONS:

CONDITION: CRITERION:

STEP/ ELEMENT	#	COMPETENCIES - SKILLS/ KNOWLEDGE/ATTITUDES/QUALITIES	TEST WORD	METHODS + MEDIA

APPENDIX C: EXPERT SYSTEMS (ESs)

In this Appendix, certain concepts, principles and techniques relating to ESs are described under the following headings:

C.1 What is an ES?
C.2 Components of an ES
C.3 Knowledge Engineering Principles
C.4 Reasons for Using the Level 5 AI Software.

C.1 What is an ES?

Numerous definitions of ES were encountered during the preparation of this report. Some focused attention on the decision-making qualities of an ES. de Bruyn (1988:2), for example, described an ES as "a computer program which allows an organisation to capture, reproduce and distribute decision-making ability."

Other definitions focused attention on the human-like performance of the ES, or its restriction to a narrow knowledge domain. Thus Bielawski and Lewand (1988:302) defined an ES as "a program that simulates the performance of a human expert in a specific, narrow field or domain."

Yet other definitions included AI as an aspect of ESs. Swartz and Petrie (1988:33) defined an ES as "AI software that reproduces the problem-solving (decision-making) of human experts in a narrowly-defined knowledge area." The elements of this definition are examined below:

1. The first component of the definition that requires attention is AI. ESs have been described by some (eg Cole, 1986:229) as not being truly representative of AI technology. One possible reason for this may lie in the way that the development of ESs parted from the original mainstream of AI. Originally, as mentioned in Chapter 2, AI techniques attempted to emulate the neural processing of the human brain. Early ESs, such as that produced by Feigenbaum et al (Feigenbaum and Feldman, 1963), on the other hand, focused on practical methods of knowledge representation, such as the use of production rules (see section C.3.4 later). Such systems were able to exhibit intelligent processing without necessarily emulating the way such processing occurs in the human brain.

   Another possible reason for the claim that ESs are not truly a form of AI may lie in a tendency to avoid the term 'Artificial Intelligence' in some circles, based perhaps on a fear of scaring away potential users with such presumptuous terminology. Terms such as "automated reasoning" have been used in the place of AI (Martin, 1989), just as ESs have been referred to as 'knowledge based systems' (Mockler and Dologite, 1988:97) for fear of creating undue awe of, or unrealistic expectations about, such systems.

   I would argue, however, that many of the features of ESs are drawn from AI technology, rather than from conventional computer programming technology, such as:

   * The solution searching process undertaken by an ES. Use is often made of heuristic search techniques, ie intelligent short cuts based on the results of information the system possesses about likely solutions, as opposed to blind, exhaustive search processes such as would be undertaken by a conventional computer program.

These search techniques came from the field of AI (Rich, 1983:30-31).

* Like many other AI applications, ESs are usually able to deal with uncertainty, ie with events having a less-than-perfect probability of occurrence. This feature is not often found in conventional computer programs (Bielawski and Lewand, 1988:302).
* Most ESs are programmed to provide explanations as to why a particular question is asked of a user, or why a particular recommendation is made. This is also a feature not usually found in conventional computer programs (Luconi et al, 1986:9).

2. Swartz and Petrie referred to an ES as a form of software, ie as a computer program. It is even possible to create an ES directly, but with some difficulty, using a conventional computer programming language, such as BASIC, Pascal or C (Schildt, 1987:13-15). Alternatively, a specialised AI computer language such as Prolog or Lisp can be used (Townsend and Feucht, 1986:45). Finally, a pre-programmed ES shell (see section C.2.2 later) or equivalent software package, such as the Level 5 package used in the present study, can be employed.

3. Swartz and Petrie's statement that an ES "reproduces the problem-solving (decision-making) of human experts" draws attention to the issue of prescriptiveness, discussed in Chapter 5 of this report. A technology purporting to reproduce human performance might be accused of implying that human performance could, in time, be replaced by that technology. The extent to which the ES is to be

regarded as supporting human decision-making, rather than reproducing it, is contentious. Both Weizenbaum (1978), and Zuboff (1988), for example, warned of dangers in supplanting human decision-making with computer technology (AI in particular). As mentioned in Chapter 2 of this report, Weizenbaum expressed concern about the alienation from human values and distortion of perceptions of reality that could arise from over-reliance on AI technology (Weizenbaum, 1976:268). Similarly, Zuboff reported cases of workers who expressed feelings of loss of control after being made to depend on computers for assistance in making job-related decisions (Zuboff, 1988:10).

As will be seen, I therefore adapted Swartz and Petrie's definition to allow for the support of human decision-making, in addition to its reproduction.

4. With regard to the inclusion of the "human expert" in Swartz and Petrie's definition, Bielawski and Lewand (1988:301) described an ideal human expert as possessing the following characteristics:
   * A specialised training in a given domain of knowledge.
   * Work experience in that domain.
   * Knowledge exceeding a lay person's in that domain.
   * The ability to provide sound, reliable advice regarding decisions required to be taken in that domain.
   * The willingness to offer timely responses to queries regarding the domain.

5. Finally, Swartz and Petrie referred to "a specified, narrow field or domain of knowledge." The word 'knowledge' will be explored later in this Appendix,

and for the time being, the focus will be on the phrase "specific, narrow field or domain."

> Most of the ESs that I have encountered to date operate within fairly narrow confines. Unlike a human expert, an ES is not usually expected to go beyond its defined area of expertise and search for a solution to a problem in some other, unspecified domain. For example, an ES intended to assist in the diagnosis of a medical condition, would not be expected to seek a solution in the area of, say, social work, if unable to find an appropriate diagnosis in its own (medical) domain of knowledge. A human medical practitioner, on the other hand, does operate outside his or her own area of specialisation at times. He or she could, for example, provide a degree of psychological counselling although his or her area of expertise is neurosurgery.

To arrive at what I considered to be an appropriate definition of an ES, I made some minor adaptations to Swartz and Petrie's definition. For the present study, an ES was defined as: "an Artificial Intelligence-based computer program that supports or performs the decision-making process of human experts, usually in a specific domain of knowledge."

C.2 Components of an ES

Most ESs are made up of at least the following three main components:

- C.2.1 The User Interface
- C.2.2 The Knowledge Base
- C.2.3 The Inference Engine

C.2.1 The User Interface

The user interface is the ES component that enables the user to communicate with the ES. In the case of ESs, a distinction can be made between two types of users, the editor and the end user:

1. The Editor's User Interface

The editor prepares the ES for use by the end user. The user interface enables the editor to:

* Add, alter or delete information in the knowledge base.
* Set ES program controls, such as thresholds of the probability that the system will generate a particular recommendation.
* Provide help screens and additional information to guide the end user.
* Control certain other features that affect the operation and appearance of the ES.

The editor may also be involved in testing the ES prior to its release. To facilitate the testing process, the user interface may include features such as a record-keeping function to trace a series of decision paths taken through the ES.

2. The End User's User Interface

The end user is the person who applies the ES in the field. The user interface makes communication possible between the ES and the end user. The user interface may include features such as:

* Introductory screens to orientate the end user and inform him or her about the purpose and operation of the ES.

* Keypress prompts on the computer screen.
* Help screens and screens containing additional information and explanations about why a particular question is being asked, or about the logic underlying a particular recommendation.
* Ideally, the ability to allow the end user to backtrack and seek alternative recommendations during an ES session.

C.2.2 The Knowledge Base

This is where the knowledge from a particular domain is stored. The particular form in which the knowledge is represented is dealt with in section C.3 of this Appendix.

ES shells come without a knowledge base. Knowledge from a specific domain can be introduced into these pre-programmed ES shells, to form a complete system ready for use. An important assumption underlying the use of these shells is that the representation and processing of knowledge from diverse domains is similar enough to justify similar treatment by the ES inference engine (Townsend and Feucht, 1986:43; Forsyth and Naylor, 1986:12). ES shells can now be purchased locally from a variety of software vendors.

C.2.3 The Inference Engine

This is the component that generates a recommendation about an end user's problem in the particular ES domain. The inference process involves a search of the knowledge base, in an attempt to match information supplied by the user or some external program with a range of possible solutions stored in the knowledge-base.

In backward chaining inference, the system first selects an hypothesised solution and then seeks confirmation for this solution from the pattern of information supplied. In forward chaining inference, the system first selects the pattern of input and then attempts to find the best matched solution to that particular pattern. In both types of inference, if no match (or specified approximation to a match) is found, the next potential solution/input pattern is tried. This process is repeated until (if ever) a suitable solution is identified. According to Forsythe and Naylor (1986:21-22), the iterative nature of the attempted matching process led to use of the word 'engine' in the term 'inference engine'.

In backward chaining, each solution must be taken in turn, to check whether it matches the pattern of input. For this reason, backward chaining is recommended for ESs with relatively few solutions and much input, whereas in situations where limited input must be matched up against many solutions, forward chaining is recommended (Bielawski and Lewand, 1988:310).

C.3 Knowledge Engineering Principles

For the present study, I defined knowledge engineering as "the systematic process of acquiring, defining and representing the ES knowledge base."

A number of principles of knowledge engineering are discussed below under the following headings:

- C.3.1 Knowledge and ESs
- C.3.2 Knowledge Acquisition
- C.3.3 Domain Definition
- C.3.4 Knowledge Representation

C.3.1 Knowledge and ESs

Knowledge has been defined as "the facts or experiences known by a person or group of people" (McLeod, 1987:550). In the same publication, a fact is defined as "a truth verifiable from experience or observation" (Mcleod, 1987:356), and experience is defined as "a particular incident, feeling etc, that a person has undergone" (McLeod, 1987:349). Knowledge can, therefore, be taken to consist of not only the empirically verifiable truths, but also of the experiences and feelings possessed by an individual or group.

Roszak (1987), wrote that:

> Information is not knowledge. You can mass-produce raw data and incredible quantities of facts and figures. You cannot mass-produce knowledge, which is created by individual minds, drawing on individual experience, separating the significant from the insignificant, making value judgements.

The above quotation draws attention to the element of subjective, personal meaning with which people invest knowledge, and which mere raw data does not possess.

Unlike conventional computer programs, in order to be able to deal effectively with knowledge, ESs must be able to store, retrieve and manipulate not only quantifiable, numerical data, but also uncertainties and abstractions. Specialised computer languages, such as LISP and Prolog have been developed to represent and handle such knowledge (Townsend and Feucht, 1986:45).

In the present study the terms `knowledge' and `expertise' are treated as being synonymous, as are the phrases `Expert System' and `Knowledge-Based System'.

C.3.2 Knowledge Acquisition

During the process of knowledge acquisition, knowledge (or expertise) is gathered and translated from its source into some form of knowledge representation (see section C.3.4), often by a specialist referred to as a knowledge engineer.

There are numerous sources of knowledge, including:

* The single human expert.
* A panel of two or more experts.
* Information accessed directly from a computer database external to the ES itself.
* Knowledge extracted from a book or procedure manual.

A combination of more than one source of knowledge may be used, as was the case in the present study.

The following methods of knowledge acquisition are examined below:

1. 'Do-It-Yourself' Acquisition
2. Interviewing and Prompted Articulation
3. Inductive Techniques
4. External Computer Program Acquisition.

