An Investigation into the possibility of using
Sociological Research Methodologies
for the Elicitation of Tacit Knowledge for building
Knowledge Intensive Systems

by

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In memory of my father who did not live to see this day and my mother to relieve her of a death-bed promise. Many thanks from your loving son.

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Abstract

The research notes that deficiencies in knowledge acquisition are impeding the advancement of Knowledge Intensive Systems (KIS), such as Expert Systems (ES) and Decision Support Systems (DSS). Humphreys (1989) maintains the problem is not the quantity of knowledge collected but its quality. Humphreys (1989) contends that 'Knowledge' has too narrow a definition in knowledge acquisition dogma and a wider definition of 'knowledge' capable of handling 'procedural uncertainty' is required.

'Tacit knowledge' by which Polanyi (1967) contends individuals interpret the world appears a fruitful area to widen the definition of knowledge. The subjective nature of tacit knowledge makes its explication problematic, however, it is noted that tacit knowledge has a social aspect (interiorization) which appears amenable to sociological investigation.

On the basis of the above it seemed prudent to focus the investigation down to the following research question,

> *'On the basis of its nature, is there a method whereby at least some tacit knowledge can be explicated for:*
>
> *a)   building the knowledge base;*
>
> *b)   more accurately predicting or planing for its usage and for setting expectations. '*

To test the thesis, a pilot investigation was undertaken at a local Housing Association in order to gain first hand experience of knowledge acquisition. Examples of how experts tacitally classify their domain were identified and methods of explicating this

knowledge were tentatively formulated.

The above resulted in the formulation of a new perspective: traditionally KBS has concerned itself with eliciting knowledge to be embodied in the knowledge base, whereas, IS has concerned itself in gaining the knowledge involved in the systems use/interpretation.

Fieldwork was later conducted in the maternity units of two local hospitals in order to test the generalizability of these methods.

Five methods for the explication of tacit knowledge were identified.

1) The analysis of the reification of existing systems and the rationality internal to these systems, can be used to explicate tacit knowledge.

2) More than one set of tacit knowledge can be present in one domain. Points where two sets of tacit knowledge interact expose contradictions which can be used as a tool to explicate the tacit knowledge of both groups.

3) The analysis of anecdotes revealed how domains were tacitally delimited and the 'criticality' of tasks within a domain.

4) Action research using a 'mock up' data base revealed tacitally held domain knowledge with implications for micro level criticality, of particular importance to interface design.

5) The thesis identified knowledge acquisition as a method of sociological investigation.

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CHAPTER 1

The Nature of the Problem

1   The Nature of the Problem

The 1980's and 90's have witnessed a tremendous amount of activity in the area of Expert Systems (ES) and Decision Support Systems (DSS). The number of these systems actually in use, however, is relatively small (Collins 1987). This thesis attempts to identify some of the reasons why many of these systems fail to be implemented, and investigate some possible solutions.

1.1   Reasons for the Failure of Expert Systems

Whilst a tremendous amount of work has been invested in the construction of knowledge based systems, there has been a large failure rate of these systems when implemented into real world situations. A considerable amount of research into why particular systems fail has been conducted, however, most of this has been undertaken by private companies, and the results of this work often remains secret, due to the commercial advantage such information could provide.

Research is further complicated by the fact that criteria for what counts as a 'successful system' is also problematic. There have been many examples of systems which are technically successful (manipulate data quickly and efficiently) but fail under practical conditions. Conversely, there are many examples of technically inept systems, which under practical conditions are being 'forced' to work, often in unintended ways. In each of these cases the system could be considered either a success or a failure.

In knowledge based systems (KBS) development, as with other products, technical superiority is no guarantee of product success. For example, the success of VHS in becoming the standard format for video cassettes had little to do with its technical merit. In fact many considered the now extinct Beta Max to be a far technically

superior product.

The above problems: high rate of KBS implementation failure; secrecy due to commercial advantage; Problems of assessing success, have caused much concern among academic and commercial researchers. As a result the BCS HCI/Expert Systems Northern Group organized a conference around the question of 'Why Systems Fail?'.

1.1.1 BCS HCI/Expert Systems Northern Group Conference - 'Why Systems Fail?'

In order to address the problem of expert system failure, and overcome the problem of commercial secrecy, a mini-conference was convened at University of Manchester Institute of Science and Technology (27th March 1991). Several experienced expert system (ES) builders volunteered to recount their experiences of various systems that they had worked upon and analyzed the reasons for why various systems failed. After a free and frank discussion the following non-exhaustive list of reasons for the failure of expert systems emerged.

*   FIT: the system should 'fit' the way that the users work and not vice versa. Systems that can only be made to work by radically changing working practices are less likely to succeed.

*   TIMING: if high technology is introduced too quickly into an organization it will not be properly understood by the users and fail due to problems of Human Computer Interaction (HCI).

*   QUALITY OF KNOWLEDGE BASE: there is often an over emphasis on HCI, rather than the core 'knowledge'. However, the most sophisticated

interface will not compensate for an inadequate knowledge base.

* REALISTIC GOALS: the limits of what is possible for the system to deliver, must be made known to the user/purchaser, otherwise it will not match their requirements. In a competitive environment (particularly one of such technical complexity) it is tempting to gloss over the shortcomings of the product and encourage unrealistic goals in the user/purchaser.

* CHAMPION 1: at the user level, an enthusiastic person (champion) is required to get the system through the initial implementation period. Implementation of new technology is particularly problematic, it requires strong leadership to overcome the 'teething problems' that inevitably accompany change.

* CHAMPION 2: if a 'single champion' initiates a system and is transferred the project effectively has no 'champion' and is likely to fail.

* CHAMPION 3: if the champion is not sufficiently high in the organization, the system can fall victim to strategic planning. Decisions at a high level in the organization can make successful systems incompatible or redundant and thus fail. For example, an expert system was successfully implemented into a UK firm. Unfortunately, the firm was a subsidiary to a multi-national which relocated production to a European factory, where the system was not appropriate and was abandoned.

* BENCHMARKS: there are often no reliable company bench marks by which to show any improvements the system may make.

* WORK REDUCTION: some systems add work, rather than reducing it. For example, E-Mail has often resulted, in the proliferation of memos, which are

required to be read, causing extra work. The end result is that E-Mail is sent but often not read. Members of such organizations know of this and important information is disseminated by paper memoranda. This results in an informal filtering system, whereby members of the organization know that they do not need to read their E-Mail because important information will be disseminated by paper memoranda.

It was the consensus of the conference that at least 60% of the problems of designing a 'successful system' are due to non-technical reasons. It follows from this that solutions to these problems are not to be found in improved technological aspects of IT. This research proposes to concentrate upon analysing the *non-technical* aspects for the failure of computer systems, with the aim of overcoming some of these problems.

1.1.2 Non-technical Reasons for 'Why Systems Fail?'

The reasons for the failure of systems due to non-technical reasons were invariably ascribed to poor knowledge acquisition. On reflection this seems to be very hard on the knowledge engineers. In many cases, the arguments often ascribing failure to poor knowledge acquisition took the form of a *post hoc rationalization*. Even causes, which could only be identified with hindsight, were attributed to poor foresight during knowledge acquisition.

It is difficult to see how improved knowledge acquisition techniques could solve these problems, unless the scope of knowledge elicitation is considerably expanded from a narrow perspective, (i.e. the identification of facts and rules required for an expert decision) to a wider perspective, (i.e. to elicit facts and rules and encompass these rules with the practical external constraints of decision making). A shift from reducing decisions to a set of objective rules which if followed, produce the 'correct' answer, to attempting to find out what counts as a 'correct answer', in a given

situation, in a given organization, at a given time.

The 'non-technical reasons for why systems fail' could be broadly classified into two distinct groups: Knowledge within the knowledge base; knowledge to do with the use of the system.

1.2 Types of Knowledge

The 'non-technical reasons for why systems fail' is extremely complicated and therefore, knowledge will be classified into two categories and the non-technical faults will be attributed to the lack of one or both types of knowledge.

1.2.1 Embodied Knowledge

The verb 'to embody' is defined as,

> *'embody ... to incarnate or invest with a material body; to express in a concrete form; to be a concrete expression of; to form into a united whole; to incorporate, include; to unite, coalesce, come into a body.*
>
> New English Dictionary (1932) page 343

Embodied knowledge is the narrow perspective of knowledge acquisition i.e. the identification of facts and rules required for expert decision making. This type of knowledge is essential for the building of a knowledge base, and can be said to be embodied in the knowledge base. Embodied knowledge could account for faults in: fit; quality of the knowledge base and work reduction.

1.2.2 Context Knowledge

Context is defined in this thesis as,

> *'context ... the parts of a discourse or book immediately connected*
> *with a sentence or passage quoted.*
>
> *New English Dictionary (1932) page 343*

Context knowledge is knowledge about the situation within which the embodied knowledge operates. Context knowledge is extremely important and can have a dramatic effect on the embodied knowledge. This point can be illustrated by the saying, 'one mans terrorist is another mans freedom fighter.' The man with the bomb is the same man in each situation. Whether he is classed as terrorist or a freedom fighter depends on the context knowledge employed in the situation. Context knowledge could account for faults in fit, timing, goals, champions 1,2 & 3, and work reduction.

It should be remembered that the classifications are only for the convenience of research, in practice the two types of knowledge have an internal relationship. For example, 'fit' could be regarded as an embodied knowledge criterion, e.g. are the experts definitions adequately represented in the knowledge base? However, it could also be considered a context criterion, e.g. does the computerized system follow in a logical manner (logical that is to the user) the information collecting process, or does it demand a radical transformation of the way information is collected?

1.3 Two Pronged Investigation

Classifying the knowledge required, in this manner allows a two pronged analysis. Although there is a considerable amount of overlap between the two types of

knowledge, embodied knowledge is the type of knowledge that is usually sought by knowledge acquisition (of the narrow perspective), while context knowledge is usually the type of knowledge sought by Information Systems (IS) designers. Therefore, research in both disciplines may be utilized in the form of a two pronged investigation. In order to remove ambiguities associated with combining the research of two disciplines (and later other disciplines) it is prudent to introduce and define the term Knowledge Intensive Systems (KIS).

1.4 Definition of Knowledge Intensive Systems

It is important that a new term is used in this thesis in order to: prevent redundant argument; remove ambiguity; allow research conducted in other disciplines to be exploited.

The original title for the thesis was,

> *'An investigation into the possibility of using sociological research methodologies, for the elicitation of tacit knowledge, in a form useful for the building of Expert Systems (ES) or Decision Support Systems (DSS).'*

It soon became apparent that this title was problematic and the research became embroiled in arguments such as: what constituted an ES? How does this differ from a DSS? Is a spread sheet with macros a DSS? Is the difference one of technical difference or the mode by which it is used?

All of the above and many other considerations while important, were found to be irrelevant to the research. The main thrust of the thesis was to explicate 'tacit knowledge' in a form capable of being encoded into a computerized system in general, rather than a specific type of computer system.

In order to overcome the ambiguous definitions which surround, any of the existing terms, it was thought prudent to coin another three letter acronym, Knowledge Intensive System (KIS). This term is designed to encompass the widest range of 'systems claiming to encapsulate knowledge' and is defined as:

> *'A computerized system which has encapsulated within it, representations of knowledge of a domain'.*

This definition is only just above the generic level. It is purposely pitched so low in order that any system of higher sophistication can take advantage of the research findings. There are, however, many systems such as MIS or even transaction processing systems that could be regarded as a KIS, these are systems for which knowledge acquisition has been actively undertaken. Systems for which knowledge acquisition has not been actively undertaken, for example a spreadsheet, cannot be considered a KIS. However, spreadsheets with tailored macros can be considered a KIS, because active knowledge acquisition must have taken place to build the macros.

With this in mind, the thesis is organized into 4 parts:

*   Part 1 concerns various aspects of knowledge and knowledge acquisition.

*   Part 2 concerns the formulation of the research question, issues concerning research design and the selection of appropriate research methods.

*   Part 3 concerns the feasibility of the research design in the pilot study followed by data collection in the main field work.

*   Part 4 is the discussion of the main field work and the implication for systems design.

1.5 Outline of Thesis

Part 1   Various Aspects of Knowledge and Knowledge Acquisition.

Chapter Two: The problems associated with embodied knowledge acquisition are discussed in Chapter Two. A key reason for the failure of the implementation of expert systems (ES) and decision support systems (DSS) is attributed to poor knowledge acquisition. Humphreys (1989) points out that ES has been reasonable successful in the area of well-structured problems but less so in areas of procedural uncertainty. Humphreys (1989) contends that this is because the definition of knowledge in the Knowledge Based Systems (KBS) is for historical reasons too narrow. A possible method of widening the definition of knowledge is indicated by Collins (1987) who contends that the algorithmic model of knowledge is flawed and indicates advancement in KBS is dependant upon the explication of tacitly held cultural skills.

Chapter Three: the context knowledge from an IS perspective is discussed in Chapter Three. It is noted that IS has been successful in well-defined situations but less successful in fuzzy situations. Checkland and Scholes (1990) note that the information required in fuzzy situations is qualitatively different than that required by well-defined situations.

Chapter Four: the type of knowledge required to solve IT problems of procedural uncertainty and IS problems of fuzzy situations is discussed in this chapter. Galliers (1984) contends that it is only when 'meaning' is subjectively added, that data is transformed into information. Meaning is found to be added either subjectively or inter-subjectively at the level of the individual, organization and culture in order to interpret the world. It is therefore, proposed to widen the definition of knowledge (for the purposes of knowledge acquisition) to include the subjective and inter-subjective meaning by which individuals and organizations tacitly interpret the world.

Chapter Five: the scope of the thesis is delimited in Chapter Five. Computerized knowledge acquisition technologies are briefly discussed in order to overcome the knowledge acquisition 'bottle-neck'. These methods were found to be able to 'handle' tacit knowledge but offer little understanding of tacit knowledge. The notion of 'double-loop' learning (Argyris and Schon 1978) make the explication of tacit knowledge essential. Therefore, the thesis proposes focussing on the explication of tacit knowledge.

A distinction is drawn between 'direct tacit knowledge' (i.e. tacit knowledge which is the result of the personal history of an individual) and 'indirect tacit knowledge' (i.e. tacit knowledge which an individual has acquired by virtue of being a member of a culture or mini-culture and is thus available to all members of that culture or mini-culture). The researched is then focussed for philosophical and practical reasons upon the acquisition of 'indirect tacit knowledge'.

Chapter Six: a conversation between the researcher and a respondent is reproduced in Chapter Six . This transcript indicates the importance of tacit knowledge and the difficulty of its elicitation using more traditional knowledge acquisition techniques.

Part 2   Research Question, Research Design and Research Methods.

Chapter Seven: the research question, the tasks required in order to answer the question and the contribution to knowledge of the thesis are outlined.

Chapter Eight: an in-depth discussion of research methods, is outlined in Chapter Eight in order to select the most appropriate methods for the elicitation of tacit knowledge.

Chapter Nine: the research design is outlined.

Part 3   Data Collection.

Chapter Ten: the pilot study at a Housing Association is described. The pilot study indicated that the explication of tacit knowledge under practical conditions was feasible. The pilot also equipped the researcher with the technical and social skills required to conduct the main field work.

Chapter Eleven: the main field work conducted at two maternity units, Area 1 and Area 2 is described, at length, in Chapter Eleven.

Part 4   Discussion of the Main Field Work.

The remaining chapters discuss the findings of the main field work.

Chapter Twelve: the reasons for the differences in the way maternity is organized in Area 1 and Area 2 are discussed. Logic is advocated as a tool to decide whether the difference between Area 1 and Area 2 is a difference of 'form' or 'style'.

Chapter Thirteen: The first method for eliciting tacit knowledge, at the macro level is discussed in Chapter Thirteen with reference to Giddens (1984) and his theory of structuration. Tacit knowledge at this level has important implications for the generalisability of a KIS.

Chapter Fourteen: the second method for the elicitation of tacit knowledge, at the micro level is discussed in Chapter Fourteen. This method makes use of unusual sources referred to as 'war stories' in order to elicit tacit knowledge at the group level. Tacit knowledge at this level has important implications for how groups of experts tacitly rather than formally delimit their domain, and how various aspects of work are tacitly rather than formally prioritized within these boundaries.

Chapter Fifteen: the findings, given in Chapter Thirteen and Chapter Fourteen, were incorporated into a modified interface and tested in Chapter Fifteen. The testing of the interface indicated further methods of eliciting tacit knowledge, but this time at the level of the individual.

Chapter Sixteen: action research is used in order to obtain the criticality of particular questions in order to match the importance of the information with the effort required to input the data.

Chapter Seventeen: the forth method of eliciting tacit knowledge is discussed. This method uses action research in order to elicit 'extra mural' tacit knowledge, i.e. knowledge which is external to a particular domain, tacitly held and having an influence upon domain decision making.

Chapter Eighteen: this chapter contains a brief discussion of how knowledge acquisition can be used as a tool for sociologists in their investigation of the workplace.

Chapter Nineteen: the concluding chapter which seeks to assess the contribution of the thesis and suggest further research.

CHAPTER 2

Embodied Knowledge

2   Embodied Knowledge

KIS are computer systems in which knowledge acquisition has been consciously conducted, i.e. elicitation, design and implementation. Expert systems (ES) and Decision Support Systems (DSS) are also computer systems in which knowledge has been consciously elicited and encoded. The thrust of this thesis is the collection of such knowledge, therefore, research conducted into knowledge acquisition for ES and DSS is relevant to knowledge acquisition for KIS. Lessons learned by knowledge engineers for these technologies must be taken into consideration in order not to 're-invent the wheel'. Therefore, it is pertinent to briefly look at research in these fields to date. It should be noted that the narrower perspective of knowledge acquisition i.e. embodied knowledge, is being employed in this chapter and by the various authors are discussing embodied knowledge.

2.1   Knowledge Acquisition

Knowledge acquisition is a very complex subject and encompasses the following elements (Hart 1989).

2.1.1 Elements of Knowledge Acquisition

2.1.1.1   Elicitation

Knowledge is collected by various methods and built into a conceptual model of the domain. This is usually achieved by searching formal texts, questionnaires and interviews with individuals or groups of 'experts'. These techniques have had varying degrees of success and techniques such as proto-typing (of various types), protocol analysis and various computerized knowledge acquisition technologies have been developed in order to improve knowledge elicitation.

2.1.1.2   Design

The conceptual model is built into a computerized system. This element of knowledge acquisition involves choosing the most appropriate hardware/software, interface and the production of the system.

2.1.1.3   Implementation

Implementation covers training and the development and testing of the system with the user.

Although these elements appear to be temporally sequenced and discrete elements, in practice a large overlap occurs, e.g. often additional knowledge emerges during implementation.

Having defined the scope of knowledge acquisition, issues around embodied knowledge will now be discussed.

2.2   Expert System Development

The number of expert systems successfully implemented so far has been disappointing. An indication of the lack of success, is the fact that expert systems such as Mycin and Dendril, dating from the late 60's and early 70's are still being cited, as examples of working expert systems [1] in current texts on Artificial Intelligence (AI) and Expert systems (ES) (see for example, Merry 1985, Hart 1989). Despite dramatic advances in hardware and software since this time the initial promise of expert systems has failed to materialize. Michie and Johnston (1985) note,

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[1] MYCIN has been abandoned, the knowledge was so deeply embedded that it was virtually unmaintainable Doukidis and Whitely (1988).

"After ten years of development only a handful of expert systems are ever likely to pay back their development costs."   *(p.1)*

Some of the reasons for the lack of progress will now be discussed.

2.2.1 Reasons for the Limited Number of Successfully Implemented Expert Systems

There is a consensus that the, the limited number of successfully implemented expert systems is due to *'Feigenbaum's Bottle-neck'*, i.e. knowledge acquisition [2]. For example Doukidis and Whitley (1988a) note that Dendril took over 40 person years to develop, while MYCIN took over 100 person-years to develop.

Humphreys (1989) while agreeing that knowledge acquisition is time consuming, also draws attention to a further more fundamental problem. Humphreys (1989) points out that success in ES to date has tended to occur where the 'problem' is so well structured that very little flexibility in decision making exists. Humphreys (1989) notes that more interesting practical problems tend to generate

'[I]mpossibly large search spaces'.

The construction of 'knowledge based systems' (KBS) has been undertaken in order to reduce the complexity of the 'search spaces' of these systems. Humphreys (1989) contends that 'knowledge' in KBS, is based on a narrow definition, arising from the historical links between KBS and AI as,

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[2] It must be noted that authors such as Michie and Johnston (1985) believe that the knowledge acquisition 'bottle neck' has been solved with the advent of computerized knowledge acquisition technologies. These technologies will be discussed in Chapter Five.

'[T]hat which could reduce complexity'.

Humphreys (1989) contends that most practical decisions are made in situations that are not well defined but characterized by 'procedural uncertainty', which he defines as,

> *'Uncertainty concerning the means to process the decision (specifying relevant uncertainties, knowing **what** information to seek, and from whom, how to invent alternatives, assess consequences and so on.'* *(original emphasis) (page. 27).*

Therefore, before software can be developed which is capable of handling 'procedural uncertainty', knowledge engineering will have to develop a wider definitions of what constitutes knowledge. This research seeks to widen the definition of knowledge and develop methods suitable for its acquisition.

To summarize the above, given the fact that knowledge acquisition is:

*   the main 'bottle neck' in the implementation of expert systems

*   the main non-technical reason for expert system failure

*   requires a wider definition if procedural uncertainty is to be handled.

It is pertinent, therefore, to briefly look at what various writers have said on the subject in order to seek a wider definition of knowledge.

2.3   Basic Assumptions of Knowledge Acquisition

The basic assumptions of knowledge acquisition are strongly influenced by the work of cognitive science.

2.3.1 Cognitive Science

Simon and Kaplan (1989) define cognitive science as,

> '[T]he study of intelligence, and its computational processes in humans, in computers and in the abstract.'

Cognitive science is a multi-disciplinary in nature see Figure 2.1 (which is part of a diagram cited in Gross (1992)).

Anthropology

| COGNITIVE SCIENCE | ———— Philosophy

Cognitive
Psychology

The Scientific
Study
of Cognition

———— Linguistics

Neuroscience

Artificial
Intelligence
(part of Computer
Science)

Source: Gross (1992)
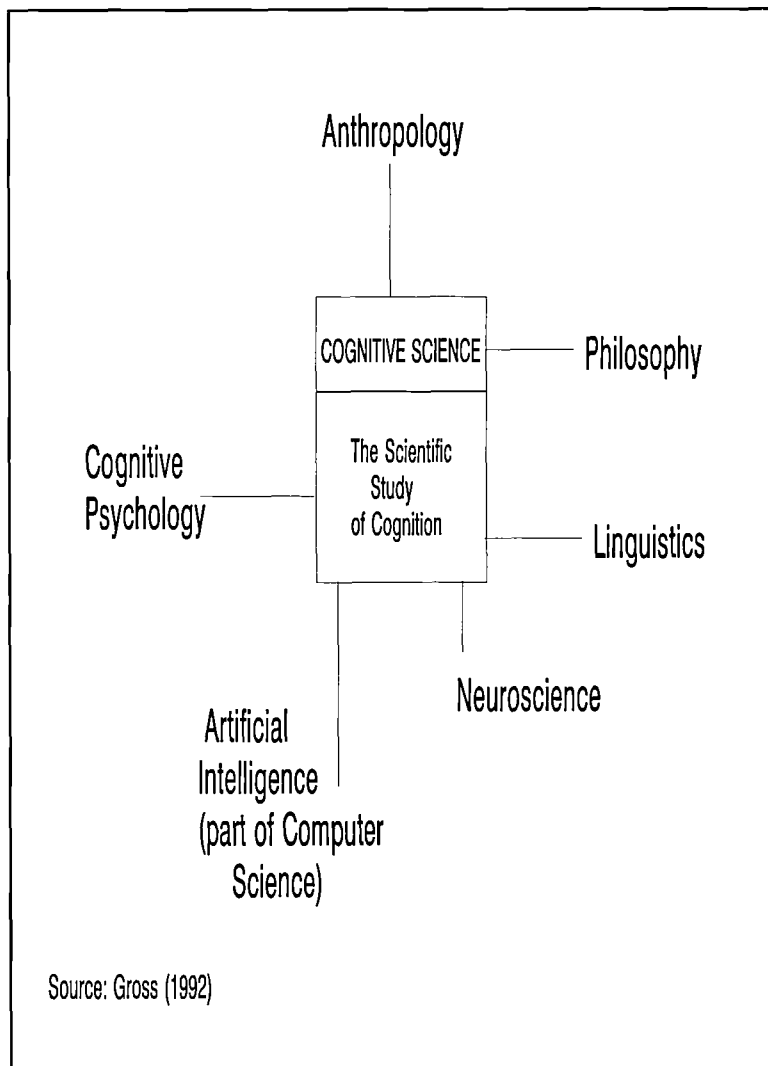
Figure 2.1   Multi-disciplinary   Nature   of   Cognitive
Science.

Despite its multi-disciplinary nature the main focus of cognitive science has been the computational aspects of intelligence (Pylyshyn, 1989). This has resulted in the acceptance of the basic 'architecture' of all intelligent systems (human, animal or machine) based on standard model of the human cognitive system proposed by Newell and Simon (1972) (see below). This model has drawn extensively on the work of cognitive psychology which has developed such an intimate relationship with computer science that Garnham (1988) cited in Gross (1992) notes,

'By the late 1970's Cognitivist psychologists had more in common with

AI researchers than with other psychologists and AI researchers had

more in common with cognitive psychologists than with other computer

scientists.' (page 389)

Cognitive science has been strongly influenced and benefited by cognitive psychology research which concerns the following topics:

Attention: The ability for an individual to notice 'significant objects in a noisy environment'. For example, the ability to follow a conversation in a noisy cocktail party where many conversations are simultaneously taking place.

Memory: Notions of the registration, storage and retrieval of memory; notions of sensory memory (sensory buffer memory), short term memory (STM) and long term memory (LTM); issues of capacity, duration and speed of retrieval; different types of LTM, episodic, semantic and procedural; working memory and theories of forgetting.

Perception: The ability to make a meaningful world out of sensory data; the ability to distinguish a subject from the background; the interpretive nature of perceptions; perceptual consistency; veridical perception of movement; gestalt organization of perception; the influence of the set on perception; the influence of context on perception; pattern recognition.

Language: The relationship between thought and language; linguistic universals; universal linguistic structures; semantics; syntax; competence versus performance

Problem Solving: Thinking is an extremely difficult topic to investigate and up to date time research has concentrated mainly upon problem solving.

This area will be discussed in greater detail using the Newell and Simon (1972) theory of 'Human Problem Solving' because it incorporates and illuminates many of the basic assumptions of the various aspects of cognitive science alluded to above.

2.3.2 Newell and Simon's Theory of Human Problem Solving

Newell and Simon explain the 'human problem solving' by use of the computer metaphor and regard humans and computers as basically *'Information Processing Systems'*(IPS) see Figure 2.2
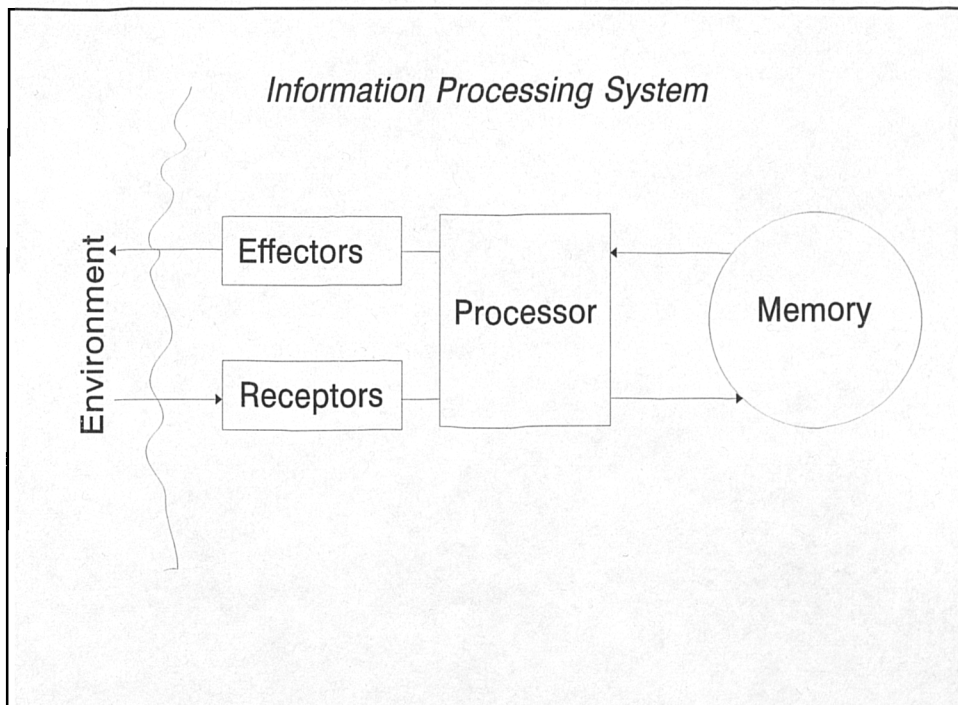
Figure 2.2   General Structure of Information Processing Systems

In this model the memory consists of two parts, the long term memory (LTM) and the short term memory (STM). The LTM has unlimited capacity to store knowledge represented as symbol structures relatively permanently. The STM stores information needed for problem solving by the IPS, but the capacity of the STM is limited (Miller, 1956) and apt to decay. The Processor contains the STM which receives all inputs to the IPS from the receptors. The STM contains a set of rules or programme which determines the order in which the Elementary Information Processes (EIP) are executed. The inputs are then processed using the symbol structures of the STM with reference to the LTM. Outputs from the IPS pass through the STM to the effectors.

The 'brain as a computer' metaphor has rapidly spread and has become the lay view of how the brain actually works, i.e. reality rather than metaphor (for an interesting and informative account of how this has occurred see Turkle (1984).

2.3.3 Critique of AI

AI has attracted a vigorous debate as to whether the building of an 'intelligent' machine is possible. Philosophical debates have raged as to whether the machine is 'thinking' or mimicking human behavior by authors such as Searle (1982), Dreyfus (1979), Dreyfus and Dreyfus (1985), Dreyfus and Dreyfus (1986) and Winograd and Flores (1986), Minsky (1987) and Gregory (1987). A full discussion of these arguments is not entered into here because the debate is somewhat confusing in that many AI researchers have abandoned the 'hard AI' stance in favour of a 'soft AI' stance, which finds it quite acceptable if the computer *only* mimics human behavior. The debate is further confused by the fact that AI critics have tended to move their definition of what actions require 'intelligence' (see Woolgar (1987) below).

As more 'intelligent' machines have been developed in combination with the increased use of local area networks (LANs), wide area networks (WANs) and the proliferation of personal computers, problems of a different order have emerged. This has

resulted in the widening of the discipline to incorporate a sociological perspective, see Figure 2.3.
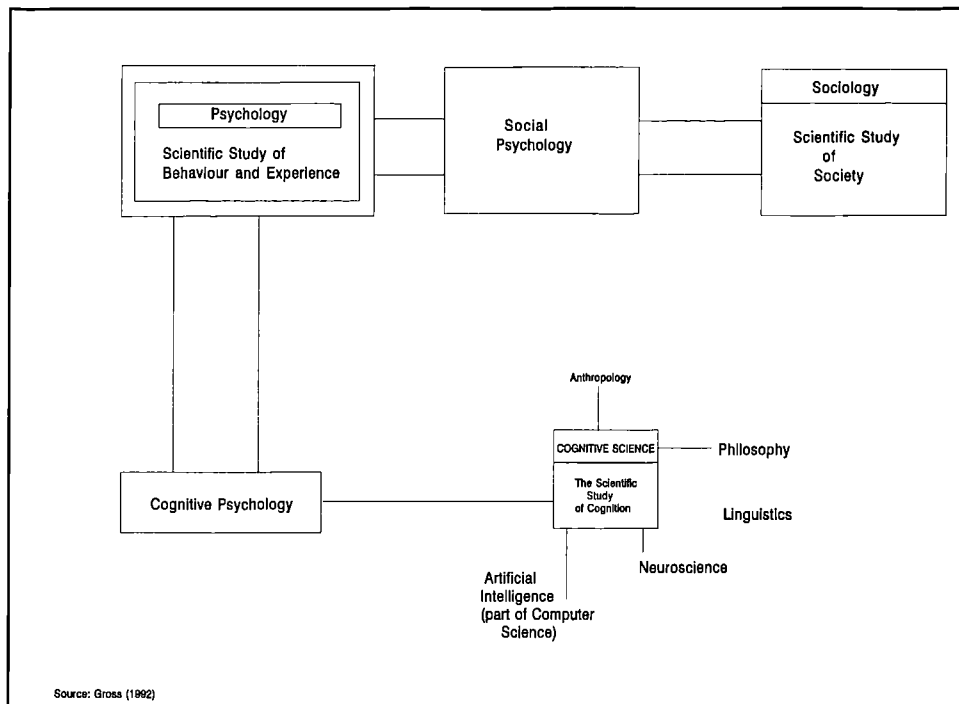
Figure 2.3   The Relationship between Cognitive Science and Sociology.

2.3.4 The Sociological Contribution

Sociologist have contributed to AI in three main areas: a critique of cognitive science; a critique of the basic assumptions of knowledge acquisition; attempts to assess the contribution sociology could make to knowledge acquisition. These will now be briefly discussed.

2.3.4.1   Critique of Cognitive Science

A comprehensive, if less accessible critique of cognitive science has been offered by Coulter (1983). Coulter takes issue, with the way Putman (1960) attempts to explain

complex human behavior in *neurophysiological* terms. Coulter points out the purposeful nature of an act, for example, what determines whether raising of an arm is, waving hello, swatting a fly or signaling, can only be determined by the individual raising the arm. A detailed description of the physical changes required to raise the arm will not reveal the purpose of the action.

Coulter also criticizes Fodor (1975) for contending that complex human action is caused by 'involuntary organic episodes'. Fodor (1975) in the case of language recognition, for example, emphasizes the importance of the central nervous system (CNS). The CNS receives the sounds of words in wave form, these are encoded and sent to the brain where they are decoded back into meaningful sentences. Coulter maintains that while the central nervous system is vitally important, its importance is as an enabling rather than a causal device.

> *'My nervous system enables me to speak, to say what I do, but it is I,*
>
> *not my brain that does these things'. (p26). (original emphasis)*

2.3.4.2   Critique of the Basic Assumptions of Knowledge Acquisition

At a different level of analysis there has also been a considerable sociological criticism of the basic assumptions of knowledge acquisition. For example, Suchman (1985) contends that the search for the protocols experts use in problem solving is misbegotten. Traditionally knowledge acquisition for DSS and ES attempted to uncover the rules that experts employ to solve problems. Suchman (1985) contends that rather than a precise step by step nature, planned actions are vague and contingent in nature. Therefore, seeking ever more detailed explanations of an experts actions is futile. Suchman (1985) points out that it is more fruitful to see what experts explain as planned actions as a form of *'post hoc rationalization'*, a way of both talking about and ordering past actions in a logical way.

This view is supported by Coulter (1983) who notes that explanations of human behavior often confuse behavior 'in accord with a rule' and behavior 'guided by a rule'. Coulter (1983) points out that one action can be in accord to many rules and therefore, have many reasonable explanations. Rules are resources that contingently explain rather than determine past actions.

2.3.4.3   The Contribution Sociology could make to Knowledge Acquisition

Of late sociologists such as Woolgar (1987) and Collins (1987) have not been content to be simply critical (although criticism alone can be very useful). They have tried to envision what kind of a contribution sociology could make to knowledge acquisition. This thesis seeks to add to this category.

Woolgar (1987) defends attempts to build intelligent machines. He points out that it is very difficult for engineers to produce an artificially intelligent machine. This is because the goal posts for defining intelligence are always moving. At various times a consensus arises around a task that requires intelligence. Once a machine has been produced that can fulfil this task, the task is redefined as 'mechanical', i.e. not requiring intelligence and a new and more difficult task that requires intelligence is devised.

Another constructive contribution has been put forward by Collins (1987). Collins (1987) points out that engineers have increasingly attempted to put more 'knowledge' into their programs, in order to improve their algorithms and declarative rules, and to limit the effect of 'information explosion' by seeking to discover the 'heuristics' experts habitually use when making decisions. However, although it is acknowledged that much progress has been made by engineers, their work in this area has been criticized by social scientists such as Collins (1987) for not being radical enough. For Collins (1987) 'facts' and 'heuristics' are similar, for although the latter are informal and to some extent 'hidden' they are if pressed easily articulated in terms of the

former. Collins (1987) contends that the real problem is explication of 'cultural skills' and 'manual and perceptual skills' (see Figure 2.4) which are the very basis of expert knowledge.