1. 'Do-It-Yourself' Acquisition

Usually applied to small-scale ESs, this method requires the knowledge domain expert to act as both as the expert and as the knowledge engineer. Some commercially available ES software, such as the Level 5 software used in the present study, is expressly designed for this approach (Information Builders Inc, 1988:4:1). In addition, there are books available with titles such as "Building Your Own Expert System" (Siegel, 1986) and "Designing and Programming Personal Expert Systems" (Townsend and Feucht, 1986), and the impression that the prospective ES developer might gain is that this form of

knowledge acquisition is not only possible, but also common practice.

Possible advantages of this 'do-it-yourself' approach include:

* Convenient access to the knowledge.
* The ability to dispense with the services of a knowledge engineer (a rare person, in any case).
* Presumably, a degree of commitment to the development process by the expert, resulting from feelings of participation in, and ownership of, the knowledge acquisition process.

However, Townsend and Feucht (1986:75) have noted problems in this approach, such as the difficulty that a knowledge domain expert may have in setting down the knowledge without making logical leaps, relying on unrecognised assumptions based on years of experience in that domain.

2. Interviewing and Prompted Articulation

These two related approaches involve a degree of face-to-face interaction between the domain expert and the knowledge engineer. The term 'prompted articulation' refers to a process during which the knowledge engineer encourages the expert to verbalise his or her expertise while the knowledge base is being constructed (D'Agapeyeff, 1988:28). When using the interviewing process, the knowledge engineer may first acquire knowledge base information from the expert and subsequently construct the knowledge base. The function of the knowledge engineer, in either an interview or a prompted articulation session, is to keep probing for more details and clarification from the expert, and then to represent this knowledge in terms that can be interpreted and manipulated by the ES.

Advantages of this approach include:

* The specialised skill that a competent knowledge engineer can bring into the knowledge acquisition process. For example, the knowledge engineer, by playing the role of devil's advocate, can help the domain expert to examine and deal with assumptions and inconsistencies in the knowledge base.
* The synergistic effects of interaction between the expert and the knowledge engineer. For example, the discussion of one aspect of the knowledge domain might trigger off an idea relating to some other aspect.

The question of whether to use more than one expert can be a difficult one to answer. The apparent advantage of more than a single source of knowledge (as the saying goes, "two heads are better than one") may be offset by disadvantages, such as irreconcilable disagreements between the experts, or the need to decide between more than one alternative path towards the same solution. If the experts are to work as a team, it may also be difficult to assemble the entire team of experts and knowledge engineer together at the same place and time for the knowledge acquisition process to take place.

3. Inductive Techniques

In some ESs, a knowledge base can be constructed by loading a number of examples of typical problems and the likely solutions to those problems into the computer. In effect, the ES develops its own model answers from the examples loaded.

The assumption in such a process is that, if a similar enough problem is encountered by the system during a subsequent consultation session, the system will be able to recognise the pattern of the problem and offer a useful solution to it (D'Agapeyeff, 1988:24).

One claimed advantage of this type of knowledge acquisition is that, as with the 'do-it-yourself' method, the services of a knowledge engineer may not be required. The ES itself is designed to deal with the interpretation and representation of the knowledge base, and can prompt the domain expert for information during the knowledge acquisition process (D'Agapeyeff, 1988:27).

Two disadvantages of this approach are;

* The demands it places on the expert to come up with a sufficient number of appropriate examples, without the assistance or encouragement of a human specialist.
* The possibility of inappropriate or inadequate information being fed into the system and later interfering with the decision-making process.

4. External Computer Program Acquisition

Some of the information upon which decisions are made by an ES can come from computer programs and systems external to the ES itself. For example, an ES intended to assist in the assessment of a bank customer's credit worthiness may access a database containing information regarding the customer's ability to meet his or her financial commitments. This information might be combined with information or expertise from other sources (for example from a human domain expert).

2.3.3 Domain Definition

This process consists of:

1. Identifying an appropriate knowledge domain.
2. Defining the overall goal of the ES
3. Establishing the scope of the domain.

1. Identifying an appropriate knowledge domain

Siegel (1986:22) distinguished between two broad types of knowledge domain suited to ES applications, those involving analysis, and those involving synthesis. One would expect, for example, an ES intended to support financial loan application decision-making to be predominantly involved with analysis. The ES could help determine whether a potential borrower qualifies for a loan by asking questions to analyse the borrower's current financial status. On the other hand, an ES intended to assist in the configuration (layout and components) of a computer system might involve mainly synthesis. Here, the system would make use of information provided by a user to put together one or more configuration proposals.

Rich (1983:38) suggested a number of criteria for determining whether a domain is suited for ES, as opposed to conventional, computer application. These criteria include:

* Bounded domain - the domain must have clear boundaries around it, to help determine what belongs in the knowledge base and what does not.
* The problems must be decomposable - ie it must be possible to break the major problems in the domain down into solvable sub-problems.
* Non-rigorous solutions to problems must be applied - the domains best suited to ES technology are those where a range of possible solutions to problems could apply, rather than only a single inevitable solution. Where more rigorous solutions could apply, conventional computer programming might be more appropriate.
* Uncertainty of relationships and data - Most ESs can deal with uncertainty more effectively than conventional computer programs.

* Information subject to a high rate of change - claims have been made for the relative ease with which information can be altered in an ES knowledge base, particularly one that is rule-based (see section C.3.4). It has been claimed that the relative independence of production rules in the knowledge base decreases the likelihood that adding, altering or deleting a single rule will affect the operation of other rules in the system (Barr & Feigenbaum, 1981:193). In conventional systems, every time an alteration to a system is made, it may be necessary to test the influence of that alteration on the rest of the program.

In the present study, the above list of criteria, together with the assurance that the proposed ES would be performing both analysis and synthesis, were used to decide whether particular knowledge domains were suited to an ES application.

2. Defining the overall goal of the ES

The twin issues of defining the overall goal of the ES and defining the scope of the knowledge domain are closely related. What the ES is intended to achieve (ie its overall goal) will determine the boundaries of the knowledge domain in which it must operate.

The inexperienced ES developer is warned to curb the ambitiousness of the goal and scope of the intended ES (Siegel, 1986:26), since the threat of combinatorial explosions (Chorafas, 1987:142) is ever-present. For the inexperienced developer, the inclusion of a single additional factor in a knowledge base can vastly multiply the number of transactions that must occur during the problem-solving process. This is because the influence

of that new factor on other (and often numerous) related factors in the knowledge base must then be taken into account during the problem-solving process. A carefully bounded statement of the overall goal of the ES is recommended to retain the scope of the ES within the capabilities of the developer to handle complexity. It is to be stressed that such combinatorial explosions are more likely to be the result of inexperience on the part of the ES developer than of some intrinsic flaw in ES technology. A fully competent ES specialist can avoid being overwhelmed by the addition of new knowledge into a knowledge base, for example by grouping knowledge with similar attributes into classes or domains that can then be subject by the same general rules.

A clearly worded goal statement can also assist in the communication process required in the development and utilisation of the ES. It can assist the domain expert and the knowledge engineer to supply and encapsulate the expertise relevant only to that goal, and it can help the ES project sponsors, the end-users or other affected parties to understand the purpose and function of the ES.

3. Establishing the scope of the domain

Once an acceptable goal statement has been produced, the scope and boundaries of the knowledge domain can be established and recorded.

The domain definition is often the product of interaction between the individuals undertaking the development of the knowledge base, usually the expert and the knowledge engineer. As these individuals consider and discuss the purpose and use of the system, the scope of the knowledge domain achieves greater definition, and some means of recording this scope becomes necessary.

One method of representing the scope of the domain is by means of a diagram. In the present study, use was made of spider diagrams (Barrett, 1988:19-20). In these diagrams, knowledge objects and their attributes (see section C.3.4) are linked to the central overall goal of the ES in a manner that expresses their relative importance to that goal (the closer to the centre, the more important). The convention is to start from the central goal and arrange the objects and attributes around this goal. Objects and attributes are represented in the form of brief phrases or words, and can be surrounded by circles or boxes, with linkages between objects and/or attributes represented by lines between the circles or boxes. The resulting diagram resembles what Buzan (1974:25) referred to as a "mind map", which contains the main concepts of the proposed knowledge base, and which defines what is and what is not to be included as content of the knowledge base. The diagram can be regarded as an organic entity, growing and changing during the ES development process as additional insight is gained, and new information is added or replaces existing information. Examples of spider diagrams are included in the main body of this report (see Chapter 3).

C.3.4 Knowledge Representation

Once the knowledge domain has been defined, the next task is usually to represent the knowledge or expertise in that domain, in a way that can be interpreted both by human beings (such as the expert, the knowledge engineer, and potential users of the ES) and by the ES computer program.

Several techniques for the abstraction and representation of

ES knowledge have been developed over the past thirty-plus years, and the following techniques are described below:

1. State-Space Representation
2. Production Systems
3. First-Order Logic Representation
4. Semantic Nets
5. Frames
6. Other Special-Purpose Representation Forms.

1. State-Space Representation

State-space representation has been credited with being the earliest form of knowledge representation that was widely used, and is claimed to have originated in the attempt to represent the state of play at a particular point in a game (Barr & Feigenbaum, 1981:153).

State-space representation depicts a series of alternative possibilities at each particular decision point in a sequence of decisions. The game of noughts and crosses, for example, could be represented as a series of decision points or nodes, where either a nought or a cross must be entered, in one of a diminishing number of positions on a grid. Each decision point, then, would indicate:

* The choice of a nought or a cross.
* The positioning of that symbol in the grid.
* When in the game sequence the symbol was entered.

The resulting graphical representation of the decisions would then form a tree, with a number of branches extending down the alternative decision paths that could be taken towards a solution. In the case of noughts and crosses, the solution would involve entering three like symbols in a line.

This form of representation has been extended to other forms of knowledge representation, and variations of such trees have been referred to in the AI literature as "decision trees" (Bielawski and Lewand, 1988:304), "search trees" (Rich, 1983:33), or "context trees" (Siegel, 1986:33).

Much of the intelligence in an ES might be said to derive from the ability of the system to find short cuts along a particular decision path in a decision tree (Rich, 1983:11).

2. Production Systems

Production systems were first developed by Newell and Simon in 1972, in their work on the representation of human cognition (Newell and Simon, 1972).

In a production system, knowledge is represented as a set of productions, usually in the form of condition-action pairs referred to as rules. These rules are usually stored in the form of IF...THEN statements, with or without the use of connectors, such as AND, OR and ELSE, in the statement. A confidence or certainty factor, indicating the confidence placed in the statement being TRUE, may also be included in the rule. An example of a rule is:

IF an animal has wings
AND the animal is covered in feathers
THEN the animal is a bird (Confidence 90%)
ELSE the animal is not a bird (Confidence 80%).

In the above example, the confidence that the rule is TRUE (ie the animal is a bird) is stated as a percentage. Other expressions of confidence might be on

a scale from -1 to +1, 0 to 1, or even verbal statements of certainty, such as "definitely", "there is a good chance that ..." or "there is little chance that..."