2.3.4.3.1   Moving Knowledge from Tacit to Explicit Categories
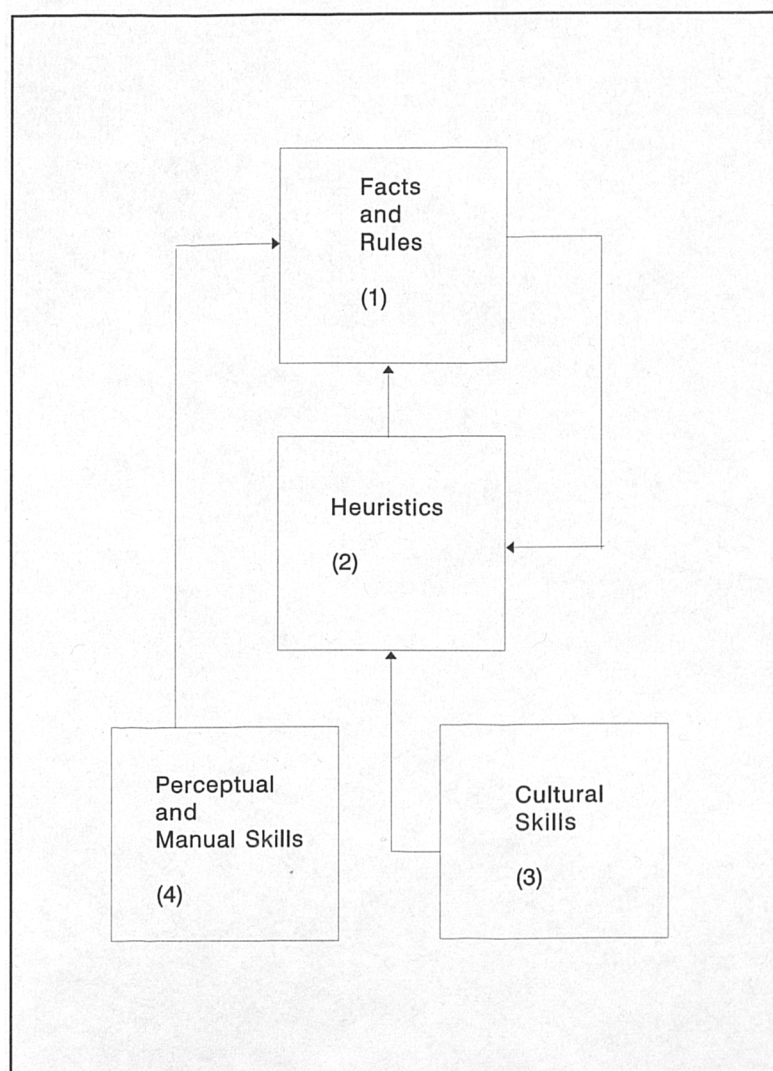
Figure 2.4   Transference of Knowledge

N.B. Here Collins uses the term 'facts' in it's every day non-problematic sense.

Collins (1987) uses the example of a previous study to illustrate how knowledge is moved from one 'box' to another (see Figure 2.4). Collins (1985) studied his colleague Harrison (a physicist at the University of Bath) in his attempts to build a T.E.A. Laser, capable of vaporizing concrete. Although still at an experimental stage these lasers had been built and made to work in various laboratories. Harrison had close contact with one such laboratory and with the best algorithmic advice built a T.E.A laser. However, the laser failed to work. After months failure Harrison asked a colleague from another laboratory (who had built a working TEA Laser) for help. Harrison was promptly told that the leads between the capacitors and the electrodes were too long. Harrison knew from the algorithm that these leads must be as short as possible and had arranged things to suit. His colleague in the other laboratory, however, told Harrison that for the wires to be *'short'* in laser building terms (culture) the capacitors must be inverted in a frame. Later when the system was updated and electronics were introduced *'short'* was further theorized into a the category 'facts and rules'. i.e. 8 inches.

Here knowledge is in at least three boxes, the first two are obvious.

BOX 1:   HEURISTIC *'SHORT'* = less than one foot.
BOX 2:   FACT/RULE *'SHORT'* = eight inches.

However, Collins contends knowledge could exist in a further box. He imagines the case where instead of being a specialized experimental practice, laser building was a widespread craft, so widespread that, it was taught by the master/apprentice system. The apprentices would invert their capacitors by tradition and may have no idea what 'short' means in this context. In this scenario 'short' would exist in box three.

BOX 3: CULTURAL SKILL, *'SHORT'* = An unexplicated cultural skill.

2.3.4.3.2   Transference of Knowledge

Collins contends that complex shifts in context are necessary for shifts of knowledge categories. If Harrison had tried to build his laser using an expert system his chances of eliciting the experts knowledge would depend on the stage that laser building had reached when the system was designed. If knowledge acquisition had taken place at the proto-type stage using the non-encultured Harrison and his extensive algorithms, the expert system would have failed. If the system had been designed once Harrison had become a member of the laser building culture, the heuristic 'short' would have probably produced a working laser. At a later stage with the introduction of electronics the heuristic 'short' was no longer sufficient and had to be formalized into the eight-inch rule. At this stage the cultural skill would have been fully explicated and an expert system designed at this time would have the best chance of success.

However, if production of lasers carried on until it became a traditional craft, it will become very difficult to design an expert system. It will no longer be a matter of teasing out the heuristics from the laser builders and codifying them into 'facts/rules'. These builders might simply invert the capacitors by tradition or habit. They might have no knowledge of what 'short' would mean in this context.

They would fail to see a significant object in a noisy environment

At this stage it would be a problem of extracting knowledge from experts, that they do not know they possess.

It could be argued that a computerized knowledge acquisition technologies such as Case Based Reasoning (CBR) could be used at the craft stage in order to identify the relevant 'significant object in a 'noisy' environment. However, for this to be possible, the relevant variable must first be incorporated into the case base of the CBR. Returning to the three boxes where Collins contends that knowledge could

exist in this instance. If the knowledge that the length of the lead between the capacitors and the electrode exists in box (1) i.e. the facts/rule box, when the laser failed to work, the CBR could consult examples of when the laser failed to work and prompt,

"Is the lead between the capacitor and the electrode less than 8 inches?"

This could then be checked and if greater, the wires could be shortened.

If at the time of when the CBR was constructed information about the lead length was in box (2) i.e. the Heuristics box. When the laser failed to work, the CBR could consult other examples of when the laser failed to work and prompt,

"Is the lead between the capacitor and the electrode short?"

Harrison would look at the laser, and by his standard (i.e. an uncultured laser builder) conclude that the leads are indeed short (using his knowledge they are as short as possible). Harrison would, therefore, 'ask' the CBR to provide another reason for the failure of the laser. This would occur because the CBR and Harrison would have different definitions of 'short'.

If the CBR was constructed at the 'craft stage' and the information pertaining to the lead length was in box (3) i.e. cultural skill, information about the lead length would not be considered a significant factor and information pertaining to the lead would not be part of the case base of the CBR. Therefore, when the laser failed to work the CBR would consult examples of when the laser failed to work, however, it would be unable to prompt information that was not present in its case memory such as 'lead length'.

This is not to say that a craftsman laser builder (with no notion of the concept of short in relation to lead length) would fail to quickly spot the reason for failure. He would know that the capacitor and electrode were in the wrong relationship, without knowing the significance of the configuration *vis a vis*, lead length. This further supports Collins' contention that the transference of knowledge is rather like learning a skill. This notion and Collins' five propositions for the transference of knowledge will be discussed in greater detail in Chapter 8.

2.3.4.3.3 Cultural Skills as Unexplicated Rules

For Collins (1987) success in K.B.S. is dependent on the ability of the knowledge engineer to elicit knowledge from experts. He notes that if the knowledge is already highly structured and theorized few problems in interpretation will arise. If, however, much of the experts knowledge is in the form of cultural skills, acquiring this knowledge will be problematic.

Collins (1987) notes, traditionally Phenomenology holds that it is impossible to explicate cultural abilities through the sediments to the foundation of the culture without infinite regress. However, Collins (1987) also notes we can communicate because we share certain aspects of a culture. The greater the number of shared cultural aspects the easier the communication, e.g. elliptical conversations between close friends are often incomprehensible to strangers. As cultural distance increases so do problems of ambiguity, requiring more of the culture to be made 'visible' or explicit. Cultural 'nearness' and cultural 'distance' can both be utilized as tools of knowledge acquisition.

Cultural 'nearness' will prevent infinite regress as shared cultural assumptions emerge. Cultural 'distance' can be employed as a tool to identify cultural knowledge (this point will be discussed in greater detail in Chapter Eight).

2.4 Summary of Chapter

The above indicates that a knowledge acquisition is too time consuming and thus, the main 'bottle neck' in the development of expert system.

Knowledge acquisition is also the main non-technical reason for the failure of expert systems.

Humphreys (1989) indicates that the problem of knowledge acquisition is more complex than the above indicates. He contends that before expert systems will be able to handle 'procedural uncertainty' a wider definition of knowledge will be required by knowledge engineers.

Collins (1987) highlights the two models of the transference of knowledge, the algorithmic and the enculturational models. He contends that the algorithmic model is flawed and if expert systems are to be constructed for practical situations, a method of explicating the cultural skills of the expert will have to be devised. Thus, transforming knowledge acquisition from a search for heuristics to the explication of tacitly held cultural skills.

Therefore, if expert systems are to be more successful in the future a wider definition of knowledge must be formulated and efficient methods for its elicitation must be devised. This is a daunting task, however, this research seeks to make a tentative step in such an undertaking.

Many of the reasons for non-technical failure are due to context knowledge, this topic will now be discussed.

CHAPTER 3

Context Knowledge

3   Context Knowledge

Problems concerning the context in which a KIS is situated have been previously encountered in the discipline of Information Systems (IS). A brief review of some of the fundamental IS findings, which are relevant to this investigation is therefore, appropriate.

3.1   Recent Innovations in IS Thinking

Checkland and Scholes (1990) note that traditional IS has been quite successful at solving problems which are well defined, but less successful in solving *'fuzzy'* problems [3]. Checkland and Scholes (1990) point out there is not a continuum with well-defined problems at one end and fuzzy problems at the other. For these authors 'well defined' and 'fuzzy' problems are different in *kind* and not simply *degree.*

Checkland and Scholes (1990) also note that systems engineers have been traditionally handed a problem and asked to solve it. The task of defining the *'what'* occurs prior to consulting the systems engineer and was as far as s/he was concerned treated as 'unproblematic'. However, most practical problems are not well defined but of a fuzzy nature. Checkland and Scholes (1990) contend that before systems engineers can design the *'how'* (best to solve a problem), managers must first have decided the *'what'* (problem to solve). The difference between 'what' and 'how' is also a difference of kind not degree.

ENGINEERS . . . ASKED . . . *'HOW'* . . . (to get a thing done).

MANAGERS . . . DECIDE . . . *'WHAT'* . . . (to do).

---

[3] This echo's Humphreys assertion in connection to expert systems

By treating 'what' to do as self evident and unproblematic Checkland and Scholes (1990) maintain traditional IS neglects large areas of the Information System. They maintain the topic of IS must be extended in order to gain a fuller understanding of the subject. Checkland (1981) advocates 'Soft Systems Methodology' (SSM) in order to gain an understanding of 'what' (problem to solve) before going on to decide 'how' to proceed.

IS, as a discipline has been undergoing a radical transition, the more progressive elements now view an information system as a social system. This has resulted in many methodological and epistemological problems which have direct consequences for knowledge acquisition.

3.1.1 The Systemic Nature of Information Systems

Checkland (1981) points out a fundamental notion in IS thinking, is that of *'emergence'*, the notion that systems have a *systemic* character.

> *SYSTEMIC:* Pertaining to the bodily system as a whole.
>
> (New English Dictionary 'John Bull Edition', 1932).

Implicit in the systems metaphor is the idea that systems have *'emergent properties'* which cannot be understood without reference to the system as a whole, e.g. It is impossible to understand the function of the 'hand' without reference to the 'body as a whole', or to use an IS example, it is impossible to gain an understanding of a personnel department, without understanding how it fits into the business as a whole. Therefore, a KIS cannot be understood without reference to the information system of which it is a part.

KIS's have tended to be treated for knowledge acquisition purposes as relatively isolated entities, i.e. knowledge elicitation concentrates upon questioning experts

about their particular domain. However, a KIS is in fact an integral part of an Information System, which can have a dramatic effect upon the functioning of the KIS, i.e. a KIS that functions in one information system, might not in another.

The systemic nature of an IS is endorsed and extended by Land (1991) who points out, traditionally what he refers to as the *'designed information system'* (of which KIS is a subset) was regarded as **the** information system. The 'designed information system' was viewed as the topic the information systems discipline. Land (1991) maintains that the 'designed information system' is only a part of the true information system. For Land an IS also contains an informal section or *'undesigned information system'* (see Figure 3.1). which has long been recognized but usually seen as problematic and/or irrational.

MODEL OF AN INFORMATION SYSTEM.

THE REAL WORLD.

OBJECTS, PEOPLE, RULES, NORMS, COMMANDS.

UNDESIGNED INFORMATION SYSTEM

DESIGNED INFORMATION SYSTEM

COGNITIVE FILTER

EMOTIONAL FILTER

INFORMATION USER

MEMORY, KNOWLEDGE

FROM INFORMATION SYSTEMS DOMAIN. F. LAND
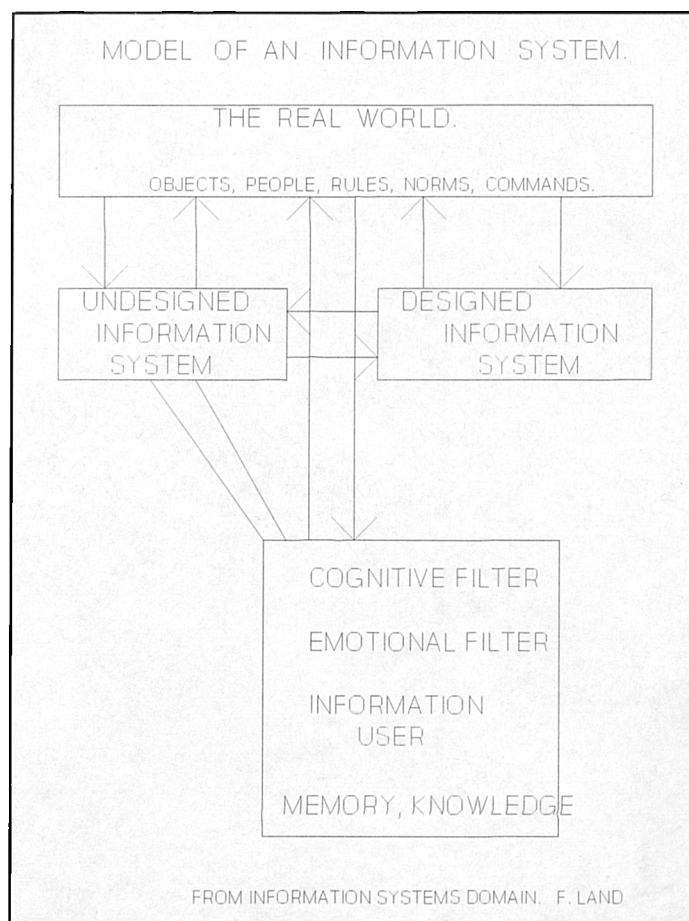
Figure 3.1   Designed and Undesigned Information System

For example, the 'designed information system' will reveal that 'x' is absent from work but the 'undesigned information system' will reveal that he has started drinking heavily again. Information from the 'designed' system is interpreted by reference to the 'undesigned' system. Thus a 'designed information system' can only be understood by reference to the total information system in which it is found. Many of the reasons for failure of ES noted in Chapter One occur due to the failure to recognize the systemic character of an IS of which a KIS is an integral part.

3.2 Summary of Chapter

This chapter illustrates that many of the problems encountered in knowledge acquisition have been previously encountered in IS.

Both have strong roots in technology, and the orthodox paradigm of both disciplines is based upon a scientific approach to the world. This approach has initially proved very successful. However, technological advances have given both disciplines vast new potential which they have only been able, as yet, to partially fulfill. The systemic nature of information systems (of which KIS are a part) has forced IS to expanded its topic to include many aspects that are simply not addressed by technology and which cannot be addressed within the paradigm of technology, e.g. informal information system, power relationships, etc.

ES has been successful where the scope for decision making is extremely limited but less successful in situations of 'procedural uncertainty'. It seems that such situations require knowledge that is qualitatively different that suitable for well structured problems. The internal relationship between a KIS and the overall IS, this on the one hand allows IS research findings be utilized in search of a wider definition of knowledge for the purposes of knowledge acquisition.

The next Chapter discusses these issues and indicates how a wider definition of knowledge can be developed.

CHAPTER 4

Characteristics of Knowledge Required for KIS and IS

4 Characteristics of Knowledge Required for KIS and IS

4.1 Introduction

The systemic nature of information systems intimately entwines KIS and IS. This is illustrated by the non-technical reasons for the failure of systems (see Chapter One). It is therefore, fruitful to discuss knowledge for both of these disciplines in general.

It must be noted that although IS predates IT and is not solely rooted in technology, IS like IT has developed into a discipline with a highly technical aspect. Mainstream IS and IT have until recently taken on board the basic assumptions of science and technology. This background has resulted in success in 'well defined situations/well defined problems' but less success in situations of 'procedural uncertainty/fuzzy problems'.

Practitioners of both disciplines indicate failures in the areas of procedural uncertainty and fuzzy problems are due to the inherent qualities of the problem. Well defined problems and fuzzy problems are different in form. Therefore, success in solving problems which are different in kind will require knowledge which is qualitatively different. This chapter discusses the characteristics of knowledge suitable for solving 'fuzzy problems' and situations of 'procedural uncertainty'.

Although this thesis is specifically aimed at knowledge acquisition for KIS, parts of an information system (such as a KIS) due to its systemic nature are only fully comprehensible with reference to the information system as a whole (Checkland 1990). It seems relevant, therefore, to discuss some of the research findings of the IS discipline which point to the development of a wider definition of knowledge for knowledge acquisition research.

4.2   The Transformation of Data into Information

Galliers (1987) points out that there is a distinction between *'data'* and *'information'*. Galliers sees data as relatively context free (pace Cicourel 1964), and it is only when 'meaning' is added to the data that it becomes information. The implications of this is information can no longer be treated as a neutral medium for the transference of knowledge. Meaning (which is neither present in the data nor its medium of transfer) must be added by an individual to data, in order to transform it into information. It must be noted that 'meaning' is not consciously added by individuals, meaning is tacitly added in an unexamined and unconscious manner which under normal situations remains 'invisible' to the individual.

Information is therefore, constructed through an interpretivist process. Galliers claims that the *'meaning'* component transforms information gathering from a *technical/scientific* task (which seeks to eliminate all subjective elements) to one of *'social science'*.

4.3   Wider Definition of Knowledge for Knowledge Acquisition

The above indicates that KIS are failing to be implemented due to a narrow definition of knowledge. In order to address this problem a wider definition of knowledge is required. A similar situation has occurred in IS in relation to 'fuzzy problems'. IS has sought to solve 'fuzzy problems' by extending the discipline beyond the scientific/technological paradigm to incorporate the philosophical base and methodologies of social science. This has enabled the subjective and inter-subjective knowledge by which individuals often tacitly add meaning to a situation to become part of the topic of IS. Thus, making available a wider definition of knowledge to IS.

The systemic nature of information systems indicates an intimate relationship between the KIS and the information system. It is therefore, proposed that the definition of knowledge for a KIS is extended in a similar way to that of IS, to include the meaning which individuals add often tacitly, to make sense of, or interpret a given situation. Widening the definition of knowledge (for the purposes of knowledge acquisition) will have methodological and philosophical consequences. Prior to discussing these consequences it prudent to review the work of authors in this area in order to ascertain the nature and characteristics of tacitly held subjective and inter-subjective knowledge. For the purposes of this thesis, tacitly held subjective and inter-subjective knowledge will be discussed interchangeably under the term of 'tacit knowledge'.

4.3.1 Tacit Knowledge at the Level of the Individual

The seminal work on tacit knowledge was produced by Polanyi (1966). This work will now be briefly described.

4.3.1.1   Polanyi 'Tacit Knowing'

Polanyi (1966) maintains that 'objectivity', by which natural science seeks to 'discover' and validate 'facts' is a misguided enterprise. Polanyi contends the world is not made meaningful due to the intrinsic qualities of its objects, rather the world is interpreted subjectively by the use of *'TACIT KNOWLEDGE'*.

TACIT KNOWING

Polanyi (1966) contends that,

> *'we can know more than we can tell'*

He cites the experiment of Lazarus and McCleary (1949) which inquired into what they termed *'subception'*. Subjects were shown a series of 'nonsense syllables', after showing certain syllables an electrical shock was administered. Soon the subjects showed signs of anticipating the shock, at the sight of the 'shock syllables'. However, upon questioning the subjects were unable to identify these syllables. They had acquired knowledge of which they could not tell.

4.3.1.1.1   Basic Structure

Polanyi (1966) contends that the basic structure of tacit knowledge is composed of two parts, which are,

FIRST TERM of tacit knowing: the 'shock syllables'.

SECOND TERM of tacit knowing: the electric shock.

It was noted that once the two are connected, the sight of the first term stimulates an expectation of the second. This seems similar to Pavlov's experiments on dogs where the sound of a bell caused the dog to salivate. But there was a great difference, Pavlov had to rely upon purely physical responses from the dogs, whereas, Lazarus and McCleary's (1949) subjects were able to be questioned about their experiences and show that they did not consciously connect the two phenomena.

Polanyi was not content to demonstrate that the subject was unable to 'tell' of this relationship, he also sought to answer the further question of why this knowledge remained 'tacit'? Polanyi contends that we have explicit knowledge of the second term the 'shock' which is 'specifiable', and this is attend *to*. However, because a knowledge of the first term relies on an awareness of it, for attending to something else, the first term remains 'tacit'.

4.3.1.1.2 Functional Relationship Between the 1st and 2nd Term

We attend *from* the first term in order to attend *to* the second term. It should be noted that the first term is often closer to the subject than the second term. Polanyi, therefore, refers to the former as *'proximal'* and the latter as *'distal'*.

In order to explain this phenomenon, Polanyi, uses the example of searching a cave by the use of a probe. When we investigate with the probe, at first we are simply aware of the various impacts the tip of the probe makes by reference to the impact the other end of the probe makes on our hand. Use of the probe soon transfers our awareness of the impacts on our hand to the impacts of the tip as it touches the contours of the cave. We attend *to* the *distal* by attending *from* the *proximal*. Thus, transforming meaningless pressure on the palm of our hand into meaningful interpretations about the inside of the cave.

Polanyi (1966) extends this notion by claiming that all perception takes this form. We are not aware of our perceptions as they occur inside our bodies except by reference to the outside world we are attending *to*. For Polanyi, therefore, there is a tacit dimension to the basic way that human beings perceive the world. Polanyi arrives at the conclusion that the world is not simply objectively 'out there' waiting to be perceived, but rather subjectively interpreted by tacit knowing.

To return to the example of the probe, by our awareness of the tip rather than the end that we actually feel in our hand, it could be said that in some way the probe becomes an extension of our body.

> *'In this sense we can say when we make a thing function as a proximal*
> *term of tacit knowing, we incorporate it into our body-or extend our*
> *body to include it-so that we come to dwell in it' (p. 16)*

Polanyi contends that the notion of indwelling is found in the works of Dilthey (1944), who notes,

'The mind of a person can be understood only by reliving its workings,

and Lipps (1903)

'Represents aesthetic appreciation as an entering into a work of art and thus dwelling in the mind of its creator'.

Polanyi building on this work, takes a radical step, and claims that the notion of 'indwelling' need not only apply to the humanities (to which Dilthey and Lipps were referring) but also encompass the disciplines of the natural sciences.

Polanyi (1966) also contends that tacit knowledge has a social aspect.

4.3.1.2   The Social Aspects of Tacit Knowledge at the Level of the Individual

Polanyi notes that there is a social aspect to the notion of 'indwelling' which occurs with the acceptance of moral teaching by individuals, with which they tacitly interpret the world. The acceptance or *'interiorization'* by which individuals identify with moral teachings is such, that they function as a proximal term of tacit moral knowledge and provide a tacit framework for acts and judgements. Polanyi (1966) notes,

'We meet with another indication of the wide functions of indwelling when we find acceptance to moral teachings described as their interiorization. To interiorize is to identify ourselves with the teachings in question, by making them function as the proximal term of a tacit

moral knowledge, as applied in practice'. (page 17)

Polanyi (1966) claims that scientists by relying on theory for understanding the world, are using theory as a proximal term and thus, interpreting the world subjectively rather than 'discovering' objective facts. At the most primitive level Polanyi (1966) contends we perceive the world tacitly, rather than experiencing it directly.

> *'Thus, do we form, intellectually and practically, an interpreted universe populated by entities, the particulars of which we have interiorized for the sake of comprehending their meaning in the shape of coherent entities'*   *(p.29).*

Thus, for Polanyi, the search by positivist philosophers of science for objectivity is misbegotten and a stable alternative should be sought.

If, as Polanyi maintains tacit knowledge is a component of scientific knowledge (a form of knowledge produced by rigorous formal methods specifically designed to eliminate all forms of subjectivity) then it seems reasonable to infer it is being used in more subjective areas of knowledge. This is of direct relevance to knowledge acquisition, in that, the expert knowledge that it seeks to acquire has a recognized subjective element, i.e. expert opinion.

The tacit knowledge individuals employ to interpret the world is also evident at the level of the organization.

4.3.2 Tacit Knowledge at the level of the Organization

The effect of tacit knowledge at the level of the organization is illustrated by Vickers' (1984) notion of *Appreciation*. Vickers (1984) defines 'appreciation' as,

'The readiness to see the value of things in one way rather than another'.

Vickers (1984) maintains that it is impossible to understand an organization, without a thorough understanding of the way it selects items from the *'life world'* and adds meaning to them. For Vickers (1984) 'appreciation' is the method by which an organization views itself and the environment in which it exists. Appreciation is a reflexive process, whereby individuals select elements and groups of elements from the life world and interpret their significance in a way that is meaningful. This interpretation and resulting actions become part of, and hence change the life world. Although the individual is in theory free to choose which elements to select, in practice the choice is not arbitrary. It is based upon the previous history of the individual. The results of previous recursive cycles of interaction with the life world, experienced not only by the individual but also by his/her 'ancestors'. It is the previous cycles of interpretation with the life world that give the individual standards of 'reality' (what counts as the reality of everyday life) and 'values' (what counts as acceptable and unacceptable behavior in a given situation).

If the notion of appreciation is taken seriously it will have far reaching consequences for information systems research (and due to the systemic nature of information systems for knowledge acquisition). If Vickers is correct, in so far as organizations are concerned, there is no external reality to be objectively 'discovered'. What counts as 'reality' to a particular organization is dependant on the 'appreciation' system of that organization. Thus, organizational needs are not external or self evident and cannot be understood without understanding the particular appreciation system of the specific organization in question. The notion of appreciation transforms knowledge acquisition from the search for objective facts and rules to a search for what counts as objective facts and rules in a given appreciation system.

Vickers (1984) notion of 'Appreciation' allows him to think of the world phenomenologically. That is to view the world, not as an objective reality to be discovered, interacted with or mastered, but as a continuous stream of experiences the life world (more often referred to by phenomenologists as *'Lebenswelt'*). Phenomenologists contend that most of what the individual perceives as reality is 'given' to him/her by virtue of being born into a particular culture and is the result of an historical cultural appreciation of the lebenswelt [4]. Members of a culture tend to share a history, have similar interests and concerns and thus, selectively interpret the lebenswelt in a way that is meaningful to the members as a whole. Previous cycles of appreciation will give its members the propensity to selectively appreciate the life world in a particular way, i.e. one that has standards of reality and values appropriate to the organization.

Checkland and Cesar (1986) use the notion of appreciation to explain how rather than a manager making a neutral objective decision he/she is in fact a part of an organization which is actively constructing the 'reality' in which these decisions are taken. Therefore, it follows that understanding of what the organization regards as reality and what is acceptable or unacceptable in a given situation is vital for the formulation of an effective IS.

Tacit knowledge by which individuals and organizations interpret the world is also evident at the cultural level.

4.3.3 Tacit Knowledge at the Level of Culture

The effect of tacit knowledge at the cultural level is demonstrated by Durkheim (1964) who attempted to give an explanation for Pascal's famous statement

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[4] For a detailed and accessible account of this phenomenon see Berger and Luckmann (1967)

'What is truth one on side of the Pyrenees is error on the other'.

(Pensees V. p.294)

by demonstrating that our basic categories of thought and forms of reasoning are culturally given. Durkheim argues that ideas of time, space, force and contradiction, vary between groups and within groups over time, thus, basic categories and reasoning are historical and therefore, *socially constructed.*

He contends that intellectual communities will be constrained to some extent by,

(1)   Cultural resources.

(2)   The structure of the group.

(3)   The place of the group in the wider society.

Thus, for Durkheim, Pascal's contradiction is explained by the fact that knowledge is culturally constructed and has been constructed differently on either side of the Pyrenees by different cultures.

However, Durkheim (1968) steps back from the brink of the relativism he seems to be proposing, by pointing out that even if our basic categories are socially constructed this doesn't necessarily mean they are devoid of objective value.

'On the contrary, their social origin, rather leads to the belief that they

are not without foundation in the nature of things'.   (p.19)

For Durkheim, a group's conception of time is due to the collective rhythm of collective life. For example, ideas of time are culturally constructed, these rhythms are, however, based on the periodicies of the physical world. Therefore, both physical and social contribute to how we understand the world.

Durkheim goes on to argue, that although notions of conceptual categories are socially constructed, it is possible to judge the validity of competing claims by the use of scientific methods.   This view has been vigorously criticized of late by interpretivist sociology.   Specifically, the work undertaken in the Sociology of Knowledge (Berger and Luckmann 1967) and its 'off spring' the Sociology of Scientific Knowledge (SSK) (Mulkay, 1979, Latour & Woolgar 1979, Ashmore, 1985) both disciplines illustrate knowledge, rather than simply corresponding to an external reality is to some extent subjectively and inter-subjectively 'constructed'.

SSK is a sociological investigation into the work of natural scientists.   This work reveals that subjectivity and inter-subjectivity are key elements in the production of science (the quintessence of objective knowledge).   If this is true in the so called 'hard' sciences, how much more so in the 'soft' social sciences. The disparate works referred to above all draw attention to the vital importance of *context* and to the active participation of the reader / analyst / researcher / man-in-the-street, who rather than simply receiving information about the world subjectively interprets it to such a degree that in many ways the individual actively construct their life world.

4.3.4 Similarities Between 'Appreciation', 'Interiorization' and 'Culturally Constructed Categories'

Tacit knowledge in the form of interiorization at the level of the individual, appreciation at the level of the organization and the culturally constructed categories at the level of society is similar in the following ways:-

*   It is brought to, and is external to the given situation at each level.

*   It is socially maintained and constructed at each level.

*   It is of such a ubiquitous nature that it is usually applied unconsciously and thus remains in normal situations unexplained and unexamined at each level.

Therefore, for the purposes of this research tacit knowledge as described by Polanyi, Vickers and Durkheim can be treated as similar entities. It must be noted that these are not discrete levels, they are intimately entwined and can dramatically effect one and other. Tacit knowledge is thus, an important constituent of a wide range of knowledge and therefore, a potential area for the widening of the definition of knowledge for the purposes of knowledge acquisition.

4.4 Implications for Knowledge Acquisition

The above has several implications for knowledge acquisition which will now be discussed.

4.4.1 Redefinition of Topic

If organizations 'construct' what appears to its members as the objective world by use of 'appreciation', it follows that the analysis of organizational 'needs' will not be possible without a thorough understanding of the organization's appreciation system. 'Needs' and values can no longer be seen as self evident Guba and Lincoln (1982) but a construction of a particular organization through it's 'appreciation system'. This changes IS in general and KIS in particular, from a purely technical topic and to a topic of social science of an interpretivist nature. The redefining of the topic will have methodological consequences to each element of knowledge acquisition. Several of the more important will now be briefly outlined.

4.4.1.1   Quality of Knowledge

The difference between 'well defined situations' and 'situations of procedural uncertainty' is one of *kind* not *complexity*. The success of KIS in handling procedural uncertainty depends on the elicitation of knowledge that is qualitatively different than that required to handle well defined situations. Therefore, a wider definition of knowledge and methodology appropriate for its collection is essential for progress in KIS for practical purposes.

4.4.1.2   Systemic Nature of Systems

The contention that information systems have a systemic nature is a prescription against Atomism. Atomism is defined by Urmson and Ree (1991) as the notion that,

> *'Atomism is the belief that all phenomena are explicable in terms of the*
> *properties and behaviour of ultimate, elementary, localized entities (or*
> *"fundamental particles").' (page 31)*

Atomism is the belief that the behavior of complex bodies can be explained in terms of their component parts. Atomism, has proved extremely successful in the natural sciences but it is inappropriate for knowledge acquisition due to the systemic nature of information systems. For practical purposes, however, in complex situations certain parts of the system will need to be focused upon. However, the artificial nature of the exercise must remain at a conscious level and results from the area of focus, must always make sense in relationship to the whole.

4.4.1.3   Generalisable

Although it is unlikely that a KIS will be of use in different domains, it seems reasonable that a system constructed for one organization will be of use to different

organizations, in the same domain. For example, it seems reasonable to believe that a KIS constructed for the maternity unit for Area 1 Hospital would with minor changes be suitable for the maternity unit at a different hospital.

If the notion of 'appreciation' is taken seriously then such an assumption is untenable, what counts as a maternity unit is not understandable without direct reference to the appreciation of the particular maternity unit. If the appreciation systems at Area 1 and Area 2 hospitals are significantly different, then what counts to an organization as a maternity unit will be fundamentally different and the KIS each require will also be different.

4.4.1.4 Rationality

The importance of the 'appreciation system' in building what for an organization is 'reality', has important ramifications on the practice of the knowledge engineer. Rationality like reality arises from within the appreciation system. Winch (1958) describes how rationality is internal to a idea system rather than an external 'gift from God' which can be applied to all idea systems. This is very important point, the temptation to impose an external rationality must be consciously and continuously resisted by the knowledge engineer as he/she reflexively reviews his/her practice.

4.4.1.5 Inter-Subjectivity

The above indicates the importance of inter-subjectivity for the construction of domain knowledge. This will have implications upon the choice of methodology i.e. one that is capable of capturing subjectivity rather than one that seeks to systematically eliminate it (see Chapter 8).

The above chapter has proposed the extension of knowledge in traditional knowledge acquisition to incorporate tacit knowledge. Tacit knowledge is an extremely large

subject, the following chapter will, therefore, focus the scope of the thesis.

CHAPTER 5

Focus of the Thesis

5 Focus of the Thesis

In the previous chapters it was noted that in IS and IT a wider definition of knowledge is required. A possible way of widening the definition of knowledge was provided by Galliers (1987) who pointed out that 'meaning' has to be subjectively added to data in order to transform it into information. It must be noted, although, it is possible to explicitly add the meaning to a situation, in the vast majority of cases meaning is added tacitly, i.e. without being either examined or explained by the individual. If an understanding of the subjective element is of vital importance to IS the same must be true for knowledge acquisition (due to the systemic nature of an information systems of which the KIS is a part). Traditionally knowledge acquisition concentrates on collecting the objective facts of an expert domain. This has (see above) proved too limiting, therefore, the subjective and inter-subjective knowledge experts tacitly bring to a situation (in order add 'meaning' and to make decisions) seems a fruitful area to find wider definition of knowledge (for the purposes of designing knowledge based systems). The previous chapter illustrated that such knowledge is an extremely large topic, clearly all aspects of tacit knowledge can not be investigated by this thesis. Therefore, this chapter seeks to focus down the area of investigation to one that is logistically possible for an investigation of this type while at the same time having the potential of producing significant findings.

5.1 Methodological Considerations

The extension of the definition of knowledge in this manner at first sight seems to exacerbate the problem of knowledge acquisition. This, according to certain authors, however, is not necessarily the case. Michie (1985), for example, contends that the knowledge acquisition bottle-neck is due to the fact that for the past decade knowledge engineers have attempted to elicit domain knowledge by questioning experts, which is too time consuming and too expensive. Michie (1985) proposes a

radical alternative and advocates the recognition that knowledge engineering should abandon the questioning of experts in favour of computerized knowledge acquisition technologies.

Three types of these technologies: machine induction, neural networks and case based reasoning, will now be briefly outlined in order to assess their suitability for the purpose of this thesis.

5.1.1 Computerized Methods of Knowledge Elicitation

5.1.1.1   Machine Induction

Michie and Johnston (1985) advocate knowledge acquisition using machine induction. These enthusiastic proponents of machine induction claim that it will be an important source of human knowledge in the future.

5.1.1.1.1   Machine Induction as an Aid to Knowledge Acquisition

Machine induction seems to offer a techniques of eliciting experts rules, whilst at the same time eliminating many of the problems associated with interviewing experts. The method basically uses a computer to analyze the decisions made by experts over a large number of instances and attempts to draw out the rules that they are consciously or unconsciously applying. Machine induction by considering large numbers of actual expert decisions overcomes the problems of the 'Hawthorne Effect', secrecy of experts and the inability of experts to articulate the rules that they routinely apply. The last case appears to offer a technique for the explication of tacit knowledge.

5.1.1.1.1.1   Machine Induction Technique

Machine induction requires a 'training set' of data, which is described as a set of attributes, a set of characteristics which describe each example, and a classification of the outcome of each set of attributes. These are encoded and analyzed using an 'inductive algorithm' which induces rules from the training set.

Name	Age	At School ?
Danny	8	Yes
Sally	10	Yes
David	5	No
Brian	9	Yes
Jane	2	No
Ian	3	No
James	14	Yes

Table 5.1   Induction Training Set

Table 5.1. is reproduced from Hart (1989) as an example of a simplified training set, whereby, a set of attributes (names of children) and a set of characteristics (their ages) are described by the characteristic of their age and a classification of the outcome of each set of attributes (does the particular child attend or not attend school). The data is encoded into a computer and the 'inductive algorithm' induces the rule that children of eight years of age and over must attend school.