A rule is said to fire when, during the process of searching through the knowledge base, the IF part of the rule (the condition), is judged by the inference engine to be TRUE, ie to match the condition specified for a particular solution (spelled out in the THEN part of the rule). A rule may also fire if the condition of the rule does NOT match the sought-for solution, provided an ELSE statement is included in the rule. If the rule is not fired, the search for a match may continue.

To date, many commercially-available ESs have been of the rule-based variety. Bielawski and Lewand (1988:312) recorded that, at the third AI Satellite Symposium sponsored by the Texas Instruments corporation in April, 1987, all of the many ESs discussed during a four-hour session were rule-based.

The following advantages of production systems have been claimed:

* The rules themselves are usually explicit, and thus relatively easily understood by both the knowledge experts and non-experts using the system (Barr and Feigenbaum, 1981:194).
* The structure of rules is also claimed to be a natural way for human beings to express knowledge, by stating what actions result from particular conditions (Townsend and Feucht, 1986:53).
* The rules are often modular, with one rule not usually dependent on others, thus allowing for relative ease of adding, editing and removing rules from the knowledge-base (Rich, 1983:32; Townsend

and Feucht, 1986:53). (This is not always the case in the present study, several sets of ES rules were nested, ie one set of rules resided within the boundaries of another set. Alteration of one rule tended to affect the logic of other parts of the knowledge-base).

A number of disadvantages of production systems have also been identified:

* Program execution may be relatively inefficient, in that each and every condition-action pair may have to be individually considered by the inference engine during the matching process (Townsend and Feucht, 1986:53).
* Barr and Feigenbaum (1981:198) noted that algorithmic information cannot easily be expressed in its "natural" (ie mathematical) form in a production system.
* The relationship between knowledge-base objects and attributes cannot be expressed in terms of the inheritance of common properties of objects and object classes, whereas this is possible using other forms of knowledge representation (see below).

3. Semantic Nets

Semantic nets represent knowledge objects linked together to form a network. The objects can be physical objects, events, acts, abstract categories or descriptors, and are referred to as 'nodes' (Townsend and Feucht, 1986:56). The relationship between nodes is indicated by the nature of the link between nodes.

Several types of links can be represented, for example:

* Taxonomic (eg IS-A, as in "The bear IS-A mammal").
* Causal (eg CAUSED-BY, as in "The explosion was CAUSED-BY the hydrogen leakage").
* Definitional (eg defining the numeric value of an object, as in "The insect has SIX legs").
* Possessive (eg HAS-A, as in "The rhinoceros HAS-A poor eyesight").

Claimed advantages of semantic nets over, for instance, production systems include:

* The ability to spell out the relationship between various elements in the knowledge base. This is claimed to encourage cohesion of the knowledge base, and to reduce the possiblity of conflict between the various elements (Townsend and Feucht, 1986:56-57).
* Common properties of various nodes can be shared. This allows nodes of knowledge to be grouped into object classes, and inherit the properties of a higher-order object without the need to specify every one of the properties in each of the lower-order nodes. This, in turn, allows for more efficient storage and manipulation of knowledge within the knowledge base (Townsend and Feucht, 1986:56-57).
* A graphical representation of the knowledge base is said to make the knowledge base easier for human beings to follow (Forsyth and Naylor, 1986:131).

Disadvantages of semantic nets recorded include:

* The possible need for a more sophisticated inference mechanism than needed, say, for production systems (Townsend and Feucht, 1986:56-57).

* The difficulty, relative to production systems, for example, of altering the knowledge base once it has been created, particularly because of the interconnectedness of the various elements (Townsend and Feucht, 1986:56-57).

4. Frames

First proposed by Minsky (1985), one of the pioneers of AI, frames can be regarded as a series of attributes, procedures or rules related to a particular knowledge object.

As for semantic nets, the object can be a physical object, an event, act, abstract category or descriptor. The attributes of the object are inserted into 'slots' associated with the object. These slots can contain an attribute value or multiple values, a procedure for calculating a value (i.e. an algorithm), or even production rules for determining an attribute.

Like semantic nets, frames are usually hierarchically arranged, and inheritance of the characteristics of one frame by another is possible.

Frames and semantic nets share many of the same advantages and disadvantages, but it has been noted that frame-based ES shells are generally very expensive to purchase (Townsend and Feucht, 1986:56).

5. Predicate Logic Representation

Predicate logic representation is an extension of formal propositional logic, which is concerned with whether the combination of a set of premises (statements) is either TRUE or FALSE (Townsend and Feucht, 1986:59). It has been claimed that the inability of propositional logic to

cater for variables, and for statements of relationships between knowledge objects and classes of objects, resulted in the development of predicate logic as a means of knowledge representation in the field of AI (Townsend and Feucht, 1986:60).

Predicate logic has been described as "an extension of propositional logic that permits the expression of symbolic relationships between objects through the use of variables" (Townsend and Feucht, 1986:60). It consists of a series of statements, composed in a specific format referred to as "well-formed formulas" (Rich, 1983:137-143).

The basic symbol in predicate logic is referred to as the atom, and there are essentially three types of atom, these being:

* The Constant, which represents a real object (eg dog, woman).
* The Function, which represents an operation on an object (eg +, age, colour).
* The Relation, which defines relations between objects (eg IS-A etc - see semantic nets above).

The three symbols, or a combination of them written in parentheses, can be used to express an atomic proposition or term. For example, the term (IS-A vulture bird) expresses the proposition that a vulture is a bird. Similarly, (sister of June Peter) expresses the proposition that June is a sister of Peter.

Predicate logic includes a number of special connectors (eg L = 'NOT, -> = IMPLIES) and quantifiers (eg E = 'there exists', A = 'for all'). Together with the atomic propositions, these connectors can be used to build up a knowledge base that can be read by special-purpose AI languages such as Prolog.

Advantages of using predicate logic to represent knowledge include:

* The precision with which knowledge objects and their relationships to one another can be expressed.
* Recourse to a formal and established body of formal rules of logic for checking these relationships.

Disadvantages of predicate logic include:

* The relative obscurity of its formulation, which could tend to make it difficult for domain experts as well as ES users to understand and apply.
* The need for specialised software, such as Prolog, to be able to express the logic in an acceptable form.
* The need for some understanding of computer programming to make effective use of predicate logic (Chorafas, 1987:166).

6. Special-Purpose Representation

A number of other approaches to knowledge representation have been developed, often on a one-off basis for some specific AI system. Examples of special-purpose representation include:

* Direct Representation - consisting of some form of internal map built into a system, intended to represent a series of alternative routes that could be followed by a robot (Forsyth and Naylor, 1986:125-126).
* Blackboard Representation - where several independent knowledge-bases might be linked into a single memory and inference engine, as in the HEARSAY system (Townsend and Feucht, 1986:62).
* Representation by Example - in which the knowledge engineer or expert feeds examples of problems and

solutions into the system. The system generates a matrix of likely problem and solution patterns, against which it can then attempt to match any new problems fed into it. An example is the EXPERT-EASE ES shell (Townsend and Feucht, 1986:62-63).

C.4 Reasons for Using the Level 5 AI Software

Although perhaps not as easy to use as some commercially available ES shells, I decided to use the Level 5 software in the present study for the following reasons:

* The software could be made relatively user friendly, capable of providing extensive explanations to a user before, during and after a consultation session.
* The software provided a degree of control over features such as access to external databases and programs if required.
* The knowledge could be represented in the form of production rules, which at the time when the system was developed was the most common form of knowledge representation used (D'Agapeyeff and Hawkins, 1988:7-8), and the method with which I was most familiar and felt most comfortable.
* The Level 5 software had already been used in the Bank by another staff member, who had highly recommended it to me.
* The Level 5 system used backward chaining inference. This suited the characteristics that I expected the ES knowledge base to have - ie a relatively small number of solutions and a relatively large number of conditions that needed to be met to propose a particular solution (see section C.2.3 for a comparison between backward and forward chaining inference).

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APPENDIX D: COMPUTER PRINTOUT OF LEVEL 5 ES PROGRAMS

This Appendix contains the computer program code for the three prototype ES knowledge bases.

To facilitate the understanding of this program code, reference can be made to the page key below:

Page	Description
D.3	Users' introduction to the needs analysis ES component.
D.3	Needs analysis knowledge base rules in skeleton form (ie as manipulated by the ES inference engine, NOT as seen by users).
D.6	Needs analysis text identifier phrases, each followed by the text statement with which users are presented and with which users are required to indicate their degree of agreement or disagreement.
D.9	Needs analysis ES recommendation identifier phrases, each followed by the text that is displayed to a user if a recommendation is selected by the inference engine.
D.14	Users' introduction to the method selection ES component.
D.14	Method selection knowledge base rules in skeleton form (ie as manipulated by the ES inference engine, NOT as seen by users).