Machine induction appears at first sight to offer a method to elicit tacit knowledge. In practice, however, great care must be taken. Hart (1989) notes,

> '[T]he induced results will be good, only if a good algorithm is used
> on a training set which contains adequate information, in a suitable
> form, about a problem. (page 121)

5.1.1.2   Neural Nets

In recent years, a great amount of research (see McClelland and Rumelhart 1986) has been conducted in the area of neural networks. It has been suggested that this approach mimics the actual working of the human brain, Gordon (1989) envisions that neural networks could revive the computer as a model of the mind. These systems differ from orthodox software in that, instead of storing knowledge in the form of rules, knowledge is stored implicitly in the strength of relationships between connecting nodes.
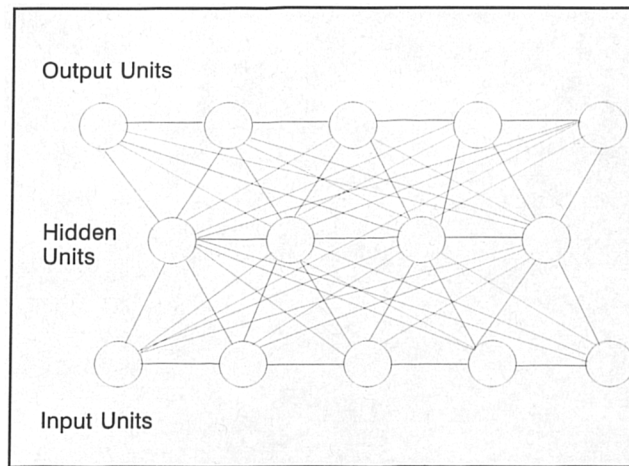
Figure 5.1   Schematic Diagram of a Neural Network

The neural network is composed of large numbers of separate units ('neurons'). The strength of the connection between two units varies and is weighted accordingly. These units form three levels (see Figure 5.1) within the neural network: input units, hidden units and output units. The input units are 'excited' by external stimuli and form connections (of varying weights) with the hidden units. (N.B. There can be more than one level of hidden units). The hidden units then activate the output units by which the neural network responds to the original stimuli. Gross (1992) illustrates this process with the following example,

'In a more complex example, the pattern of activation of input units encodes the spelling of a word and the output encodes how it sounds.'

A neural network has the power to model extremely complicated relationships between items of data. In this way, complicated situations with large amount of rules can be expressed in relatively simple networks. Readers interested in a fuller account of neural networks should consult Garnham (1991).

Neural networks have had a considerable amount of success especially in the areas concerned with perception, such as pattern recognition. Of late neural networks have been constructed to work at higher level processes concerning symbolic content. For example, Rumelhart and McClelland (1986) devised an neural network in order to imitate how children learn to put English into the past tense. Verbs were divided into regular (i.e. those which required an 'ed' to form the past tense and irregular verbs (i.e. those which did not). The neural network at one level appeared to learn the syntactical rule. However, this claim has been criticized, Garnham (1991), for example, notes that at a more sophisticated level of analysis the neural network had not 'discovered' the rules of English, but had used rules based on statistics, it had linked the probability of an 'ed' ending being attached to a particular word.

It is claimed neural networks are different from normal conventional software in that they are capable of generating new rules, rather than simply following procedural programs. Programmers in neural networks speak of training the neurons, the neurons are learning etc., rather than programming software. This is heralded as a significant advance, in that many of the rules that the neural networks produce are not known to the programmer and therefore, could not have been encoded into procedural software. Neural networks, therefore, seem to have the potential to elicit tacit knowledge.

5.1.1.3 Case Based Reasoning

Case-based reasoning attempts to mimic the learning processes of humans. When a new experience is encountered, humans draw on their knowledge of past experiences in order to understand the new situation and formulate appropriate actions. This is a reflexive process in that these actions (along with lessons learned in the new situation) then form part of an individual's past experiences, for future consultations. The individual, therefore, learns from one situation to another.

Kolodner and Simpson (1989) maintain case-based reasoning applications likewise assesses the current situation and probes the memory for a similar earlier cases. The solution to the most appropriate earlier case is then applied to the current situation. The current situation then becomes a case which is stored (along with lessons learned in the current situation) in the memory and can be used as an enriched case for future consultations. In this way case base reasoning applications are not dependant upon fundamental knowledge representation and processing techniques. However, this requires that each case base reasoning application to be individually developed.

Despite the individual nature of case based reasoning applications they are all require three basic elements,

INDEXING   A method of indexing the cases in order that they can be located in the memory.

SELECTION   A method of selecting the cases that are most relevant to the solving of particular problems.

UP-DATING   A method of up-dating cases with information 'learned' by solving the latest problem.

McGovern et al (1994) indicate the cyclic nature of problem solving by case based reasoning application with Figure 5.2.

Problem specification

Recall relevant cases from case memory

Select most promising cases

Construct a solution to problem

Failure

Simulate solution

Success

Implement solution

Evaluate solution
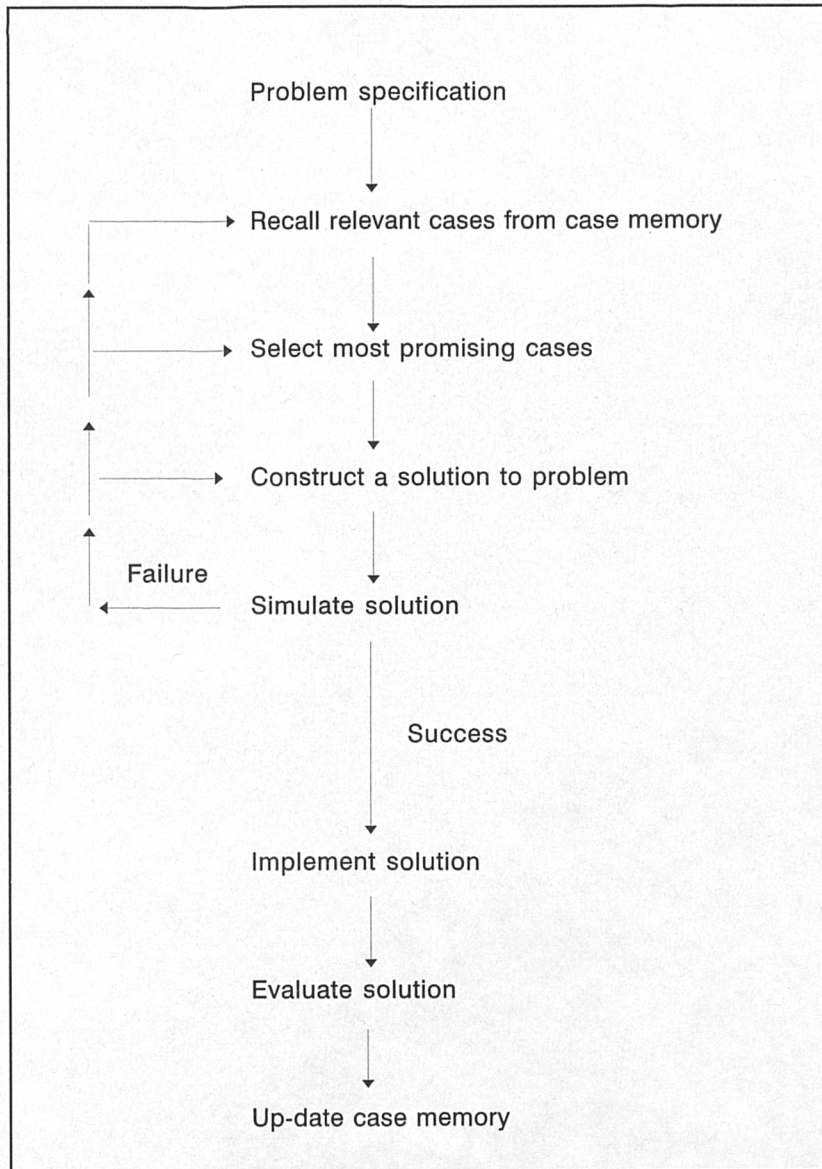
Up-date case memory

Figure 5.2   Case based reasoning cycle.   From McGovern et al (1994) P.45.

Thus, a problem is specified to the CBR application which searches its case memory and extracts relevant cases. From these cases, the most promising are selected, a

solution to the problem is constructed and simulated. If the solution is successful it is implemented and evaluated in order to up-date the case memory. If, however, the simulated solution is a failure further cycles of recall, selection, construction and simulation are undergone until a successful solution is produced. Once this occurs implementation, evaluation and update can take place.

CBR seems to have the potential to utilize tacit knowledge. If the CBR is able to provide solutions to specific problems and if tacit knowledge is required for this function, the cases must embody tacit knowledge. Thus, CBR has the potential to make use of the tacit knowledge embodied in the cases in the case memory.

5.1.2 Evaluation of Computerized Knowledge Acquisition Technologies for the Purposes of this Thesis

The above technologies all show considerable promise, they all seem to varying degrees to be able to 'handle' tacit knowledge. For example, it is generally agreed that neural networks are very good at pattern recognition, they must, therefore, embody, tacit knowledge of how to recognize patterns. Similar claims could be made that machine induction and CBS also embody tacit knowledge. However, it must be noted that these computerized knowledge acquisition technologies offer no help in understanding tacit knowledge. These technologies do not address the fact that they are using tacitly held knowledge, it is the quality of the outcome rather than the type of knowledge used, that is of importance to advocates of these technologies. These technologies have some relevance to tacit knowledge, but give little understanding of it, they simply make use of it, where it falls into their 'learning'. The type of knowledge used (tacit or otherwise) is simply irrelevant to the advocates of these technologies, as long as a satisfactory outcome is produced.

In many ways all these methodologies are similar, in that raw data is input and is manipulated by the programme and raw data to some extent is output. It seems that tacit knowledge or at least the effects of tacit knowledge can be incorporated into a KIS using these three techniques. Therefore, if these technologies are capable of 'handling' tacit knowledge, albeit in an arcane way, one might question whether there is any point in expending time and energy in explicating tacit knowledge. For the purposes of KIS design, these knowledge acquisition technologies seem to have solved the problem of tacit knowledge.

However, in practical situations of 'procedural uncertainty' the situation is far more complex. The above knowledge acquisition technologies seem to be able to 'handle' tacit knowledge, but they do not explicate, nor seek to explicate the incorporated tacit knowledge . The next section illustrates, contrary to the above, it is essential to gain a greater understanding of the tacit knowledge of a domain, an understanding that these techniques can not provide.

5.2 The Importance of Explicating Tacit Knowledge

Behavioral scientists such as Argyris and Schon (1978) have shown how organizationally specific tacit knowledge, can dramatically effect the actions of individuals within an organization, by reference to the capacity of an organization to learn. For Aygyris and Schon (1978),

> *'Organizational learning involves the detection and correction of error.' (page 2).*

To illustrate the importance of organizational learning Argyris and Schon (1978) cite the example of Product X, which was produced by a multi-national company. This product was a failure and when discontinued resulted in losses to the company of over $100,000,000. Argyris and Schon (1978) point out that much of these losses need

not have occurred, because for more than five years before the product was discontinued at least five senior officials (three plant managers and two marketing men) of the company knew that this product, (due to design faults and marketing problems), was not viable. Despite this knowledge it took five years and massive losses before the top management learned that Product X was not viable and ceased its production.

Argyris and Schon (1978) investigated the reason for the time lapse between the plant managers and marketing men realizing that the product was a failure and this information being passed on to top management. Argyris and Schon (1978) concluded that the problem lay in the organizational learning of the company. Argyris and Schon (1978) contend that organizational learning can be divided into two categories *single loop learning* and *double loop learning*, which they define as,

Single loop learning: When the error detected and corrected permits the organization to carry on its present policies and achieve its present objectives.

Double loop learning: When an error is detected and corrected in ways that involve the modification of an organization's underlying norms, policies and objectives.

Argyris and Schon (1978) contend that most companies are reasonably good at single loop learning but find double loop learning problematic. Argyris and Schon (1978) analyzed the communication problems associated with Product X and identified the following 'barriers to organizational learning'.

Barriers to Organizational Learning

The barriers to organizational learning in this case were identified as the informal norms of the organization. It soon became apparent to the plant managers and marketing men that the original decision to produce Product X was wrong. However, this information was not relayed to top management because it would contravene several organizational norms which Argyris and Schon (1978) identified as,

> *'The first norm was that policies and objectives, especially those that top management were excited about, should not be confronted openly. The second norm was that bad news in memos to the top had to be offset by good news.' (page 3).*

Therefore, in this particular organization it was not possible to openly oppose the production of Product X to the top management. Problems could be raised in an oblique manner, but 'softened' with good news about the product. The net effect was that top management perceived Product X as a sound product albeit with (soon to be solved) production and marketing problems.

These organizational norms run counter to both management theory and the economic health of the company and place the employees in a 'double bind'.

1)   To openly confront top management decisions would be against the norms of the organization.

2)   To suppress the knowledge that the product was a failure would contravene formal organizational norms.

This problem was further exacerbated by a further norm against discussing double binds. Thus the problem of Product X became 'undiscussable' and remained

'camouflaged' for 5 years at great cost to the company.

Argyris and Schon (1978) illustrate the dramatic effect tacitly held organizational norms can have on the running of an organization. These tacit norms operate on top of domain knowledge and influence how it is interpreted. For example, (see Figure 5.2) Product X is produced and is interpreted by the plant managers and marketing men using their domain specific background knowledge as a failure which should be discontinued as soon as possible. However, the organizational norms of that organization act as a barrier to 'camouflage' this information passing to the top managers. In a different organization if Product X had been produced it would also be interpreted by the plant manager and marketing men using their domain specific background knowledge as a failure. However, in a different organization, different organizational norms could operate and the knowledge of Product X's failure could be passed rapidly (without fear of repercussions to the 'carriers of bad news') to top management and the product discontinued as soon as possible, at minimum cost to the company.

Top Management

Camouflage   Organisational Norms   Inform

Domain Specific
Tacit Knowledge
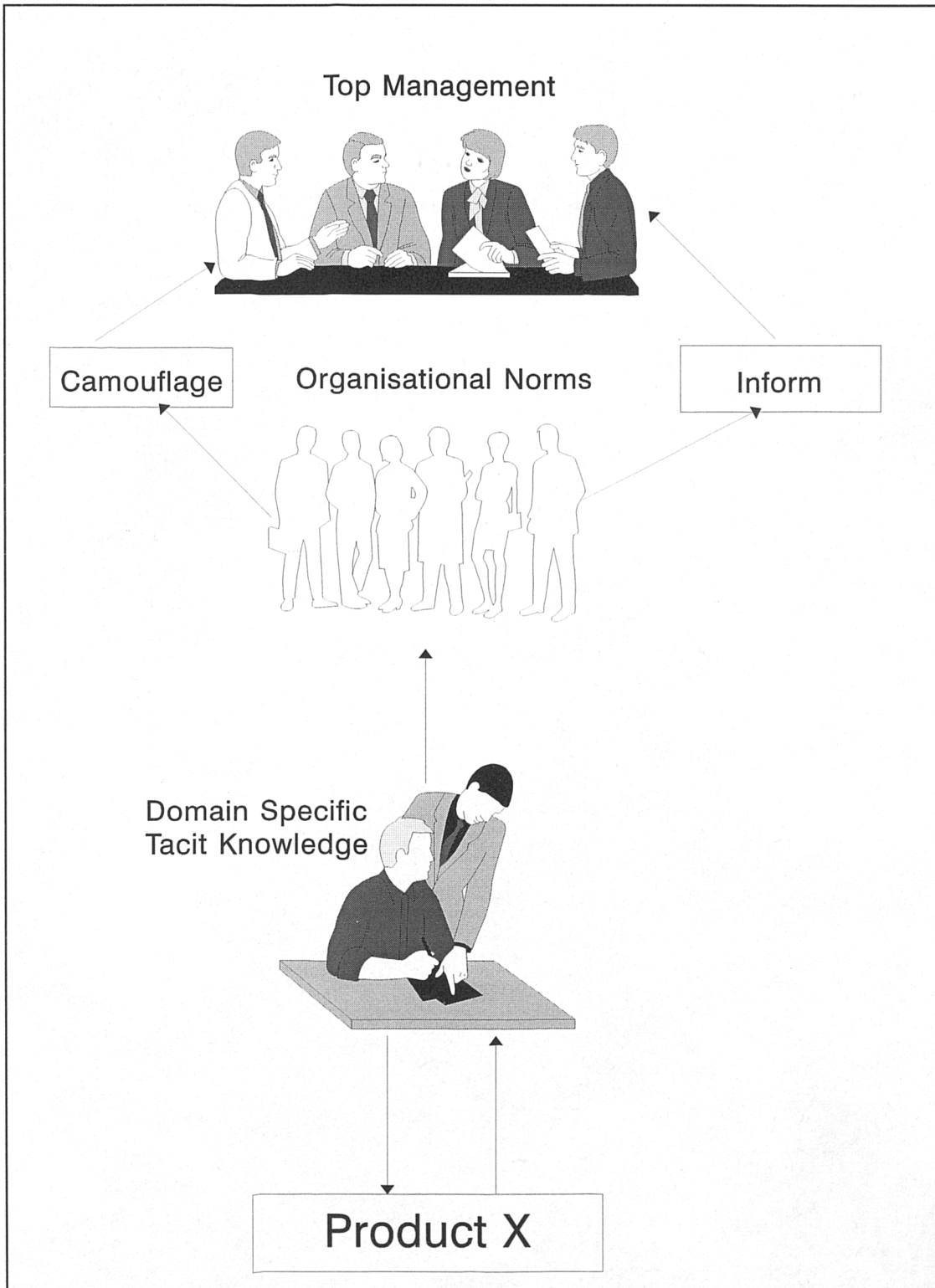
Product X

Figure 5.2   The Effect of Organisational Norms.

5.2.1 Suitability of Using Computerized Knowledge Acquisition Technologies for the Purposes of this Thesis

The example of Product X illustrates that organizational norms are have great power to affect the learning process of an organization. More importantly for the purpose of this research Argyris and Schon (1978) point out that organizational norms (which often operate at a tacit level) do not necessarily work to the advantage of the organization. Therefore, it can not be assumed that such norms are benign or even neutral to the health of an organization. In fact the main thrust of Argyris and Schon's (1978) work is develop methods that help overcome organizational norms which act as barriers to the double loop learning of organizations.

The work of Argyris and Schon (1978) points out that it is not enough simply to embody tacit knowledge, in some cases it is to the advantage of the organization that some tacit knowledge is actively eliminated. In order to do this requires an explication rather than arcane incorporation of tacit knowledge.

If one of the three previous knowledge acquisition technologies had been used on the above example, the organizational norms would have been tacitly embodied into the resulting KIS and remain hidden. Therefore, although Product X was a failure this knowledge would be 'camouflaged' from top management, at a tremendous cost to the company. Computerized knowledge acquisition technologies employed in such a situation could 'handle' the tacit knowledge, but in this case the tacit knowledge (in the form of organizational norms) would operate against the interests of the company. Therefore, it is not enough that the computerized technologies embody tacit knowledge, the consequences of embodying such knowledge must first be assessed. Assessment of tacit knowledge necessitates that it is first explicated.

5.3   Defining the Research Approach to Tacit Knowledge

The above indicates that it will be fruitful to focus the scope of this thesis down from the general topic of tacit knowledge, to methods which make tacit knowledge explicit in order that it can be assessed for its suitability to be embodied into a KIS. Focussing the thesis in this manner makes the use of the computerized knowledge acquisition technologies mentioned above inappropriate.   For. although these technologies all show considerable promise in 'handling' tacit knowledge they do not explicate tacit knowledge and are therefore, inappropriate to the focus of this thesis.

The explication of tacit knowledge is still too large and problematic a topic to be logistically feasible for a Ph.D. thesis. Practical and philosophical considerations will now be discussed, which will allow the scope of the research to be focussed down to one more appropriate to research of this nature.

5.3.1 Practical Considerations

Attempting to elicit all an experts or individuals subjective and inter-subjective tacit knowledge at first sight appears an impossible task.   In the case of knowledge acquisition in an expert domain, two options seem possible, both of which are problematic.

Firstly, one could attempt to elicit the tacit knowledge of domain experts. This option is problematic, in that each expert has a different personal history and has subjectively experienced the world in different ways.   Therefore, the subjective knowledge that each expert tacitly brings to a situation will be different Therefore, the tacit knowledge of *all* relevant experts would need to be undertaken. This is not only logistically problematic it would also be counter-productive in that different experts (due to their different histories) are likely to add meaning in different and

sometimes contradictory ways.

Secondly, one could attempt to gain an understanding of the cognitive processes that are responsible for adding meaning to a situation, and incorporate it in a KIS. Unfortunately, knowledge of such processes is at a nascent stage at this time and it is unlikely that our understanding of this process will increase to such a stage where it will be of use to KIS development in the near future.

However, it is noted in Chapter Four that a large portion of tacit knowledge has a social aspect. This at first seems a contradictory notion, it seems counter intuitive that a phenomenon which is subjectively held by an individual can have a social aspect. However, although tacit knowledge is subjectively held by the individual certain aspects are the property of members of cultures or mini-cultures and have an inter-subjective nature. Inter-subjective tacit knowledge will now be described in terms of direct and indirect knowledge.

5.3.1.1   Direct and Indirect Tacit Knowledge

When an individual uses tacit knowledge to add meaning to, or interpret a situation, some of it is due to his/her personal interaction with the world. For example,

'Spain is too hot in August, it spoilt my holiday last year.'

However, a proportion of such knowledge is not the result of direct experience but of a second-hand or nature. This can be the result of a second persons experience. For example an individual might remark,

'Spain is too hot in August my brother went last year and told me.'

More usually the actual experience that produced this second-hand knowledge has been lost in time, The knowledge is carried forward in a taken-for-granted, common sense way that everybody-knows,

'Spain is too hot in August.'

The knowledge is known to the individual and each member of the individuals culture or mini-culture but the source of the knowledge is unknown. The individual thus receives this knowledge indirectly by virtue of being a member of a particular culture. Indirect knowledge is known by all members of a given culture, thus has a social aspect and is, therefore, a 'cultural tool' available for all individual members to interpret given situations.

The 'meaning' an individual brings to a given situation can be classified as being composed of a direct element (subjective experience) and an indirect element (inter-subjective experience). For knowledge acquisition purposes, the elicitation of a part of the 'meaning' an individual brings 'tacitly' to interpret a given situation now seems possible.

Although it would be impossible to elicit the total tacit knowledge each expert brings to a given situation, the indirect tacit knowledge, being available to all members of the expert community, is social in nature and thus, amenable to sociological investigation.

There are also some philosophical considerations which indicate this thesis should the importance of explicating indirect tacit knowledge. These will now be discussed.

5.3.2 Philosophical Considerations

In order to illustrate the nature of domain specific tacit knowledge it is necessary to briefly discuss certain philosophical considerations. The nature of explicit rules of social institutions are first discussed, in order to inform the discussion of the nature of the tacit knowledge of social institutions (for example, expert domains).

5.3.2.1   Explicit Rules

Winch (1958) contends that the study of human society is fundamentally different than the study of the natural world and thus requires different methods of investigation. Winch (1958) uses Wittgenstein's (1953) notion of *'following a rule'* to show the relation between thought and reality. Winch (1958) will be extensively quoted in this section, due to his elegant and extremely economic style. Winch (1958) notes that,

> *'[T]he notion of following a rule is logically inseparable from the notion of making a mistake.' (his emphasis page 32).*

One can only be said to be following a rule if it is possible to tell when one has transgressed the rule. This seems at first contradictory, however, if it is not possible to break a rule (even theoretical) then all actions are possible, in such a situation no rule can exist. Furthermore,

> *'[T]he point of the concept of a rule is that it should enable us to evaluate what is being done.' (his italics page 32).*

For an individual to follow a rule there must be external checks on his her actions. Such external checks require that the rule be publicly accessible. Therefore, Firstly, one can be said to be following a rule if it can be broken; secondly, evaluation of whether a rule has been broken requires the rule to be publicly accessible.

In order to examine what is meant by 'following a rule' Winch (1958) draws the distinction between learning and copying. For an individual to learn a rule requires more than the ability to simply copy what one has seen, but also the ability to apply a criterion in *'what counts as the same way'*. For example, to learn the rule governing the series 2,4,6,8 will allow the pupil to carry on in a different manner in what counts as the same way, i.e. by learning the rule governing the series 2,4,6,8 would allow one to write *10,12,14* etc. Whereas to copy a rule would only allow the one to write 2,4,6,8. Winch (1958) notes,

> *'In one sense, that is, it involves doing something **different from** what one was originally shown; but in **relation to the rule** that is being followed, this counts as 'going on in the same way' as one was shown.'* (his emphasis page 59).

Therefore, before one can evaluate whether a rule has been followed or broken, one must be able to identify what counts as 'going on in the same way' or what Winch (1958) refers to as *'rules of sameness'*. However, rules of sameness can be problematic, to use the above example, if asked to complete the series 2,4,6,8, one could answer *10,12,14,16*. However, it would be just as acceptable for an Englishman (but not a person from China) to follow the rule 2,4,6,8, by the words 'who do we appreciate'.

5.3.2.2   Tacit 'Rules'

Rules of sameness are problematic due to the possibility of cultural diversity. This problem is compounded in the case of social institutions of which expert domains can be considered. Such institutions tend to take on the characteristics of mini-cultures (see Collins (1987)) and the rules of sameness for one mini-culture might differ from the rules of sameness of other mini-cultures within the same overall culture. Winch (1958) notes,

'Criteria of identity are necessarily relative to some rule: with the corollary that two events which count as qualitatively similar from the point of view of one rule would count as different from the point of view of another.'

Winch (1958) uses the parable of the Pharisee and the Tax Collector (Luke 18, 9) to illustrate how the rules of sameness of an observer, researching a social institution and the rules of sameness of the members of the social institution might differ.

The Parable of the Pharisee and the Tax Collector

'To some who were confident of their own righteousness and looked down on everybody else, Jesus told this parable:

"Two men went up to the temple to pray, one a Pharisee and the other a tax collector. The Pharisee stood up and prayed about himself: 'God, I thank you that I am not like all other men-robbers, evildoers, adulterers-or even like this tax collector. I fast twice a week and give a tenth of all I get.'

"But the tax collector stood at a distance. He would not even look up to heaven, but beat his breast and said, 'God have mercy on me a sinner.'

A researcher who understood little of the social institution of Christianity would conclude that both men were acting in 'what counts as the same way' by obeying the rules of their religion and praying to God. However, a Christian with a deep understanding of the rules of sameness of the Christian religion would contend that these men were most certainly **not** acting in 'what counts as the same way' but were performing very different acts. The difference between the pharisee's and the tax

collector's actions for Christians is confirmed in the next verse,

"I tell you that this man (the tax collector), rather than the other, went home justified before God. For everyone who exalts himself will be humbled, and he who humbles himself will be exalted. "

This verse will be of tremendous significance to the member of the Christian social institution but incomprehensible to the non-member who observes the action

In the Christian religion the fact that the two men are praying in not enough to say that they are 'going on in the same way' and doing the same thing. It is the attitude of the men when praying which defines whether the rules of sameness are being followed or transgressed.

In order to informally test the above several scientists and Christians were read the parable and asked if the pharisee and the tax collector were 'acting in what counts as the same way'? Both groups thought that the answer was so obvious that it did not constitute a serious question. The scientists were all convinced the two men were doing the same thing, and could not be convinced other. While Christians found the question disconcerting, for them it was unimaginable for anybody to believe the pharisee and the tax collector were doing the same thing.

The above illustrates that members of a social institution can be engaged in very different activities, which to the outsider appear to be the same. Where social institutions are concerned the knowledge engineer can not assume that members are involved in the same activity, just because it seems so to him (an outsider).

The above posits a fine question: if the observer and the observed disagree over the rules of sameness, who shall be the arbitrator? This is the crux of the Winch (1958) critique, which points out that scientific methods are not appropriate for the

investigation of the social world for the following reasons:-

*   In a scientific investigation it is the observer (the scientist) who decides whether rules of sameness have been adhered to or contravened.

*   In an investigation into a social institution the observer is not in a position to decide rules of sameness, it is the member of the social institution who decides whether rules of sameness have been adhered to or contravened.

Therefore, observation alone can not provide an adequate understanding of a social institution. Rules of sameness as stated above must be publicly accessible. What constitutes 'acting in what counts as the same way' can only be judged by the members of the social institution in question. Such knowledge is therefore, sociological, and inter-subjectively held by members of a social institution. It is legitimate for practical and philosophical reasons for this thesis to concentrate upon the explication of indirect tacit knowledge.

5.3.3 Advantages of Investigating Indirect Tacit Knowledge

Investigating the indirect tacit knowledge has the following advantages,

1)   It is amenable to sociological investigation, therefore, overcoming problems of investigating tacit knowledge at the level of the individual (i.e. idiosyncratic, often contradictory personal histories.

2)   It is public knowledge, (open to all members of the mini culture) therefore, open to testing by 'rules of sameness'

3)   Indirect tacit knowledge of a mini-culture acts as a sieve, to filter out the non-domain tacit knowledge of the individual. Only items that are indirectly

known by members of the mini-culture need be investigated, other tacit knowledge can be considered idiosyncratic and pertaining to the individuals particular history.

5.4 Focus of the Thesis

In Chapter Four it was a wider definition of knowledge was proposed to include the subjective and inter-subjective meaning by which individuals and organizations tacitly interpret the world. As such this is a very large topic therefore, the scope of the thesis is delimited in Chapter Five. Computerized knowledge acquisition technologies were briefly discussed in order to overcome the knowledge acquisition 'bottle-neck'. These methods were found to be able to 'handle' tacit knowledge but offer little understanding of tacit knowledge. It was contended that the notion of 'double-loop' learning (Argyris and Schon 1978) make the explication of tacit knowledge essential. This has the consequence of eliminating computerized knowledge acquisition technologies (which 'handle' but do not explicate tacit knowledge) from further consideration in the research design.

In order to sharpen the focus of the thesis, a distinction was drawn between 'direct tacit knowledge' and 'indirect tacit knowledge' and for philosophical and practical reasons it was found to be both legitimate and pragmatic to focus the thesis upon the acquisition of 'indirect tacit knowledge'.

The scope of this research is therefore, reduced to the explication of indirect tacit knowledge

CHAPTER 6

The Importance of Tacit Knowledge

6   Importance of Tacit Knowledge

The importance of eliciting tacit knowledge is graphically illustrated by the following conversation the researcher had with community midwife.

Although this is not a verbatim account, the conversation is transcribed as if it was, in an attempt to retain some of the character of the conversation.

MW1A3:	Oh what a day I've had. I've been running around all day making calls on my ladies. Do you know what ? I had to visit seven of them, six on Hillside' [A large 'problem' estate notorious for crime and drug abuse] and guess where the other one was ? Parkside Road. [the local 'millionaires row'].
Researcher:	That's a bit of a difference.
MW1A3:	I know, but do you know what ? I spent longer at Parkside Road than I did at the other six put together, it was awful.
Researcher:	I told you the middle class always get more out of the Health Service.
MW1A3:	Oh shut up, this was different.
Researcher:	Why? You would think that the mob on Hillside would need your care much more than her on Parkside Road. I'm sure that she is eating enough green leaf vegetables. [this is a reference to a joke about dietary advice to pregnant women]. Why was it awful?
MW1A3:	Well there I was perched on the end of this huge sofa balancing a cup and saucer making polite conversation. I noticed the way I was talking changed, it was very hard, you know I try to treat all my ladies the same.
Researcher:	Well what was the difference on Hillside ?
MW1A3:	Oh well you just go in and say 'hiya, how are you getting on' and you feel at home right away. You just sit down and start

chatting.

For instance they [the ladies from Hillside] never ask you if you want a cup of tea. They know me and if I want one I just get up and put the kettle on. Well you don't do that in every house, you pick the ones that you know are quite clean, some houses you would never have a drink in.

Researcher: Yet you felt they were OK despite their problems and the woman at Parkside Road needed help.

MW1A3:   I never worry about a 'roughy'. I always know that they will be alright no matter what. If you ask them, as they leave hospital with their baby, 'do you have any backup at home ? Is there any one at home to help you with the baby or have they been able to get everything the baby needs?' No matter what they say you just know that they will be alright, when I go to visit them they are always OK.

It's that they are such social people. You know, if you get a couple of middle class women in the hospital, they sit in there on their own and mind their own business. After a couple of days they might nod to each other but in general they just look after their babies until they can get out.

You get two roughies on the ward, after about ten minutes they are walking down the ward arm in arm like life long friends. Probably going to the day room for a fag, but never mind [there are tremendous moral pressures placed on pregnant women in hospitals not to smoke]. When you go and see the girl on Hillside, who says she has no backup, you will find that far from being isolated her house is full. Not the best environment for a baby, lay in a room with four or five adults smoking like chimneys and the gas fire on full belt, but the girl gets lots of support from her neighbors.

That girl on Parkside Road had all the material advantages that money could buy, but she was totally isolated. Her husband has a high powered job which takes up most of his time. Her mother lives somewhere down South and her mother-in-law is a headmistress and can give her little time. I can see I'm going to have a lot of problems with her. But what can you do ?

Analysis of the Conversation

Clearly MW1A3 sees social support of the mother to be of vital importance to both the mother and baby. The poverty stricken smoke filled room on Hillside appears to be preferable to the luxurious mansion on Parkside Road as far as the midwife is concerned, despite conventional knowledge to the contrary. However, it should be noted that in such conversations tacit knowledge **does** emerge. Therefore, at least some of it can be made explicit, the question is how ?

The conversation above illustrates,

*   Tacit knowledge can emerge in a recognizable form.

*   Tacit knowledge is important and often takes precedence over formal domain knowledge.

*   Tacit knowledge is not amenable to traditional knowledge acquisition techniques.

The same conversation will be analyzed in Chapter 14 to demonstrate how tacit knowledge can be explicated in a form that is useful for both building and using a KIS.

6.1   Instrumental Aspects of Information

It must be noted that information in general, and tacitly held information in particular has the potential to be used in an instrumental way, i.e. rather than an exchange of information a method of eliciting specific behavior from the respondent of the information. Land for example, points to the instrumental effect of propaganda. A sensitive reader will observe many instances of instrumental information from the

evidence of the fieldwork. The author points to Appendix VI, concerning fetal monitoring, in which the fetal monitor has the manifest function of providing the doctors with a continuous stream of information about the stress level of the fetus. However, the use of the fetal monitor has a latent function which has an instrumental effect upon the mums. Amongst other things by 'strapping down', (this is a midwives' term for the procedure) a mother-to-be with a fetal monitor, she receives the following information,

1)   She is receiving constant care. They are comforted by the regular 'bleep' of the machine.

2)   She is important enough to require hi-tech machinery.

2)   She is really in labour and the birth will take place shortly.

As will be shown later the staff use fetal monitoring for very different (and often non-medical) reasons. A less sinister form of instrumental information occurred when the researcher asked a midwife the purpose of asking the sex of babies from previous pregnancies. The midwife replied that there was no real medical reason for the question, they just felt it was a 'nice' question to ask,

> *'If, say she has had a boy, you can say "are you hoping for a girl this time?'*

Given the importance of eliciting tacit knowledge the following chapter discusses how tacit knowledge can be explicated in a more systematic way.

CHAPTER 7

Research Question

7 Research Question

On the basis of the above it seems prudent to focus the target of the investigation down to the following research question.

> **'Is there a method whereby at least some tacit knowledge can be explicated for:**
>
> **a)**   **building the knowledge base**
>
> **b)**   **more accurately predicting or planning for its usage and for setting expectations'**

In order to answer the question the following tasks will be undertaken.

7.1 Tasks

7.2 An Investigation of How Authors in Different Disciplines Have Viewed 'Tacit Knowledge'

Before undertaking any research project it is prudent to gain an understanding of what other writers have to say on the subject, by conducting a thorough literature search. This is necessary in order to prevent redundant research, 're-inventing the wheel'. More importantly it allows the research to benefit from the thoughts of authors of high repute and their critics. This is important in that it forces the researcher to address the strengths and weakness's of the basic assumptions of the research stance. A knowledge of these assumptions and their limits is essential in constructing a strong foundation for the research to be built upon.

A literature search also allows work from other academic disciplines, in this case

Philosophy, Sociology, Information Systems. to be considered and applied to knowledge acquisition. Investigating the topic 'tacit knowledge' from the perspective of other disciplines has the potential for allowing a deeper more rounded understanding of 'tacit knowledge' to be formulated.

7.3 Ascertain the Character of 'Tacit Knowledge'

Based upon the deeper understanding of 'tacit knowledge' formulated above a definition of its character for the purposes of this research must be developed before investigations can proceed. Such an understanding and definition are particularly important due to the nebulous nature of 'tacit knowledge'.

7.4 Ascertain the Mechanism by Which 'Tacit Knowledge' Is Constructed and Maintained

It is essential that the mechanism by which 'tacit knowledge' arises/is constructed, is maintained and transformed in the natural course of events is 'located' (by located this research means the site of 'tacit knowledge' is discovered, identified and delimitated as if it was a 'real phenomenon. (N.B. this is not an attempt to reify the phenomenon). The location of 'tacit knowledge' must be found because its site will effect the choice of methodology.

7.5 Ascertain How 'Tacit Knowledge' Can Be Made Explicit

In order to answer the 'research question', it is important not only to gain an in-depth understanding of 'tacit knowledge' and its effects, but to explore the ways of in which tacit knowledge can be made explicit, in a form useful to KIS design. It will be useful to reassess how others have attempted to make 'tacit knowledge' explicit for their own purposes and the usefulness of these methods be appraised in answering the

research question. This appraisal will then be tested under real world conditions.

Although the question has been broken into 4 discreet tasks, it is expected that there will be a considerable overlap between tasks. It must also be noted that there will also be a that there will also be a considerable overlap in temporal sequence.

7.6   Contribution to Knowledge

This research aims to make a contribution in the following ways:

1)   Recognition that similar problems afflict knowledge acquisition for the knowledge base and the use/interpretation of the system.

2)   Widen the definition of 'knowledge' (for the purposes of knowledge acquisition) to include the part of the subjective aspect that an individual brings to a situation.

3)   To aid knowledge elicitation of 'tacit knowledge' for KIS. This research will test the feasibility of such and undertaking.

4)   Test the utility of applying existing techniques to a new domain.

5)   The use of sociological methods and their philosophical underpinnings will allow the inclusion of new sources such as:- informal occupational working practices, 'war stories', joke analysis etc.