Page	Description
D.19	Method selection text identifier phrases, each followed by the text statement with which users are presented and with which users are required to indicate their degree of agreement or disagreement.
D.21	Method selection ES recommendation identifier phrases, each followed by the text that is displayed to a user if a recommendation is selected by the inference engine.
D.26	Users' introduction to the media selection ES component.
D.26	Media selection knowledge base rules in skeleton form (ie as manipulated by the ES inference engine, NOT as seen by users).
D.31	Media selection text identifier phrases, each followed by the text statement with which users are presented and with which users are required to indicate their degree of agreement or disagreement.
D.35	Media selection ES recommendation identifier phrases, each followed by the text that is displayed to a user if a recommendation is selected by the inference engine.

```
! ***************************************************
! ***** Needs Analysis K-Base Version 1.0 *****
! ***** by Frans Brigando - July 1990 *****
! ***************************************************

! ***** Last worked on - 5/04/92
TITLE Training Needs Analysis DISPLAY

  ********** TRAINING NEEDS ANALYSIS **********

                EXPERT ASSISTANT

In this section, you will examine a problem in an
organisation to check whether it can be solved entirely or
at least in part via training.

The recommendations provided at the end of this section will
only be of use if you have a specific, job-related problem
to address, and if the answers that you provide to the
questions that follow are accurate.

To answer the questions that follow, indicate your
CONFIDENCE using the SPACE BAR or ARROW keys on the
keyboard, and then press the ENTER key.

          Press Function Key 3 to begin.

THRESHOLD = 60
SUPPRESS ALL
CONFIDENCE ON

! ***** The overall goal - (never seen by user) *****
1. Needs Analysis

! ***** Dummy goal *****
RULE N0
IF Problem is not training related
OR Problem is training related
THEN Needs Analysis

RULE N1
IF Ethnic training
OR Basic skills training
OR Social skills training
OR Psychomotor skills training
OR Procedural skills training
OR Cognitive skills training
OR Knowledge training
OR Attitude training
THEN Problem is training related CF 85
AND DISPLAY Training problem text
```

```
RULE N2
IF Problem due mainly to work environment
OR Problem due mainly to personal situation
THEN Problem is not training related CF 65
AND DISPLAY Not training problem text

RULE N111
IF Job definition problem
OR Performance matching problem
OR Working conditions problem
OR Management or organisation problem
OR Reward and recognition problem
THEN Problem due mainly to work environment CF 70
AND DISPLAY Work environment problem text

RULE N112
IF Domestic problem
OR Substance abuse problem
OR Travel problem
OR Personality problem
THEN Problem due mainly to personal situation CF 35
AND DISPLAY Personal situation problem text

RULE N1111
IF Task description is available
THEN Job definition problem CF 15
ELSE Job definition problem CF 65
AND DISPLAY Job description problem text

RULE N1112
IF Performance standards are available
AND Individual's competencies are matched to standards
THEN Performance matching problem CF 10
ELSE Performance matching problem CF 60
AND DISPLAY selection problem text

RULE N1113
IF Environmental factors in workplace ok
AND Tools and Equipment ok
AND Staff numbers ok
AND Workload not overwhelming
THEN Working conditions problem CF 25
ELSE Working conditions problem CF 45
AND DISPLAY Working conditions problem text

RULE N1114
IF Supervision of the job or [illegible] not too lax
AND Supervision of the job or [illegible] is not too rigid
AND Communication channels work effectively
AND Feedback on performance is ok
THEN Management or organisation problem CF 25
ELSE Management or organisation problem CF 65
AND DISPLAY Management or organisation problem text
```

```
RULE N1115
IF Reward for performance is ok
AND Promotion prospects ok
AND Recognition for performance ok
THEN Reward and recognition problem CF 10
ELSE Reward and recognition problem CF 75
AND DISPLAY Reward and recognition problem text

RULE N1121
IF No domestic problems suspected
THEN Domestic problem CF 35
ELSE Domestic problem CF 55
AND DISPLAY Domestic problem text

RULE N1122
IF Substance abuse not suspected
THEN Substance abuse problem CF 30
ELSE Substance abuse problem CF 45
AND DISPLAY Substance abuse problem text

RULE N1123
IF Travel to work not a problem
THEN Travel problem CF 15
ELSE Travel problem CF 80
AND DISPLAY Travel problem text

RULE N1124
IF No serious clashes between team members noted
AND No worker being treated as a misfit
THEN Personality problem CF 25
ELSE Personality problem CF 40
AND DISPLAY Personality problem text

RULE N2111
IF Employees from different ethnic groups
THEN Ethnic training CF 35
AND DISPLAY Ethnic training text

RULE N2112
IF Employees lack basic skills
THEN Basic skills training CF 85
AND DISPLAY Basic skills training text

RULE N2113
IF Employees lack social skills
THEN Social skills training CF 75
AND DISPLAY Social skills training text

RULE N2114
IF Employees lack psychomotor skills
THEN Psychomotor skills training CF 85
AND DISPLAY Psychomotor skills training text
```

```
RULE N2115
IF Employees lack procedural skills
THEN Procedural skills training CF 80
AND DISPLAY Procedural skills training text

RULE N2116
IF Employees lack cognitive skills
THEN Cognitive skills training CF 60
AND DISPLAY Cognitive skills training text

RULE N2117
IF Employees lack knowledge
THEN Knowledge training CF 95
AND DISPLAY Knowledge training text

RULE N2118
IF Employees lack right attitude
THEN Attitude training CF 45
AND DISPLAY Attitude training text

! **********************************************************
!  ** Full question text seen by user is displayed below **
! **********************************************************

TEXT Task description is available

        There is a clear definition available of
        the job or task that has to be performed

TEXT Performance standards are available

        There are clear performance criteria that
        spell out the requirements of the parson
        or people who are to perform the job or task

TEXT Individual's competencies are matched to standards

        A real attempt has been made to select
        people to perform the job or task using
        criteria for performance

TEXT Environmental factors in workplace ok

        Conditions in the working environment,
        such as space, lighting, noise and comfort
        are conducive to effective job performance.

TEXT Tools and Equipment ok

        Any tools and/or equipment required for
        effective job performance are fully
        available when needed and in good repair.
```

TEXT Staff numbers ok

The number of staff required for effective job performance is sufficient

TEXT Workload not overwhelming

The workload for the job or task being examined is reasonable and not considered by you to be overwhelming.

TEXT Supervision of the job or task is not too ...

When necessary, performance is supervised closely enough for the staff to know what is expected of them.

TEXT Supervision of the job or task is not too rigid

Where desirable, supervision of performance is loose enough to allow staff a sufficiently free rein to use their own initiative.

TEXT Communication channels work effectively

Communication channels related to both the job or task being performed and to the organisation as a whole function effectively enough to not significantly affect performance.

TEXT Feedback on performance is ok

The employee receives clear feedback about the quality and effectiveness of his or her performance.

TEXT Reward for performance is ok

The employee is adequately rewarded in terms of financial remuneration for his or her performance.

TEXT Promotion prospects ok

Prospects for career growth and advancement within the organisation, if at all possible given the specific job circumstances, do exist.

TEXT Recognition for performance ok

The employee is adequately rewarded in terms of recognition for a job well done.

TEXT No domestic problems suspected

As far as is known, the employee's domestic circumstances are not resulting in performance or motivational problems at work.

TEXT Substance abuse not suspected

As far as is known, the employee does not abuse substances such as alcohol or drugs.

TEXT Travel to work not a problem

The employee is not known to experience problems in travelling to work each day.

TEXT No serious clashes between team members noted

No serious personality clashes between co-workers employed in the area of the problem being addressed have been noted.

TEXT No worker being treated as a misfit

The treatment of one worker as a 'misfit' or as an outcast by other workers has not been detected.

TEXT Employees from different ethnic groups

The people employed in the problem area come from different ethnic or cultural backgrounds (eg from different racial or language groups), and the perceived differences are resulting in conflict that is affecting performance.

TEXT Employees lack basic skills

The people employed in the problem area lack needed basic skills, such as the ability to read or write adequately, to communicate effectively in English, or to manipulate figures arithmetically.

TEXT Employees lack social skills

The people employed in the problem area lack needed social skills, such as the ability to listen, assert themselves, communicate effectively or market the Bank's products or services.

TEXT Employees lack psychomotor skills

The people employed in the problem area lack needed psychomotor skills, such as ability to operate equipment, or work with their hands or use hand-eye coordination effectively as required by the job or task.

TEXT Employees lack procedural skills

The people employed in the problem area lack needed procedural skills, such as the ability to complete documentation, or follow a set of laid down procedural steps.

TEXT Employees lack cognitive skills

The people employed in the problem area lack needed cognitive skills, such as problem-solving, planning or decision-making abilities.

TEXT Employees lack knowledge

Employees lack the knowledge of products, services or procedures required for satisfactory performance of the job or task being addressed.

TEXT Employees lack right attitude

At least some people employed in the problem area appear to lack the sort of attitudes considered necessary to effective performance of their jobs.

! **********
! *** Text for recommended solutions follows below: ***
! **********

DISPLAY Training problem text

From the answers that have been provided it seems that the problem may indeed be solvable, at least in part, by some form of training programme.

DISPLAY Not training problem text

A training solution to the problem being addressed does not seem to be appropriate at this stage. Try to first address the non-training problems before attempting a training solution.

DISPLAY Work environment problem text

The problem appears to be related to conditions in the work environment. It is recommended that these conditions be addressed before attempting a training solution.

DISPLAY Personal situation problem text

The problem appears to be related to the personal or domestic situation of one or more employees. It is recommended that this situation be addressed before attempting a training solution.

DISPLAY Job description problem text

It appears that the problem is a lack of a clear job description, spelling out exactly the functions and tasks of the person or people performing the job or tasks, rather than a lack of training

DISPLAY selection problem text

The problem appears to be related to a lack of performance standards or of adequate matching of individual abilities to those performance standards. Try to address these issues before attempting a training solution.

DISPLAY Working conditions problem text

The problem seems to be related to the physical conditions prevailing in the workplace. Try to address these factors before attempting to apply a training solution.

DISPLAY Management or organisation problem text

The problem appears to be largely attributable to management style, inadequate communications, recognition or reward patterns. Address these issues before attempting to provide training for the task being analysed.

DISPLAY Reward and recognition problem text

The problem seems to be related to the lack of an adequate reward structure for performance. Try to address this structure before attempting to apply a training solution.

DISPLAY Domestic problem text

The problem seems to be related to the influence of domestic problems in the workplace. Try to identify and resolve these problems via the use of counselling before attempting to apply a training solution.

DISPLAY Substance abuse problem text

The problem seems to be related to some form of substance abuse (alcohl or drugs). Try to identify and resolve the substance abuse problem (via referral to counselling, for example), rather than applying a training solution.

DISPLAY Travel problem text

Performance and/or motivation appears to be suffering as a result of problems associated with travelling to work. Address these problems before attempting a training solution.

DISPLAY Personality problem text

Performance and/or motivation appears to be suffering as a result of personality problems or clashes. Although some form of social skills training or team-building training might help, it is recommended that an attempt be made to first identify the underlying personality problem/s and deal with them via psychological counselling or treatment if necessary before attempting any training 'solutions'.

DISPLAY Ethnic training text

The problem appears to be related to some form of ethnic misunderstandings. Such misunderstandings can often be successfully addressed via experiential intercultural awareness training programmes.

DISPLAY Basic skills training text

The problem seems to be related to a lack of basic literacy or numeracy skills. A (probably long-term) programme addressing these basic skills may need to be adopted. This lack of basic skills must be tackled before attempting any more sophisticated training that may depend on mastery of these skills.

DISPLAY Social skills training text

The problem seems to be related to a lack of social skills. A programme aimed at teaching the specific social skills considered to be lacking may prove to be useful. As a wide variety of such programmes are already in existence, be sure to examine the possibility of using an existing programme before going to the trouble and expense of developing your own programme.

DISPLAY Psychomotor skills training text

The problem seems to be related to a lack of psychomotor skills. A programme aimed at teaching the specific skills considered to be lacking may prove be useful. As a wide variety of such programmes are already in existence, be sure to examine the possibility of using an existing programme before going to the trouble and expense of developing your own programme.

DISPLAY Procedural skills training text

The problem seems to be related to a lack of procedural skills. A programme aimed at teaching the skills considered to be lacking may prove be useful. As a wide variety of such programmes are already in existence, be sure to examine the possibility of using an existing programme before going to the trouble and expense of developing your own programme.

DISPLAY Cognitive skills training text

The problem seems to be related to a lack of cognitive skills. A programme aimed at teaching the skills considered to be lacking may prove be useful. As a wide variety of such programmes are already in existence, be sure to examine the possibility of using an existing programme before going to the trouble and expense of developing your own programme.

DISPLAY Knowledge training text

The problem seems to be related to a lack of knowledge or understanding. The specific knowledge may well be a requirement for the performance of some skill, and if this is the case, it may be best to teach both the knowledge and the skill in the same programme.

```
DISPLAY Attitude training text

        The situation seems to indicate some form of
        attitudinal problem.  Such problems might be
        partly solvable by means of some intensive
        attitude-changing programmes, but one must
        realise that it can be extremely difficult
        to influence a person's deep-seated attitudes
        or values, and that a long-term approach may
        be necessary.

END
```

```
! *****  Method Selection K-Base  *****
! by Frans Brigando - June, 1990
! Last worked on - 6/4/92

TITLE Method Selection DISPLAY

          ********** METHOD SELECTION **********

                    EXPERT ASSISTANT

In this section you will be able to check what instructional
methods are appropriate for a particular training programme.

The system will encourage you to distinguish between
EXPOSITIVE learning methods and DISCOVERY learning methods.

In EXPOSITIVE learning, the learning content is presented up
front.  The learner is then required to understand, remember
or apply it.

In DISCOVERY learning, the learner seeks out the learning
content on his or her own, often with some guidance, before
attempting to understand, remember or apply it.

To answer the questions that follow, indicate your
CONFIDENCE using the SPACE BAR or ARROW keys on the
keyboard, and then press ENTER.

                Press Function key 3 to begin.

THRESHOLD=40
SUPPRESS ALL
CONFIDENCE ON

! *****   Goal Statement   *****
1. Method Selection

! First rule is a Dummy goal

RULE M0
IF Skills shortage
OR Knowledge shortage
OR Attitude related issue
THEN Method Selection CF 100

RULE M1
IF Social skills training
OR Cognitive skills training
OR Psychomotor skills training
OR Procedural skills training
THEN Skills shortage CF 75

RULE M2
IF Facts knowledge required
```

OR Concepts knowledge required
OR Procedure knowledge required
OR Principles knowledge required
THEN Knowledge shortage CF 85

RULE M3
IF Superficial attitude problem
OR Deep rooted attitude problem
THEN Attitude related issue CF 55

RULE M10
IF Social discovery method ok
OR Social expositive method ok
THEN Social skills training CF 75

RULE M12
IF Cognitive discovery method ok
OR Cognitive expositive method ok
THEN Cognitive skills training CF 65

RULE M14
IF Psychomotor discovery method ok
OR Psychomotor expositive method ok
THEN Psychomotor skills training CF 70

RULE M17
IF Procedural discovery method ok
OR Procedural expositive method ok
OR Procedural job aid ok
THEN Procedural skills training CF 65

RULE M20
IF Fact discovery method ok
OR Fact expositive method ok
OR Fact job aid ok
THEN Facts knowledge required CF 60

RULE M23
IF Concepts discovery method ok
OR Concepts expositive method ok
OR Concepts job aid ok
THEN Concepts knowledge required CF 70

RULE M25
IF Procedure discovery method ok
OR Procedure expositive method ok
OR Procedure job aid ok
THEN Procedure knowledge required CF 65

RULE M28
IF Principles discovery method ok
OR Principles expositive method ok
OR Principles job aid ok
THEN Principles knowledge required CF 45

```
RULE M30
IF Superficial attitude change required
AND Environment can influence attitude
OR Superficial opinion held
THEN Superficial attitude problem CF 45
AND DISPLAY Superficial attitude problem text

RULE M32
IF Deep rooted attitude change required
AND Strong emotion is displayed
OR Attitude seems to be unconcious
THEN Deep rooted attitude problem CF 35
AND DISPLAY Deep rooted attitude problem text

RULE M80
IF Must adapt learning to different circumstances
AND Need deep understanding of subject
AND Time available for intensive training
THEN Discovery method ok CF 80
ELSE Discovery method not ok CF 65

RULE M90
IF Unaided recall not critical
AND Easy to understand but hard to remember
THEN Job aid ok CF 75
ELSE Job aid not ok CF 75

RULE M101
IF Social skill required
AND Discovery method ok
THEN Social discovery method ok CF 85
AND DISPLAY Social discovery method ok text

RULE M101A
IF Social skill required
AND Discovery method not ok
THEN Social expositive method ok CF 75
AND DISPLAY Social expositive method ok text

RULE M102
IF Cognitive skill required
AND Discovery method ok
THEN Cognitive discovery method ok CF 75
AND DISPLAY Cognitive discovery method ok text

RULE M102A
IF Cognitive skill required
AND Discovery method not ok
THEN Cognitive expositive method ok CF 80
AND DISPLAY Cognitive expositive method ok text
```

```
RULE M103
IF Psychomotor skill required
AND Discovery method ok
THEN Psychomotor discovery method ok CF 65
AND DISPLAY Psychomotor discovery method ok text

RULE M103A
IF Psychomotor skill required
AND Discovery method not ok
THEN Psychomotor expositive method ok CF 75
AND DISPLAY Psychomotor expositive method ok text

RULE M105
IF Procedural skill required
AND Discovery method ok
THEN Procedural discovery method ok CF 65
AND DISPLAY Procedural discovery method ok text

RULE M105A
IF Procedural skill required
AND Discovery method not ok
AND Job aid ok
THEN Procedural job aid ok CF 75
AND DISPLAY Procedural job aid ok text

RULE M105B
IF Procedural skill required
AND Discovery method not ok
AND Job aid not ok
THEN Procedural expositive method ok CF 80
AND DISPLAY Procedural expositive method ok text

RULE M201
IF Fact learning required
AND Low usage of facts
AND Job aid ok
THEN Fact job aid ok CF 80
AND DISPLAY Fact job aid ok text

RULE M201A
IF Fact learning required
AND Job aid not ok
AND Low usage of facts
AND Discovery method ok
THEN Fact discovery method ok CF 65
AND DISPLAY Fact discovery method ok text

RULE M201B
IF Fact learning required
AND Job aid not ok
AND Discovery method not ok
THEN Fact expositive method ok CF 75
AND DISPLAY Fact expositive method ok text
```

```
RULE M203
IF Concepts learning required
AND Discovery method ok
THEN Concepts discovery method ok CF 65
AND DISPLAY Concepts discovery method ok text

RULE M203A
IF Concepts learning required
AND Discovery method not ok
AND Job aid ok
THEN Concepts job aid ok CF 70
AND DISPLAY Concepts job aid ok text

RULE M203B
IF Concepts learning required
AND Discovery method not ok
AND Job aid not ok
THEN Concepts expositive method ok CF 75
AND DISPLAY Concepts expositive method ok text

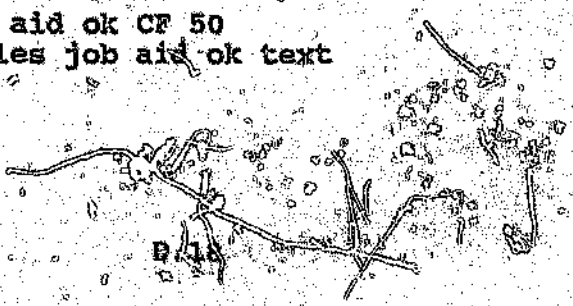
RULE M205
IF Procedure learning required
AND Discovery method ok
THEN Procedure discovery method ok CF 65
AND DISPLAY Procedure discovery method ok text

RULE M205A
IF Procedure learning required
AND Discovery method not ok
AND Job aid ok
THEN Procedure job aid ok CF 70
AND DISPLAY Procedure job aid ok text

RULE M205B
IF Procedure learning required
AND Discovery method not ok
AND Job aid not ok
THEN Procedure expositive method ok CF 80
AND DISPLAY Procedure expositive method ok text

RULE M207
IF Principles learning required
AND Discovery method ok
THEN Principles discovery method ok CF 45
AND DISPLAY Principles discovery method ok text

RULE M207A
IF Principles learning required
AND Discovery method not ok
AND Job aid ok
THEN Principles job aid ok CF 50
AND DISPLAY Principles job aid ok text
```



```
RULE M207B
IF Principles learning required
AND Discovery method not ok
AND Job aid not ok
THEN Principles expositive method ok CF 50
AND DISPLAY Principles expositive method ok text

! ********************************************************
!  **** Question text seen by user is displayed below ****
! ********************************************************

TEXT Strong emotion is displayed

     The attitude, value or opinion appears to arouse
     strong emotions in the employee(s).

TEXT Attitude seems to be unconcious

     The attitude, value or opinion seems to be unnoticed
     or unconcious.

TEXT Social skill required

     The instructional method now being sought is for the
     development of one or more SOCIAL SKILLS, such as
     listening, selling, persuading, establishing social
     rapport with people or assertiveness.

TEXT Cognitive skill required

     The instructional method now being sought is for the
     development of one or more COGNITIVE SKILLS, such as
     such as problem-solving, planning or decision-making.

TEXT Psychomotor skill required

     The instructional method now being sought is for the
     development of one or more PSYCHOMOTOR SKILLS, such as
     using hand-eye coordination in some task, operating
     equipment or manipulating physical tools etc.

TEXT Procedural skill required

     The instructional method now being sought is for the
     development of one or more PROCEDURAL SKILLS, such as
     filling in documents, using a computer programme, etc.

TEXT Fact learning required

     The instructional method now being sought is aimed
     at increasing the learner's FACTUAL KNOWLEDGE, such
     as names, the location of objects or people, labels,
     foreign or unfamiliar words and acronyms etc.
```

TEXT Concepts learning required

The instructional method now being sought is aimed at increasing of the learner's CONCEPTUAL KNOWLEDGE, ie ability to recognise objects and events as belonging to a particular category of objects or events which share certain common characteristics. Thus the concept of a 'dog' includes a number of different animals with certain characteritics in common.

TEXT Procedure learning required

The instructional method now being sought is aimed at increasing of the learner's PROCEDURAL KNOWLEDGE, ie the ability to recognise and/or list a series of steps to be followed to perform some task.

TEXT Principles learning required

The instructional method now being sought is aimed at increasing of the learner's KNOWLEDGE of certain RULES or PRINCIPLES, ie the ability to identify, describe or apply the principle or law underlying some process related to his or her job.

TEXT Superficial attitude change required

The instructional method now being sought is aimed at bringing about a fairly SUPERFICIAL change in the learner's ATTITUDES or OPINIONS regarding a matter that is probably not too emotionally disturbing to that learner.

TEXT Deep rooted attitude change required

The instructional method now being sought is aimed at bringing about a fairly DEEP-ROOTED change in the learner's ATTITUDES, OPINIONS or VALUES regarding a topic that is probably very emotionally disturbing to that learner.

TEXT Environment can influence attitude

The attitude or opinion displayed can quite easily be affected by environmental or contextual factors, ie it can change from one moment to the next.

TEXT Superficial opinion held

The attitude or opinion appears to be be relatively superficial or shallow, ie not deeply emotionally based.

TEXT Must adapt learning to different circumstances

The skills and/or knowledge to be learned will have to be ADAPTED to widely differing circumstances or conditions when they are put into practice at work.

TEXT Need deep understanding of subject

In order to action effectively after training, the learner will require an IN-DEPTH UNDERSTANDING of the knowledge and/or skill that is to be taught.

TEXT Time available for intensive training

There is sufficient TIME available for intensive training to take place, if necessary, to ensure a satisfactory level of mastery of the learning material.

TEXT Low usage of facts

The facts that are required to be learned are only expected to be USED INFREQUENTLY on the job.

TEXT Unaided recall not critical

UNASSISTED, on the spot RECALL of the skill/knowledge is NOT critical to effective performance of the job or task.

TEXT Easy to understand but hard to remember

The material to be learned is easy to understand but difficult or unnecessary to remember off by heart.