6)   To improve and clarify an understanding of tacit knowledge.

7)   The research seeks to find new insights into a particular expert occupational culture.   This will enable the building of KIS that *'fit'* the way experts

actually work. The notion of 'fit' is of great commercial importance in that computerized systems that can only be made to operate at the cost of radical changes to existing working practices are likely to be resisted and fail.

8)   A sociological investigation into various expert occupational cultures will add to the existing body of sociological knowledge in this area.

CHAPTER 8

Research Methods

8   Research Methods

8.1   Introduction

Before a research design can be formulated a research method must first be chosen. This chapter outlines at various methods of knowledge collection and assesses their usefulness for the purposes of the elicitation of tacit knowledge. This chapter is covered at considerable length for two reasons,

1)   to show why many of the existing techniques are inappropriate for the elicitation of tacit knowledge.

2)   to garner aspects from existing techniques which might prove useful in developing new methods for the elicitation of tacit knowledge.

Outline of the Chapter

The chapter first considers traditional research methods in general and concludes that these methods are inappropriate, because they systematically exclude subjectivity and inter-subjectivity, the very areas in which tacit knowledge is to be found.

Various knowledge elicitation techniques are then discussed in order to assess their applicability to the explication of tacit knowledge. Techniques which involve interviews with, and direct questioning of, experts are found to be inherently problematic for the elicitation of tacit knowledge.

Knowledge elicitation techniques which do not directly question experts such as, critical incident technique (CIT) and protocol analysis, are then discussed and found unsuitable for the elicitation of tacit knowledge. N.B. Computerized knowledge

acquisition technologies were deemed inappropriate for the purposes of this thesis in Chapter Five.

Objective research methods and traditional knowledge acquisition methods are found unsuitable for the elicitation of tacit knowledge. Therefore, the search is extended into other domains which might have already developed methods for the task.

Collins (1987) contends that sociologists and knowledge engineers share a topic, the explication of cultural knowledge. Collins advocates the use of sociological methods especially participant observation. Sociological methods such as Grounded Theory and Garfinkel's Disruption of Social Order are discussed. Both methods are found to be capable of eliciting tacit knowledge, but Grounded Theory is extremely labour intensive and the Disruption of Social Order too confrontational for the purposes of knowledge acquisition.

The chapter is then summarized and recommendations are made as to the most appropriate method to discover/modify future methods capable of eliciting tacit knowledge within realistic constraints.

8.2   Analysis of General Research Methods

Churchman (1971) regards epistemology as 'systems of inquiry'. He notes that epistemologies differ not only in how they investigate the world, but also what is considered information. Different epistemologies produce different understandings of the situation. It is therefore, necessary to first ascertain the type of understanding required before choosing the most appropriate method of producing such an understanding. This, as will be shown in below, is problematic when attempting to gain an understanding of indirect tacit knowledge. It is therefore, pertinent to discuss different methodologies and the different types of understandings each produces, in order to choose the most appropriate for the understanding of tacit knowledge.

There are many methods of gaining an understanding of the world, however, the following scheme seems both uncontentious and fruitful:- (Cuff & Payne 1981)

(1)...PHILOSOPHICAL UNDERSTANDING.

(2)...MATHEMATICAL UNDERSTANDING.

(3)...NATURAL SCIENTIFIC UNDERSTANDING.

(4)...HUMAN SCIENTIFIC UNDERSTANDING.

(5)...LITERATURE OR AESTHETIC UNDERSTANDING. (*)[5]

8.2.1 Philosophical Understanding

A philosophical understanding seeks to uncover the underlying assumptions of different epistemologies. A philosophical understanding of the type of understanding, an investigation is trying to acquire, should indicate the most appropriate method for its collection. e.g. if the type of understanding required is 'scientific' then scientific methods are appropriate. Therefore, it will be fruitful to conduct a philosophical analysis of the various types of research methods in order to assess their appropriateness for the elicitation of tacit knowledge.

(*)Although this area is recognized as extremely important it is also extremely problematic and exceeds the scope of this research. Many insights into this area will be uncovered in the methods advocated below, it is therefore proposed that this type of understanding be 'BRACKETED' off from this research and laid aside for future investigation.

A philosophical understanding of the other categories of knowledge would be:-

8.2.2 Mathematical Understanding

Mathematical understanding is based upon *'axioms'* and *'rules of deductive logic'* which are used to both construct and verify mathematical statements. Mathematical understanding is purely abstract and thus can be 'bracketed' from the contamination of the real world. This accounts for the success of translating mathematical formula into code and the resulting powerful mathematical software.

The abstract nature of a mathematical understanding eliminates the subjective as well as the objective world. It is therefore, inappropriate to use mathematical methods to elicit tacit knowledge. This type of understanding is the type required by the formal deductive systems which Churchman (1971) refers to as *Leibnitzian IS*.

8.2.3 Natural Scientific Understanding

Natural (hard) scientific understanding is based upon the assumption that:

1)   *'all statements must be capable of empirical verification'*

2)   *'statements must be expressed in clear logical procedures to enable verification by replication'.*

The above does not seem to take into account the notion of falsification, which is most notably argued by Popper (1968). Popper argues, science advances by rigorous testing of theory through observation and experiment. Theories that are 'falsified' are rejected and theories that are 'not falsified' are held to be provisionally stand. Chalmers (1994) notes,

'Only the fittest theories survive. While it can never be legitimately said of a theory that it is true, it can hopefully be said that it is the best available, that it is better than anything that has come before.'
(Page 38)

However, for a theory to be capable of falsification it must satisfy the two criteria stated above. Statements must be unambiguous and in a form capable of being proven true or false (criteria two). The veracity of the statement must be tested by observation or experiment (criteria one). Therefore, if a theory cannot satisfy the two above criteria it cannot be tested by falsification, and therefore, can not achieve the status of being scientific.

If a statement is to be tested by falsification, many attempts must be made to replicate empirical verification of statements. The important distinction of the falsification is that a replication does not provide proof (although it lends support to a theory) whereas failure to replicate falsifies the theory under examination.

Natural science is not purely abstract and is therefore, much more difficult than mathematics to encode. Scientific methods attempt to systematically eliminate 'subjective beliefs' and leave only 'objective facts'. Science is interested in how the world 'actually' functions ('hidden machinery') rather than how individuals or groups believe the world functions ('the world of appearances'). This is an important point which will be referred to later, it can be illustrated by the following example,

The 'layman' might be content to observe the sweep of the Sun across the sky, conclude that the Sun orbits the Earth, and order his/her life accordingly. Science on the other hand interested in an objective explanation of how the world actually functions rather than how individuals believe it functions. A scientific explanation of the phenomenon has concluded that the Earth actually orbits the Sun, the subjective beliefs of individuals are erroneous and can thus be ignored.

Therefore, although scientific understanding is about the 'real world' it is only concerned with a part of the world which is 'bracketed off' in a *'closed system'*. The practice of Science is sometimes referred to as a dynamic 'open system' in that nothing is simply accepted as dogma, any and all of its assumptions are open to continuous investigation. However, science can be considered a closed system because statements not capable of empirical verification including falsification are systematically excluded from the scientific ontology (see Figure 8.1).

The 'Closed System' of Science.

Non Scientific Ontology

Statements Not Capable of
Empirical Verification

Scientific Ontology

Statements
Capable of
Empirical
Verification
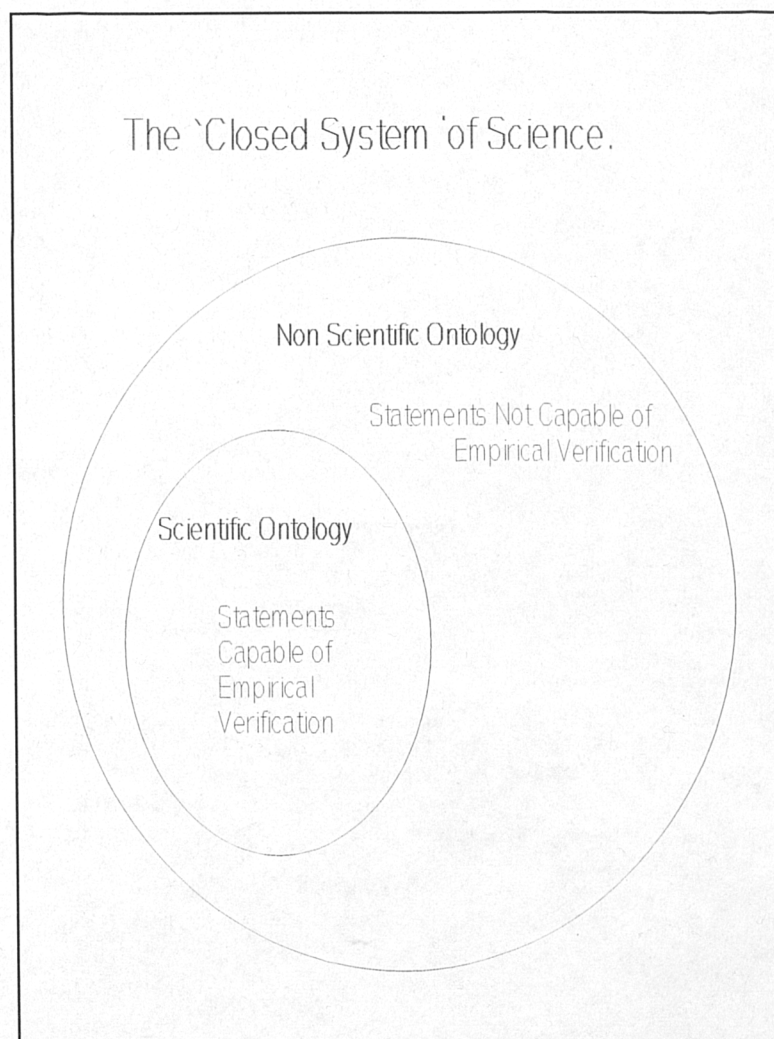
Figure 8.1   The Closed System of Science

Statements not capable of empirical verification include:- Social Science (Popper 1960), Beliefs, Ethics, Religion, Aesthetics, Emotions, etc. Science is closed system in that anything not amenable to scientific methods is quite correctly ignored. The systematic elimination of subjectivity significantly simplifies the task of knowledge acquisition. However, by eliminating subjectivity, scientific methods systematically eliminate the area where tacit knowledge is expected to be found. Thus, scientific methods are inappropriate for the elicitation of tacit knowledge.

8.2.4 Human Scientific Understanding

Social science due to the subjectivity of its topic can study either 'hidden machineries' or the 'world of appearances' of the social world. Traditionally social science has sought to investigate the objective forces (hidden machineries) that govern the social world, but increasingly it has been forced to take into account the subjectivity and inter-subjectivity of its topic. Certain branches of social science such as anthropology and interpretivist sociology are (to use the above example) concerned with the fact that, because individuals believe the Sun orbits the Earth, they order their lives in a particular way. The epistemological status of the belief is of little importance, social scientists of this kind are interested in how people order their lives. Techniques such as ontological neutrality have been developed to enable such research.

This has lead to a vigorous debate as to the correct topic of the social sciences. If the correct topic is the 'hidden machineries' that regulate social life a natural scientific understanding and methodology will be required. If the correct topic is the 'world of appearances' then an alternative is required, for the 'world of appearances' falls outside the scientific bracket.

8.2.5 Summary of General Research Methods

Different epistemologies produce different types of knowledge (Churchman (1971)). The philosophical analysis of the different epistemologies indicates that, mathematical and natural scientific methods are inappropriate for the elicitation of tacit knowledge. Human scientific understandings that attempt to gain an understanding of the objective 'hidden machinery' of the social world likewise seen in appropriate for the elicitation of tacit knowledge. Only methods for gaining a human scientific understanding of the 'world of appearances' appears to be fruitful for investigating tacit knowledge.

Knowledge Acquisition has developed a considerable number of methods. These will now be assessed using the above philosophical understanding for their suitability for the explication of tacit knowledge.

8.3   Existing Approaches to Knowledge Acquisition

There are many methods of knowledge elicitation, however, many of these are founded on the basic scientific assumptions. Therefore, instead of discussing each technique individually, it is proposed that knowledge elicitation techniques which attempt to elicit objective domain knowledge are dealt with at a higher level of abstraction i.e. the philosophical basis of this group of techniques

8.3.1 Tacit Knowledge is Subjective not Objective

Science seeks to understand the world by the use of 'scientific methods', which systematically eliminate subjectivity and inter-subjectivity in order to reveal objective knowledge. Tacit knowledge is by nature subjectively or inter-subjectively held. It stands to reason that any attempt to elicit tacit knowledge using scientific methods is misbegotten, in that such methods would systematically eliminate the knowledge that

the researcher was trying to capture.

It could be argued that if tacit knowledge exists, it must have an objective existence and (although problematic for empirical research) must be amenable to investigation by scientific methods. An analogue might be the discovery of fundamental particles in physics. This analogy will be briefly outlined, for although the analogy does not hold, the method by which physicists investigate fundamental particles is useful for the purposes of this research.

Quantum theory postulates that the nucleus of the atom is composed of elementary particles. Physicists conducted experiments to try to prove the existence of the elementary particles even though they are (or expected to be) one million times smaller than the smallest item that can be observed under the most powerful microscope. In order to investigate such small particles a huge 'bubble chamber' was constructed and bombarded with a stream of neutrons. When a neutron happens to 'hit' an atom in the bubble chamber at the correct angle a tiny spark is emitted, which is amplified using computers until it can be seen by the human eye.

The analogy of tacit knowledge with fundamental particles is inappropriate, for although, it is not possible to observe fundamental particles (or will be in the near future) physicists will never the less claim that they have an objective existence. The same cannot be said of tacit knowledge, which cannot exist outside the subjective thought processes of individuals. It is therefore, difficult to imagine how the investigation of tacit knowledge can satisfy the two criteria necessary for the production of a natural scientific understanding (see 8.2.3). The problematic nature of investigating thought process, is noted by Minsky (1986),

> *'Many modern scientists think it quaint to talk about "mental states."*
> *They feel that this idea is too "subjective" to be scientific, and they*
> *prefer to base their theories of psychology on ideas about information*

processing.' (page 84).

To return to the 'bubble chamber' experiment, although the fundamental particles can not be observed it is possible to observe the effect of the particles (hitting atoms in the bubble chamber). The same is true of tacit knowledge, in that although tacit knowledge cannot be directly observed the effect of tacit knowledge can be traced using empirical techniques and will be in the field work of the thesis.

Knowledge elicitation of tacit knowledge, therefore, requires a radical shift from objective methods of knowledge elicitation [6].

Such a shift is extremely difficult but necessary, Eilon (1974) notes when discussing management science'

> *'[O]ne finds that many researchers are committed to a particular school of thought or methodology, either because it has affinity with the academic discipline from which they have originally come, or because of a combination of habit and conviction.*

Habits, even habits of research methods are difficult to break, however, Eilon (1974) maintains that in management science failure to do so will have,

> *[I]mplications for the ability to generalize and advance our knowledge in the field of management science. (p.9)*

It must be noted that not all knowledge elicitation concentrate on obtaining objective knowledge, although most would claim to be objective. The terms objective and

---

[6] This is not to say that objective methods cannot produce good results, simply in the express area of tacit knowledge they are inappropriate.

objectivity have entered the language in such a way they have a lay and a technical definition. The term objective has become synonymous with 'truth' and conversely subjective synonymous with 'speculation'. The terms objective and subjective will be used extensively throughout this research, in all cases (unless indicated otherwise) they will be used in accordance to their technical definitions, which for the purposes of this research will be,

Definition of Subjective

'A view is said to be subjectivist if it maintains that the truth of some class of statements depends on the mental state of reactions of the person making the statement. Thus in ethics and aesthetics a subjectivist will hold that to say something is good or beautiful is to say something about one's reaction to something, perhaps that it gives one a special feeling of pleasure, and not to say anything about the "objective" characteristics of the thing.'

Urmson & Ree (1991) page 311.

Definition of Objective

Objective. a. Proceeding from the object of knowledge or thought as dist. from the perceiving or thinking subject; external, actual, real, self-existent, substantive; pertaining to or concerned with outward things as dist. from thoughts or feelings

New English Dictionary 1932 (page 786)

Knowledge acquisition methods that do not concentrate on obtaining objective domain knowledge, will now be discussed in order to assess their appropriateness for the elicitation of tacit knowledge.

8.3.2 Knowledge Acquisition Techniques Which Do Not Concentrate on Objective Knowledge

There are many established knowledge elicitation techniques that do not concentrate on obtaining objective domain knowledge.

8.3.2.1   Interviews with Experts

Perhaps the most generic form of knowledge elicitation takes the form of interviewing experts. Interviews have been the topic of much research (see Wicks (1984), stages of interviews, Wielinga & Breuker (1984) weakness's of interviews, Hart (1989) how to get the most out of interviews), however, although much information can be garnered from such interviews, they present two major problems for the elicitation of tacit knowledge.

8.3.2.1.1   Shared Penetrable Horizons

The problem of shared penetrable horizons was first noted in the fieldwork when trying to assess the thought processes that had gone into designing the GIT maternity system (see Chapter 11). Shared penetrable horizons can be used as a tool of knowledge acquisition, it is also potential 'trap' which can result in skewing the elicitation in a particular way. It is therefore, worth briefly describing the process.

When an expert is interviewed by a knowledge engineer, each is an expert in their own domain, therefore, members of what Collins (1987) refers to as different mini-cultures. These mini-cultures are not incommensurable, Schutz (1967) notes *inter alia* the life-world is composed of 'fields of interest' each of which have their 'centres of density' and 'open inter-penetrable horizons' (see figure 8.2). It is at these horizons that the expert and the engineer begin to communicate. As the expert and

the engineer understand more about each others domain, the penetrable horizons
expand towards the core of each others domain.