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! **********************************************************
! ****  Solution text seen by user is displayed below ******
! **********************************************************
```

DISPLAY Superficial attitude problem text

Part of the problem seems to revolve around the need to alter or adapt the employee's SUPERFICIAL ATTITUDES or OPINIONS. Any attempt to change attitudes can involve as lot of effort and produce very little in terms of tangible evidence of results. Try to alter the learner's outwardly-visible behaviours and also create an awareness in him or her about the existence of the problem. Where the attitude or opinion is truly superficial, sometimes simply providing more information about a topic can help.

DISPLAY Deep rooted attitude problem text

Part of the problem seems to revolve around the need to alter or adapt the employee's DEEP ROOTED ATTITUDES or VALUES. Any attempt to change attitudes can involve as lot of effort and produce very little in terms of tangible evidence of results. Try to alter the learner's outwardly-visible behaviours and also create an awareness in him or her about the existence of the problem. Any attempt to alter deep rooted attitudes, values or opinions must be regarded as a difficult and long term project.

DISPLAY Social discovery method ok text

Some of the SOCIAL SKILLS seem to call for the use of DISCOVERY learning methods. You could begin the training with EXPOSITIVE demonstration and practice, and follow this by providing an increasingly greater variety of challenging simulated or real social situations for the learner to deal with. Be sure to provide extensive instructor feedback.

DISPLAY Social expositive method ok text

Some SOCIAL SKILLS required seem to call for the use of EXPOSITIVE learning methods. Try demonstrating part or all of a SKILL, followed by extensive learner practice together with instructor feedback for guidance. Behaviour modelling is often a successful technique.

DISPLAY Cognitive discovery method ok text

There is a need for the development of in-depth COGNITIVE SKILLS. You could begin with EXPOSITIVE demonstration and practice, followed by guided problem-solving, case studies, projects or simulations.

DISPLAY Cognitive expositive method ok text

Some of the COGNITIVE SKILLS seem to call for EXPOSITIVE learning methods. Try demonstrating part or all of the SKILL, and follow this with extensive learner practice and instructor FEEDBACK for guidance.

DISPLAY Psychomotor discovery method ok text

Some of the PSYCHOMOTOR SKILLS seem to call for a DISCOVERY learning approach. You could begin with an EXPOSITIVE demonstration and practice approach, and follow this with an increasingly wider variety of conditions under which to perform the skill. Be sure to provide sufficient feedback on the learner's

performance. Be aware of the need for safety during the learning process.

DISPLAY Psychomotor expositive method ok text

Some of the PSYCHOMOTOR SKILLS seem to require an EXPOSITIVE learning approach. Try demonstrating all or part of the skill, followed by extensive learner practice and feedback on the learner's performance. Be aware of the need for safety during the learning process.

DISPLAY Procedural discovery method ok text

Some of the PROCEDURAL SKILLS seem to call for a DISCOVERY learning approach. You could begin with an EXPOSITIVE demonstration and then follow this with practice under an increasingly wider variety of conditions. Be sure to provide adequate and frequent feedback on the learner's performance.

DISPLAY Procedural job aid ok text

At least some of the PROCEDURAL SKILLS seem to require little more than a simple JOB AID or memory-jogging device to be made available to the employee at the place of work. The only formal training needed might be on how to go about using the JOB AID.

DISPLAY Procedural expositive method ok text

At least some of the PROCEDURAL SKILLS seem to require an EXPOSITIVE approach. Try demonstrating all or part of the procedure and follow this by extensive learner practice and feedback on the learner's performance.

DISPLAY Fact job aid ok text

The conditions under which the FACTS are required seem to indicate little need to remember the various FACTS off-by-heart, so a simple JOB AID or memory-jogging device made available to the employee at the place of work may be sufficient. The only training required might well be on how to go about using the JOB AID.

DISPLAY Fact discovery method ok text

Provided that a simple JOB MEMORY AID (eg wall or desk chart) is not suitable, try a DISCOVERY method, like "Socratic" questioning to enable learners to form associations between objects and names.

DISPLAY Fact expositive method ok text

Provided that a simple JOB MEMORY AID (eg wall or desk chart) is not suitable, try EXPOSITIVE methods such as classroom tutorials, textbooks, programmed instruction and drill & practice.

DISPLAY Concepts discovery method ok text

Try using DISCOVERY methods to teach the CONCEPTS, such as think-tanks, "Socratic" questioning, case studies, projects and simulations. Get the learner to recognise the CONCEPTS in different situations and contexts.

DISPLAY Concepts job aid ok text

The conditions under which the CONCEPTS are required seem to indicate little need to remember them off-by-heart, so a simple JOB AID or memory-jogging device made available to the employee at the place of work may be sufficient. The only training required here might well be on how to go about using the JOB AID.

DISPLAY Concepts expositive method ok text

Try using EXPOSITIVE methods to teach the CONCEPTS, such as textbooks, classroom demonstrations or programmed instruction. Use lots of examples and "non-examples" to highlight distinguishing features.

DISPLAY Procedure discovery method ok text

Provided that a JOB MEMORY AID is insufficient, try a "GUIDED DISCOVERY" approach, getting learners to DEDUCE each step in turn. Try discussions, case studies or simulations, or "Socratic" questions.

DISPLAY Procedure job aid ok text

The conditions under which the PROCEDURES seem to be used appear to call for little need to remember the various steps off-by-heart, so a simple JOB AID or memory-jogging device made available to the employee at the place of work may be sufficient. The only training required here might well be on how to go about using the JOB AID.

DISPLAY Procedure expositive method ok text

Provided that a simple JOB MEMORY AID is unsuitable, try some EXPOSITIVE methods, such as demonstration & practice, modelling examples, drill & practice and other repetitive conditioning techniques.

DISPLAY Principles discovery method ok text

Try using DISCOVERY methods to teach these PRINCIPLES, such as think-tanks, "Socratic" questioning, case studies, projects and simulations. Get the learner to recognise the PRINCIPLES in different places.

DISPLAY Principles job aid ok text

The conditions under which the PRINCIPLES seem to be used appear to call for little need to know the principles off-by-heart, so a simple JOB AID or memory-jogging device made available to the employee at the place of work might be sufficient. The only training required here might well be on how to go about using the JOB AID.

DISPLAY Principles expositive method ok text

Try using EXPOSITIVE methods to teach these PRINCIPLES, such as classroom techniques, textbooks, or programmed instruction. Demonstration & practice or behaviour modelling may be useful.

END

```
! ******  MEDIA SELECTION KNOWLEDGE-BASE ******
! *****  Copyright Frans Brigando July, 1990  ******

! Last worked on 7/4/92

TITLE  Media Selection DISPLAY

          ************  INSTRUCTIONAL MEDIA  ************

                        EXPERT ASSISTANT

In this section, the system will assist you to select the
appropriate delivery media for a particular training
programme.

The system will help you to examine some of the factors that
could be taken into account when deciding which delivery
media to use.

It must be remembered, however, that there may be many other
delivery media that could be used but which are not
mentioned in the final recommendations supplied by the
system, and that the system merely provides a few ideas for
your consideration.

To answer the questions that follow, indicate your
CONFIDENCE using the SPACE BAR and ARROW keys on the
keyboard and then press ENTER.

                Press Function key 3 to begin.

THRESHOLD = 40
SUPPRESS ALL
CONFIDENCE ON

! *****  Dummy Goal Statement for Media Selection  *****
1. Media Selection

! Dummy Rule
RULE MD0
IF Non training media solution
OR Training Media solution
THEN Media Selection CF 85

RULE MD1
IF Mass address ok
OR Oneway video ok
OR Mass media workbook ok
OR Other mass media ok
OR Personal contact ok
OR Lack of suitable mass medium
THEN Non training media solution CF 60
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RULE MD2
IF Local lecturers ok
OR Visiting lecturers ok
OR Programmed learning or correspondence ok
OR Technology based training ok
OR External training consultants ok
OR Lack of suitable training medium
THEN Training Media solution CF 65

RULE MD10
IF Low learner participation required
AND Significant number of learners expected
AND Learners all grouped together
AND Mass address resources exist
THEN Mass address ok CF 50
AND DISPLAY Mass address text
ELSE Mass address not ok CF 45

RULE MD11
IF Low learner participation required
AND Significant number of learners expected
AND Video players exist
AND Video resources ok
OR Suitable video films already exist
THEN Oneway video ok CF 55
AND DISPLAY Oneway video text
ELSE Oneway video not ok CF 45

RULE MD12
IF Low learner participation required
AND Significant number of learners expected
AND Printing resources ok
OR Suitable workbooks already exist
THEN Mass media workbook ok CF 60
AND DISPLAY Mass media workbook text
ELSE Mass media workbook not ok CF 45

RULE MD13
IF Low learner participation required
AND Significant number of learners expected
AND Other resources ok
THEN Other mass media ok CF 55
AND DISPLAY Other mass media text
ELSE Other mass media not ok CF 40

RULE MD14
IF Low learner participation required
AND Small number of learners expected
THEN Personal contact ok CF 65
AND DISPLAY Personal contact text
ELSE Personal contact not ok CF 40

RULE MD15
IF Low learner participation required
AND Mass address not ok
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AND Oneway video not ok
AND Mass media workbook not ok
AND Other mass media not ok
AND Personal contact not ok
THEN Lack of suitable mass medium CF 50
AND DISPLAY Lack of suitable mass medium text

RULE MD20
IF High learner participation required
AND Face to face contact not required
AND NOT Hands on required
AND Significant number of learners expected
OR Learners spread and cannot travel
AND Technology based training resources ok
THEN Technology based training ok CF 75
AND DISPLAY Technology based training text
ELSE Technology based training not ok CF 55

RULE MD21
IF High learner participation required
AND Face to face contact ... required
AND NOT Hands on required
AND Significant number of learners expected
OR Learners spread and cannot travel
AND Programmed learning resources ok
THEN Programmed learning or correspondence ok CF 60
AND DISPLAY Programmed learning or correspondence text
ELSE Programmed learning or correspondence not ok CF 50

RULE MD22
IF High learner particip...  required
AND Learners located clos...  training centre
OR Learners can travel
AND Lecturers resources ok
THEN Local lecturers ok CF 75
AND DISPLAY Local lecturers text
ELSE Local lecturers not ok CF 55

RULE MD23
IF High learner participation required
AND Learners spread and cannot travel
AND Visiting lecturers resources ok
THEN Visiting lecturers ok CF 65
AND DISPLAY Visiting lecturers text
ELSE Visiting lecturers not ok CF 50

RULE MD24
IF High learner participation required
AND Local lecturers not ok
AND Visiting lecturers not ok
AND External training consultants resources ok
THEN External training consultants ok CF 55
AND DISPLAY External training consultants text
ELSE External training consultants not ok CF 50
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RULE 25
IF Local lecturers not ok
AND Visiting lecturers not ok
AND External training consultants not ok
AND Programmed learning or correspondence not ok
AND Technology based training not ok
THEN Lack of suitable training medium CF 75
AND DISPLAY Lack of suitable training medium text

RULE MD100
IF Purpose is not merely informative
AND Learning must be applied in practice
THEN High learner participation required CF 55
ELSE Low learner participation required CF 55

RULE MD101
IF Target learner population more than 100
OR Learning is critical to safety or firm's survival
THEN Significant number of learners expected CF 80
ELSE Small number of learners expected CF 80

RULE MD102
IF Learners located close to training centre
AND Learners can all attend training together
THEN Learners all grouped together CF 70

RULE MD103
IF Speaker is available
AND Room is available
THEN Mass address resources exist CF 60

RULE MD104
IF Script writer is available
AND Subject matter expert is available
AND Video crew is available
AND Video production facilities are available
AND Time for development is available
AND Video budget is available
THEN Video resources ok CF 65

RULE MD105
IF Printer is available
AND Workbook writer is available
AND Subject matter expert is available
AND Time for development is available
AND Workbook budget is available
THEN Printing resources ok CF 70

RULE MD106
IF Internal communications are possible
OR Job aid is possible
OR Performance support system is possible
AND Writer is available
AND Subject matter expert is available
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```
AND Time for development is available
AND Budget for alternative is available
THEN Other resources ok CF 55

RULE MD107
IF NOT Definite need for interpersonal contact
AND Learners reasonably motivated
AND NOT Learners have low literacy skills
THEN Face to face contact not required CF 75

RULE MD108
IF NOT Learners located close to training centre
AND Learners may have domestic problems if travel
OR Learners cannot be spared from work to travel
THEN Learners spread and cannot travel CF 80
ELSE Learners can travel CF 65

RULE MD109
IF Technology based training facilities ok
AND Technology based training writer available
AND Instructional designer available
AND Subject matter expert is available
AND Technology based training crew available
AND Technology based training production facilities ok
AND Time for development is available
AND Technology based training budget available
THEN Technology based training resources ok CF 65

RULE MD110
IF Instructional designer available
AND Printing resources ok
THEN Programmed learning resources ok CF 55

RULE MD111
IF Lecturers resources ok
AND Lecturers can travel
AND Lecturers travel budget available
THEN Visiting lecturers resources ok CF 70

RULE MD112
IF Enough lecturers available
THEN Lecturers resources ok CF 80

RULE MD113
IF External training consultants available
AND Can adapt training to Bank requirements
AND NOT Training material is highly confidential
AND External training consultants acceptable to management
AND External training consultants budget available
THEN External training consultants resources ok CF 55
```

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! ************************************************************
!     *** Question Text seen by users is listed below ***
! ************************************************************

!   TEXT Continue Media Selection

TEXT Purpose is not merely informative

     The programme that you are designing is aimed at
     providing TRAINING, rather than simply providing
     INFORMATION to employees.

TEXT Learning must be applied in practice

     What is learned is or will be put into practice by
     the learners during or after the training programme.

TEXT Target learner population more than 100

     The anticipated number of people who will undergo
     the programme is over one hundred.

TEXT Learning is critical to safety or firm's survival

     What is learned on the programme is vital in terms
     of safety or in terms of the survival of the
     organisation.

TEXT Learners located close to training centre

     The learners are all located geographically close to
     a training centre.

TEXT Learners can all attend training together

     It would be possible for large groups of learners to
     all attend a training programme at the same time and
     place.

TEXT Speaker is available

     A competent speaker, who is adequately knowledgeable
     about the subject-matter, is available or could be
     made available to address the target audience.

TEXT Room is available

     A suitable room or auditorium is or could be made
     available for conducting a mass lecture or address.

TEXT Script writer is available

     A competent person is available to create and write
     a suitable video script dealing with the subject.
```

TEXT Subject matter expert is available

A person who has sufficient expertise in the subject-matter is available to assist in the creation of the training programme.

TEXT Suitable video films already exist

Suitable video films, that could be used in the present programme, are already available or could be acquired.

TEXT Video crew is available

A competent video production team is available to produce a video on the subject of the programme.

TEXT Video players exist

Suitable video playing equipment is available at the intended training or presentation points.

TEXT Video production facilities are available

Suitable video production facilities are available or could be made available.

TEXT Time for development is available

Sufficient time for development of the programme is available.

TEXT Video budget is available

An adequate budget is available for a video production.

TEXT Suitable workbooks already exist

Suitable instructional workbooks or manuals, that could be used in the present programme, are already available or could be acquired.

TEXT Printer is available

A suitably-equipped printing facility is available or could be made available.

TEXT Workbook writer is available

A competent person is available to write the workbook.

TEXT Workbook budget is available

An adequate budget is available for workbook production.

TEXT Internal communications are possible

Some form of internal communications (eg circulars, computer mail, posters, brochures or in-house magazine) would be a viable possibility for transmitting the desired information to the target population.

TEXT Job aid is possible

Some form of job aid or memory-jogging device would be a viable possibility for transmitting the desired information to the target population.

TEXT Performance support system is possible

Some form of computerised online referencing system would be a viable possibility for transmitting the desired information to the target population.

TEXT Writer is available

A competent writer is available or could become available to produce the text for the information transmission.

TEXT Budget for alternative is available

Sufficient funds are available to produce and transmit the information message.

TEXT Definite need for interpersonal contact

A definite need exists in the programme for interpersonal contact and/or communication during the learning process.

TEXT Hands on required

A definite need exists in the programme for learners to actually manipulate or operate tools and/or equipment.

TEXT Learners reasonably motivated

The prospective learners are expected to be reasonably well-motivated to engage in the training programme.

TEXT Learners have low literacy skills

The prospective learners are expected to posess a low level of literacy or numeracy.

TEXT Learners may have domestic problems if travel

The probability is high of learners encountering domestic pressures that will prevent them from travelling to a centralised training point.

TEXT Learners cannot be spared from work to travel

Prospective learners can absolutely not be spared from their work in order to travel to some central point for their training.

TEXT Technology based training facilities ok

Technology based training facilities are available or could be made available if necessary.

TEXT Technology based training writer available

A competent technology based training writer is available or could be made available if required.

TEXT Instructional designer available

A competent instructional designer is or could be made available if required.

TEXT Technology based training crew available

A competent technology based training team is or could be made available if required.

TEXT Technology based training production facilities ok

Suitable technology based training production facilities are or could be made available if required.

TEXT Technology based training budget available

Sufficient funds are available to produce and deliver technology based training.

TEXT Enough lecturers available

An adequate number of competent lecturers are or could be made available to deliver training courses.

TEXT Lecturers can travel

The lecturers would be available to travel to the areas where the training is to be delivered.

TEXT Lecturers travel budget available

Sufficient funds are available to allow the lecturers to travel to the training points.

TEXT External training consultants available

Suitable external training consultants are or could become available to deliver the necessary training.

TEXT Can adapt training to Bank requirements

The training offered by the external consultants is suited or could be adapted to the Bank's specific requirements.

TEXT Training material is highly confidential

The content of the training programme is too confidential to allow external consultants to have access to for training purposes.

TEXT External training consultants acceptable to management

The external training consultants would be acceptable to the Bank's management.

TEXT External training consultants budget available

Sufficient funds are available to employ external training consultants to delver the training programme.

! **********
! **** Solutions Text seen by users is listed below ****
! **********

DISPLAY Mass address text

The content of the programme seems best delivered via some form of mass address, perhaps a mass lecture or speech. Be sure to avoid lengthy and/or unvaried, monotonous sessions, since lectures offer very limited opportunities for audience participation, and are best kept short, relevant and lively.

DISPLAY Oneway video text

Part of the learning content seems suited to the use of video films. The production of effective videos calls for extensive expertise and sophisticated equipment and facilities.

DISPLAY Mass media workbook text

At least a part of the learning content seems to be suited to presentation via workbook reading assignments. The success of this medium depends to a large extent on the level of learner literacy and motivation.

DISPLAY Other mass media text

At least a part of the programme's content appears to lend itself to presentation via some form of widely distributed information. Consider the use of the organisation's internal communications mechanisms (circulars, magazines, posters or conventional or electronic mailing systems), or some form of on-job memory aid or computerised on-line referencing system.

DISPLAY Personal contact text

It would seem that the best way of communicating with the target audience might be by contacting each member of the audience personally and informing him or her about the content of the programme.

DISPLAY Lack of suitable mass medium text

At least a part of the programme appears to lend itself to presentation via some form of "mass medium". However, no (further) media could be identified by the system.

DISPLAY Technology based training text

Part of the learning content appears suited to some form of TECHNOLOGY-BASED TRAINING delivery. Depending on the availability of development, equipment and time resources and the specific needs of the programme, the instruction could be delivered by either AUDIOTAPE, COMPUTER, or INTERACTIVE VIDEO. This type of instruction is often most effective when combined with other media, such as workbooks, and when it also includes practical exercises.

DISPLAY Programmed learning or correspondence text

At least part of the programme appears suited to delivery via CORRESPONDENCE or via PROGRAMMED LEARNING. CORRESPONDENCE has been demonstrated to be a successful delivery medium for adequately motivated and literate learners, particularly if it is backed up by other media and activities, such as study groups, reading assignments or telephone contact with an instructor or mentor.

At least part of the learning might be suited to formal "PROGRAMMED LEARNING", where some device (often a workbook or a computer) is used to lead the learner through a series of tutorial lessons. Here again, learner literacy and motivation must be sufficiently high for this approach to succeed.

DISPLAY Local lecturers text

At least part of the learning appears to be suited to some form of centralised classroom and groupwork delivery. Since some learner participation seems to be called for, avoid relying purely on a lecture-based approach.

If part of the programme seems best delivered via a lectures, avoid lengthy and/or unvaried sessions, since lectures offer very limited opportunities for learner interaction, and are best kept short, relevant and lively.

DISPLAY External training consultants text

At least part of the learning appears to be suited to delivery via external training consultants. It is often useful when employing such consultants to draw up a careful set of conditions under which they are to operate, and to insist on some form of evidence that the training is indeed effective.

DISPLAY Lack of suitable training medium text

At least a part of the programme's content appears to lend itself to presentation via some form of training medium. However, no (further) medium could be identified by the system.

DISPLAY Visiting lecturers text

At least part of the learning appears to be suited to some form of decentralised classroom and groupwork instruction delivered by travelling instructors. Since some learner participation seems to be called for, avoid relying purely on a lecture-based approach.

If part of the programme seems best delivered via a lectures, avoid lengthy and/or unvaried sessions, since lectures offer very limited opportunities for learner interaction, and are best kept short, relevant and lively.

END

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APPENDIX E: SAMPLE INTERVIEW TRANSCRIPT

The account below is a transcript of the tape recording of the post-ES consultation interview that was conducted with sample user VS. The interviewer's speech is indicated by the initials FB.

FB: Right, V___, now that you've used the computer program and made all the changes to your JD document, I'd like to go over some of the details with you - a bit more about you yourself, and also how you feel about the computer program you've been using.

VS: Okay - I'm ready, F___

FB: I'd like to make a recording of our conversation - for my research on the computer program, you know - is that okay with you V___? As you know, I won't be using your name when I write up the report or anything ...

VS: Sure, no problem with that, F___.

FB: I also want you to say exactly what you really feel about the computer program - the more you tell me about what you really think and feel about it, the more you'll help us to decide whether it has any use for us, or what to do to make it better to use.

VS: Fine, F___

FB: Right ... now, let's find out a bit more about you, V___. First of all, what was your highest level of schooling?

VS: I've got my matric - I wanted to go to University to do a B. Comm., but so far I haven't yet. Maybe I need to finish my Banker's exams first ...

FB: Are you busy with them now?

VS: Yes, but it's difficult, you know, you work all day ...

FB: Uh Huh. So how long have you been working in the Bank, then?

VS: Umm.. I worked as an Information Assistant for two years, then I was a Teller for ... about four years. Then I did Investments and Interviewing Officer for a year before I came to Training.

FB: And how long is it now that you've been in Training?

VS: Its since nearly two years ago ... September the year before last I came over.

FB: What sort of training have you been doing?

VS: Well, I've been running mainly skills courses and frontline[1].

FB: So with these you've been working with computers?

VS: Yes, for the last year or so I've been training with mainframe[2].

FB: Any work with micro computers?

VS: Ja... a bit in the branches, but really only teaching people how to fetch information with the mainframes. I did use micros a bit for Lotus[3] ... in the region[4] we use it a bit to keep student records and stuff.

FB: How do you feel about working with computers?

VS: No, okay ... You know, you get people who get all nervous with them, but I tell my students they mustn't worry, they must just get used to them. They mustn't be scared to, you know, try things and so on, because they're not going to break anything or anything.

FB: So you're saying you're pretty comfortable with computers?

VS: I'm not scared of them. They can be very useful when you know about them. I want to get my own PC soon, at home.

FB: Okay then V___. Um, how about this training design ... have you been involved in designing any training courses or anything?

VS: Ja ... I did the Gendep[5] course with J___ - then I'm also busy with the UUU[6] course now ... its about three-quarters finished. I've done about five months of design.

FB: So you helped J___ with the Gendep course. What did you yourself do on it?

VS: I helped her with the writing - I wrote two modules - then I also wrote the tests.

FB: Did you help her with the front-end analysis? You know, the needs analysis and the task analysis and so on?

VS: We talked about it - she wanted to check things about the job and so on ... and I knew more about the job than she did because I was just from a branch.

FB: Did you help with choosing methods and media, and setting objectives?

VS: Not with Gendep, no ... I have been doing that with the UUU course. But I didn't really know what I was doing until I came on your workshop last month. You just do things which you think is the right way, but you don't think to write proper objectives or to analyse the job properly. You don't think of that.

FB: So did the workshop help you?

VS: Oh yes. This last module I've been working on is all different ... There's a proper objective and testing and now I know that people will be able to do the job afterwards properly.

FB: Okay ... now this computer program you've just been using - how did you find it?

VS: Ja, I think it helps ... Well, initially I did not understand what exactly I was supposed to do ... you know, you told me what it was about, but I couldn't see how it worked. Then when I worked with it a bit, I started to see why I was using it and what it was telling me.

FB: What was it that you had trouble with?

VS: Its just that it didn't tell you what was really going to happen. It should tell you more about what it's going to do. You see the instructions but you don't know what to expect really, what the program expects you to know.

FB: Ja, I see ... you would like it to explain what's expected from you?

VS: Yes, that's right ... Maybe it could give you some sort of practice. Like a CBT lesson or something before you start, to give you the feel for what its doing.

FB: That's an idea ... a CBT lesson before the person starts to use the program. Can you think of anything else about the program that you'd like to see, that you had any trouble with?

VS: Well, sometimes the questions were confusing. There was this thing where it would ask you if it was one thing or the other, and you didn't know which one it meant.

FB: The wording was confusing?

VS: It's asking you to choose one thing or another, but if one is right and the other you don't agree with, you don't know which to pick - then also when you want to pick one, you've got to use the bar, the Space Bar, to mark how much you agree with what it says, and that's difficult because you aren't sure what it wants. Why doesn't it just ask you to say "yes" or "no" instead? It makes it difficult to use.

FB: So you found the Space Bar marking a problem?

VS: Ja ... I'd rather have a simple "yes" or "no" there.

FB: And the business with the questions that are confusing ... is there anything you can suggest to do about that?

VS: I don't know ... sometimes you need more information about something, and you can't get it from the program. Maybe if you could like press a button or something for help ... I mean, there is a Help button, but it doesn't tell you enough, it doesn't really help you to answer that question you need help with.

FB: Okay, tell me what you would like the help to provide?

VS: Well ... the help that the system gives is really inadequate, it's not specific enough to be of much use.

FB: So you would like the help to be more specific to a particular question?

VS: Exactly.

FB: Right ... V___, now, how did you find the recommendations that the program made?

VS: I liked them a lot. They really helped me to think about the training course.

FB: The one you were designing?

VS: Ja ... you know, it was like having someone to talk to. The computer was like an outside person, helping me to think of things I didn't think of.

FB: Yes ...?
VS: Well, where we do our course writing, everyone is busy, there's no-one who's got time to look at what you're doing.
FB: And so your found that the computer could help?
VS: Yes ... in real life, other people are too busy doing their own work to take time to offer advice and assistance. The computer can sort of guide you along, give you ideas and things.
FB: Would you want it to lead you through the whole design process?
VS: No, I like it to help me, but not to make all the decisions. I still want to make the decisions in the end. But it is good for getting ideas.
FB: Let's look at your ID document. I see you made some changes in green pen. Did the computer program affect the design you prepared for the course?
VS: Oh ja ... I included quite a lot. There's a lot now about hands-on practice, for psychomotor skills. I've included that in a few different places.
FB: I see you also say here that you want to use CBT?
VS: Yes, that's because of the way the people are spread around the different regions ... I think that's a better idea than trying to get to everyone with lecturers like I wanted to in the beginning. But I don't think that the id- of correspondence or that other learning thing is so good.
FB: Programmed learning?
VS: Yes. I think that would be too much administration which we can't do from here.
FB: Ja, I think so too ...
VS: Then with the knowledge that the people must have, I put in that bit about using examples and non-examples. For concepts. There's a lot of concepts in the course.
FB: Yes, I see that. And did you make any other changes?
VS: Lets see ... umm ... no, I think that's all.
FB: Is there anything else you can think of about the program? Anything else you'd like us to do with it?
VS: No, like I said, I liked it, and so on, and I think it should be used for people designing courses, because they can bounce their ideas from it, and its like someone to talk to.
FB: So you think we should use it for helping us to design training?
VS: Yes, 'specially if you can make it easier with that Space Bar thing.
FB: Yes, we'll have to sort that story out. Okay, V___, well thanks a lot. What you've told me about the program will definitely be looked at, and I really appreciate you helping us like this with it.
VS: That's fine, it was very interesting.
FB: Before we finish up here, is there anything that's worrying you about using the computer.
VS: Worrying me?

FB: Ja, any questions that it left you worrying about, anything that makes you unhappy, things like that.

VS: No, I really can't think of anything else. There's nothing worrying me. I want to use it again when I've got the next module to do, so I'll be 'phoning you about that later.

FB: Well that'll be a pleasure, V___. You know where to find me. Also 'phone me or come see me about anything else, like when you've finished developing your training course, so we can talk about it, or anything else. And thanks again.

VS: Okay, see you F___.

FB: Cheers, V___, see you.

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NOTES ON APPENDIX E

1. VS's reference to 'frontline' concerns a training course for frontline staff, ie bank staff who deal directly with customers on a face-to-face basis.
2. The mainframe is a large central computer, located in a Johannesburg suburb, and linked to a series of terminals in bank branches.
3. VS's reference to Lotus concerns the Lotus 1-2-3 microcomputer spreadsheet application package produced by Lotus Corporation in the USA.
4. The region is one of the six geographical areas into which the Bank's branch banking operations are divided. The day-to-day management of each region is semi-autonomous.
5. Gendep is a trainig course on Generalised Deposits, one of the branch banking accounting operations.
6. UUU is a training course on unpaid accounts, another branch banking accounting operation.

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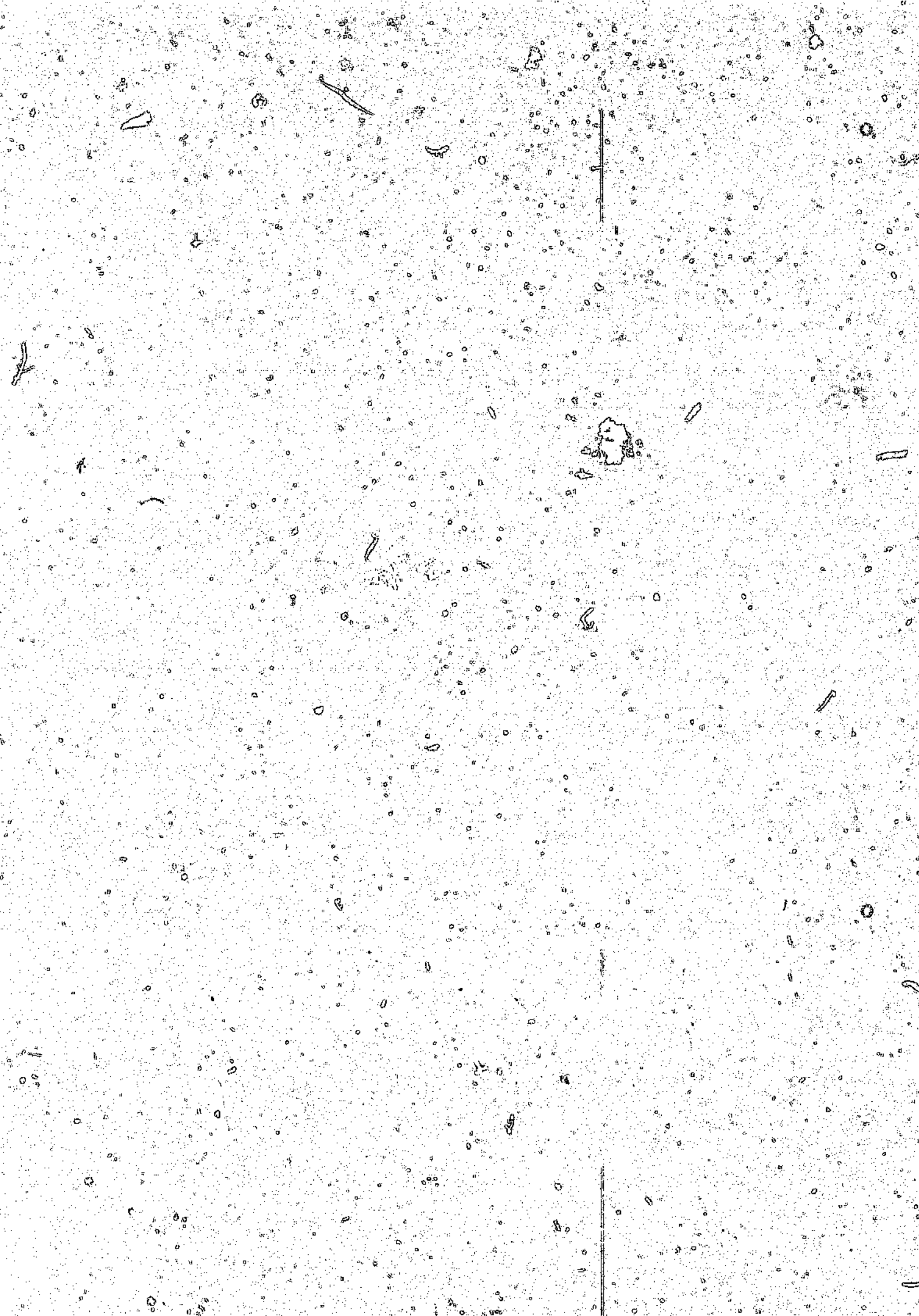

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