Shared Penetrable Horizons

Expert's
Knowledge

Engineer's
Knowledge
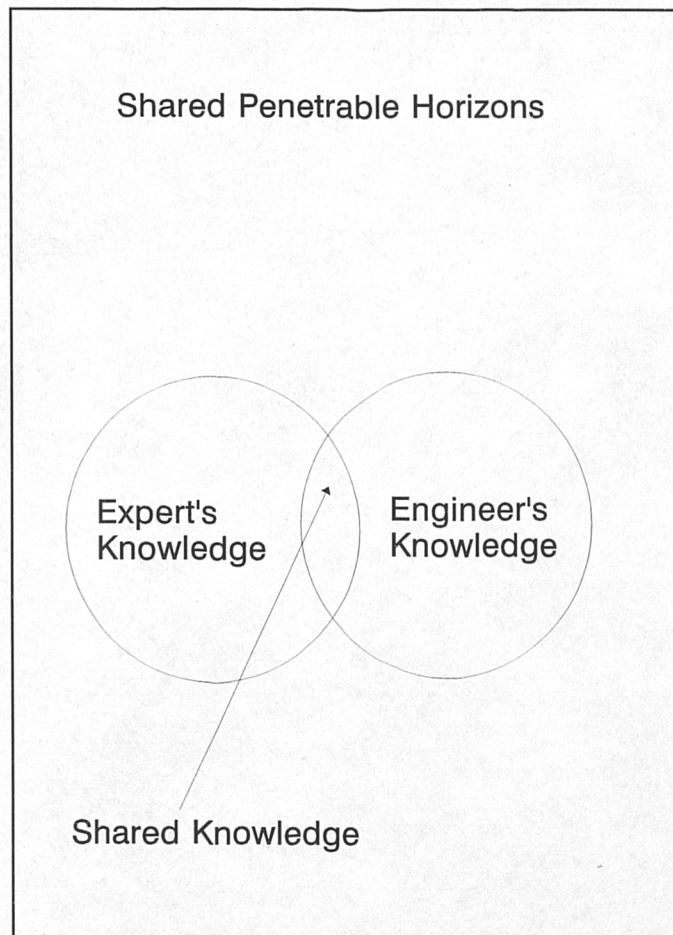
Shared Knowledge

Figure 8.2   Shared Penetrable Horizons

8.3.2.1.1.1   Consequences for the Elicitation of Tacit Knowledge

This phenomenon presents a problem for the elicitation of tacit knowledge. When
two experts of different domains discuss a subject, a negotiation occurs until a
common discourse emerges. This discourse usually takes place at a higher level of

abstraction than domain discourse, e.g. an accountant and an engineer can converse in terms of the basic assumptions of science (objective facts, rules, etc.) and mathematical reasoning. Both engineering and accountancy are extremely different domains but both share common assumptions.

While this is extremely useful for inter-disciplinary discourse it is problematic for knowledge elicitation of tacit knowledge. If interviews between experts and engineers take place at a higher level of abstraction the knowledge elicited will tend to be more formal domain level. In fact, if a discourse is entered into with scientific assumptions and mathematical reasoning it is difficult to imagine how topics external to the formal domain knowledge can be discussed.

The medicine discipline (a topic pertinent to this research) is an example which will illustrate this point. Medicine is considered a scientific subject (comparable to applied biology), however, the practice of medicine has a very important non-scientific aspect which is often tacitly held. Byrne and Long (1976) recorded 2500 consultations with G.P.s and concluded that approximately 75% of the interviews were 'doctor centred'. The doctor would ask a series of closed questions about the patients symptoms (e.g. 'When did you last move your bowels ?' 'Did you experience any pain ?' etc.) and in some cases physically examine the patient prior to diagnosis. If a doctor was asked by a knowledge engineer, (a non-doctor) how s/he diagnosed a particular illness s/he would be likely to reiterate the above consultation.

This could be encoded,

> e.g. IF the patient has not moved their bowels for 3 days and when they did it was painful THEN illness Z.

The code could later be checked by the doctor for verification. The code would be found to be correct because it corresponded to medical knowledge. However, in practice the process of diagnosis is much more complex.

8.3.2.1.1.2   Medical Knowledge & Clinical Experience

A doctors diagnosis is the result of a combination of *medical knowledge* (formal knowledge) and his/her *clinical experience* (experiential knowledge). The importance of clinical experience in the training of doctors has been well documented. Foucault (1973) dates the beginning of modern medicine to the creation of the 'clinic' at the beginning of the 18th Century. The clinic allowed the systematic, large scale, studying and teaching of disease. The clinic witnessed the emergence of the clinician at the bedside of the patient. Dingwall and Heath (1977) note,

> *'The clinic emerged when it became possible to treat the individual as a field of investigation, and that space by the patient's bedside, therefore, became the locus of medical inquiry and research, as well as treatment and instruction.'*   *(page 86)*

From this point, a key component of the transmission of medical knowledge occurs at the bedside. Jamous and Peloille (1970) note although medicine has undergone considerable structural changes, the 'real work' of a doctor is taught by the bedside by an apprenticeship system. A doctor becomes a competent practitioner not in a library or laboratory (though each of these have their place) but at the bedside where they receive first hand, what Becker, Geer and Strauss (1961) refer to as 'clinical experience' treating patients.

Becker, Geer and Strauss (1961) point out that there often occurs a conflict between 'clinical experience' and theoretical or scientific knowledge. Where such a conflict

occurs 'clinical experience' almost always predominates. Dingwall and Heath (1977) note,

> *'These authors go on to comment that "argument from experience was quite commonly used and considered unanswerable'. Such unanswerable experience is gained in the context of clinical instruction - which is itself unquestionable.' (page 88).*

Therefore, although doctors appear to make diagnosis using objective formal scientific knowledge, they are also diagnosing by tacit use of their 'clinical experience. It is important to note the high status of clinical experience *vis a vis* medical knowledge.

8.3.2.1.2 Problem for Knowledge Elicitation

It is relatively easy for a knowledge engineer to communicate with the expert at the penetrable horizons of their respective domains. This is a natural tendency in inter-domain communication, however, if, for example this happens between a doctor and an knowledge engineer, they will have long discussions of cause and effect (often at a complex level) about the medical knowledge of the doctor. This can be advantage (it eliminates much of the confusing detail) if the aim is to elicit objective domain knowledge. However, the aim of the interview is to gain an understanding of the process of diagnosis, large areas of important knowledge such as 'clinical experience' will remain 'invisible'.

The explication of tacit knowledge requires methods capable of penetrating deep into the centres of density of the experts field of interest.

8.3.3 Problems of Asking Questions

Many knowledge elicitation techniques revolve around asking questions, of various types (this includes questionnaires etc). However, the nature of tacit knowledge makes its explication through questioning problematic. As Polanyi (1966) notes that although we 'attend from' proximal terms, if we concentrate on (attend to) these terms they lose their meaning. Tacit knowledge is not normally consciously referred to by individuals, it remains unexamined and unexplained.

If an engineer directly questions a respondent about a specific area of tacit knowledge, in order to reply the respondent must first consciously examine that knowledge. Once explicitly examined the tacit knowledge changes in character.

8.3.3.1   Tacit knowledge made Explicit Becomes Qualified

To illustrate how tacit knowledge changes in character when consciously examined, the following example will be used. An individual could at an unexamined and unexplained level believe that 'all people with red hair are short tempered' and order his life accordingly. However, if asked the question 'Do all people with red hair have a short temper?' They are forced to examine this belief, once this occurs they can think of many cases where this is not true e.g. a) their next door neighbor, b) people who dye their hair red, c) their aunt who was always kind to them etc. Instead of replying,

> *'Yes all people with red hair are short tempered.'*

They are more likely to reply,

> *'Yes, people with red hair often have a short temper, except my next door neighbor, or if they dye their hair or are my kindly aunt.*

The tacitly held assumptions are thus changed simply by making them known to the respondent. This experience changes the character of the proximal term, once examined it can no longer remain viable without the being qualified with a series of exemptions. This transformation makes the elicitation of tacit knowledge extremely complex, because each respondent is likely due to their different personal histories to provide different exemptions.

Direct questioning transforms the character of tacit knowledge, therefore, knowledge acquisition techniques which directly question experts, are inappropriate for the elicitation of tacit knowledge.

8.4 Knowledge Elicitation Techniques that Do Not Ask Direct Questions

The above indicate that methods which seek objective domain knowledge, methods which depend on interviewing experts and methods which directly question experts are likely to be inappropriate for the elicitation of tacit knowledge. However, not all knowledge acquisition methods fall into these three categories, these methods will now be briefly discussed and assessed for the purpose of the elicitation of tacit knowledge.

8.4.1 Critical Incident Technique

A knowledge elicitation technique which does not rely on direct questioning is Critical Incident Technique (CIT). Doukidis & Whitley (1988b) recommend this method for heuristic modelling and seems particularly relevant for this research because they contend,

> *'This technique enables: Definition, location and categorization of all*
> *basic concepts in the domain.'* *(page 78).*

CIT is an applied psychology technique, first attributed to Flanagan (1954). It is used to elicit knowledge by asking experts to describe past incidents that they consider of particular interest (critical incidents). CIT has been applied to knowledge acquisition by Bliss & Ogborn (1979) and has been recommended for heuristic modelling Poulymemakou & Doukidis (1987). CIT is an interesting technique in that it allows the expert to, in some ways set the agenda by choosing interesting past events. The expert can chose incidents that the knowledge engineer might not recognize as 'interesting' thus raising questions, of which the knowledge engineer (left to his/her own resources) might not have thought. However, CIT is in many ways a formal interview in which once the expert has identified a critical incident s/he is invited to explain their actions step by step fashion.

CIT may be useful in eliciting Heuristics and pinpointing critical areas of decision making, however, it takes the form of a 'post hoc rationalization' of an interesting incident [7]. One in which much of the data has already been unconsciously 'written out' of the account by the respondent. By definition that which is left out, is that which does not need to be included, because it is self-evident. Unfortunately for this research what is self-evident to the members of a mini-culture is likely to contain the tacit knowledge. To use the example cited by Collins (1987) of the physicist Harrison attempted to build a TEA laser. In order to do this he received a set of instructions from a colleague (whom shall be referred to as Dr. X) who had previously built a working TEA Laser. If Dr. X had been asked to relate a critical incident in his career he might have cited the building of a TEA laser. When asked to explain how he had achieved this he would have presented a step by step set of instructions similar to those provided to Harrison.

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[7] For problems associated with post hoc rationalization, see Coulter (1983) and Suchman (1985) above.

To recap, although Harrison succeeded in building a TEA laser using these instructions he could not get it to work. One instruction was that the wires to the capacitors should be 'short'. Harrison made them as short as possible, but, it finally emerged that for the wires to be 'short' in laser building terms, required the capacitors must be inverted in a frame. This point had been written out of the instruction because it was redundant, an instruction that Dr. X would tacitly assume any body constructing a TEA laser would know. If CIT was employed on the expert laser builder, his *post hoc* rationalization would have omitted the inversion of the capacitors, in the same way it would have omitted the information that nuts must be turned in a clockwise direction to tighten them on the bolt. This is problematic for the purposes of this research in that the knowledge omitted is likely to contain tacit knowledge.

8.4.1.1   Potential for the Elicitation of Tacit Knowledge

Although CIT has many uses, it is too linear for the purposes of this research. *Post hoc rationalization* omits much of the tacit knowledge from the narrative, therefore, this method is of limited use to this research.

8.4.2 Protocol Analysis

Protocol analysis attempts to overcome many of the problems of *post hoc rationalizations* of CIT, by eliciting knowledge, while the expert actually carries out his/her task. There are many variations on the technique, these will be classified under three main headings and assessed in relation to the elicitation of tacit knowledge.

8.4.3 Variations of Protocol Analysis

Protocol analysis is the method by which knowledge elicitation attempts to capture the complex data which is the basis of decision making. The general method of protocol analysis takes the form of an expert being given various problems to solve. This is usually video taped (although audio tape is sometimes used) and the tapes later analyzed for the protocols the expert employs, when making expert decisions.

There are many variations of protocol analysis, these fall into three main categories, which will now be assessed for their applicability for the elicitation of tacit knowledge.

8.4.3.1   Concurrent Protocols

To conduct concurrent protocol analysis, the expert is set a series of domain problems and asked to 'think out loud' as s/he solves the problems. The thinking out loud is then later analyzed for decision protocols. This appears to allow the expert to make decisions in as realistic a way as possible. There are, however, several drawbacks to this method: the Hawthorne Effect must be noted; transcripts with large irrelevant areas need to be analyzed; the choice of problem will affect the resulting protocol.

8.4.3.2   Restricted Protocols

To overcome the irrelevant material the expert can be asked to restrict his responses to specific areas. This results in shorter, more easily analyzed protocols. However, this method tends to force the respondent to concentrate on his responses, rather than 'thinking out loud'. This could affect the objectivity of the responses.

8.4.3.3   Retrospective Protocols

In the final variation of protocol analysis the expert is set a series of problems, after completing the tasks, he is asked to explain the protocols by which he completed the task. This method presents the problem associated with *post hoc rationalizations*. The respondent will often construct a reasonable account of why they made certain actions, the relationship of this account and the actual actions is at best dubious (see Coulter (1985) in Chapter Two).

8.4.3.4   Matching the Type of Protocol Analysis to the Task

The different methods of protocol analysis have strengths and weaknesses in respect to different research objectives:

Concurrent Protocols:	Best suited to research into the decision making process and to explore ill defined research areas.
Restricted Protocols:	Best suited to research where problem areas have already been identified.
Retrospective Protocols:	Best suited to testing hypothesis regarding information content.

Ericsson and Simon (1980) after studying a large number of cases to assess the effect of verbalization on the task being performed found.

> *"verbalizing information is shown to affect cognitive processes only if the instructions require verbalization of information that would not otherwise be attended to"* *(p.215)*.

Therefore, concurrent protocols are much more likely to capture more accurately the decision process. Interference by the researcher in restricting or focussing the respondent, while simplifying the analysis, is likely to adversely affect the results of the analysis.

Concurrent protocol analysis can add depth to purely objective types of knowledge elicitation. For example, Bainbridge et al (1969) set a group of experts and a group of novices a task. To the surprise of the researchers, when measured quantitatively both groups produced similar results. However, when re-tested it was found that,

> *'The experienced group was setting themselves a harder task by trying to take into account more factors, the result being that their performance was no better on the simulation.' (page 98)*

8.4.3.5   Potential for the Elicitation of Tacit Knowledge

Concurrent protocol analysis appears with careful analysis to be capable of capturing tacit knowledge. The expert by 'thinking out loud' could reveal tacit knowledge essential to the decision making process. However, this method does not seem practical for this research for several reasons.

8.4.4 Practical Considerations

Protocol analysis is usually used to trace the decision making process of experts. This assumes that decisions are made with in limited, framework. For example Hayes (1988) used protocol analysis in order to elicit the way international bank credit officers decide which businesses to grant loans. Concurrent protocol analysis was the chosen research method. This was conducted in the field to make the analysis as realistic as possible. However, rather than asking the participants to think out loud as they made real decisions, the concurrent protocol analysis was conducted

in an adjacent room (so that the loan officers would not be disturbed by phone calls), using an artificial test case.

The test case was based on figures from a liquor firm, Distillers, which had just purchased a distribution company in New York. The test case changed the name of the firm to Waperton-Smith (in order that the officers did not have personal knowledge of the firm), the turnover was divided by 100 (in order that the loan would be of the size the officers were used to dealing with), the business was changed from liquor to liqueurs and the distribution company was situated in California. None of these changes were felt to change the decision making process.

Although this field test was set up to be as realistic as possible, any one of these changes could have a dramatic effect on the decisions the officers reached. Moving the officer into a room without a phone, on the one hand eliminates interruptions, however, it also isolates the officer from his contacts with the outside world. Such contacts (for example if the officer had a colleague with an expert knowledge of the liqueur business) could drastically effect the officers decision. Changing the name of the firm indicates Hayes believes that all firm are interchangeable. Firms have diverse objectives, the purchase of a distribution company might make economic sense to one firm and not to another. The officer might know or have access to the objectives of particular Firms. The liquor and the liqueur business can be considered interchangeable only if the officer knows nothing of either business. Likewise changing the site of the distribution company from New York to California might have a dramatic effect upon whether it was a good buy. Finally to assume what is economic sense to company X, would also make economic sense to company Y, 100 times its size, seems to be, at least naive.

If a desk based, purely decision making process can not be captured by protocol analysis without such drastic modifications to the experts usual behavior, the technique is likely to be totally impractical in a multi-function (midwives and doctors

perform many more tasks than decision making), mobile (doctors and midwives are not confined to desks) dynamic (the work of the maternity unit changes minute by minute) process such as a maternity unit. Protocol analysis might be useful in limited well defined areas, but for the main field work other research methods must be sought.

The above seems to indicate the research techniques of science and technology in general, and knowledge acquisition in particular are inappropriate for the elicitation of tacit knowledge. Therefore, the research methods of other overlapping disciplines will now be investigated to assess their usefulness for this research.

Investigations of this type are extremely worthwhile, because the identification of research methods from one domain which can be applied in another domain, is extremely valuable.

8.5   Sociological Research Methods

One such overlapping domain is identified by Collins (1987) who contends that sociologists and knowledge engineers share a topic: the explication of cultural knowledge. Sociologists can help knowledge engineers in this task by contributing the findings of both philosophy and the 'modern sociology of knowledge'.

8.5.1 Sociology and Knowledge Acquisition Share a Topic

Collins (1987) contends that sociologists and knowledge engineers share a topic: the explication of cultural knowledge. For Collins progress in what he refers to as Intelligent Knowledge Based Systems (IKBS), will depend on progress in explicating the cultural knowledge base and making the culture of the expert, understandable to the less skilled end user.

Collins (1987) arrives at this conclusion by assessing recent developments in IT. Collins notes that most of the debates in AI have centered around the dichotomy of the algorithmic and enculturational models of knowledge.

8.5.1.1   Algorithmic Model

The algorithmic model holds knowledge is transferable via *logical instructions,* as a kind of 'recipe'. This notion is central to the practice of 'replication', a fundamental plank in the scientific method.

8.5.1.2   Enculturational Model

The enculturational model holds that knowledge is only transferred by a method which is closer to 'learning a skill'. This model holds that knowledge is difficult to transfer by logical instruction because it contains a 'tacit' component.

Collins (1987) discusses each model by reference to a previous study of replication (Collins 1974), and concludes that the enculturational model was correct. Collins contends that it is only by joining a culture, (or more correctly a mini-culture) that one can take on board the taken-for-granted-assumptions which members of the mini-culture routinely use to interpret the world.

Collins (1987) demonstrated for knowledge to be successfully transferred required, the transfer of cultural knowledge. Collins maintains that algorithms alone are not sufficient for the transfer knowledge because of the five propositions for the transference of expertise.

COLLINS' FIVE PROPOSITIONS
FOR THE TRANSFER OF KNOWLEDGE

Proposition 1:   Transfer of skill-like knowledge is capricious.

Proposition 2:   Skill-like knowledge travels best (or only) through accomplished practitioners.

Proposition 3:   Experimental ability has the character of a skill that can be acquired and developed with practice. Like a skill, it cannot be fully explicated or absolutely established.

Proposition 4:   Experimental ability is invisible in its passage and in those who possess it.

Proposition 5:   Proper working of the apparatus, parts of the apparatus and the *experimenter* are defined by the ability to take part in producing the proper experimental outcome. Other indicators cannot be found.

These can be summed up as, it is only possible to be sure that a transference of knowledge has taken place when the recipient can demonstrate the skill.

The rejection of the algorithmic model of knowledge expands the topic of the knowledge acquisition. Collins (1987) points out that the discipline of sociology (in a different context) shares the expanded topic of the knowledge engineers. Sociology, however, being a much older discipline has developed many skills that can be exploited by knowledge acquisition. Collins (1987) notes,

> *'[I]t is worth noting that the major problems-encoding cultural knowledge and transmitting it to the non-encultured-are already within the purview of the sociologist and anthropologist. (page 345).*

Collins equates the knowledge engineer to the sociologist or anthropologist.[8]

> The anthropologist approaches a foreign culture as a novice of that culture. S/he investigates, and gains a deep understanding of that culture. The anthropologist then writes up his/her understanding of the culture in a way understandable to novices of that culture (i.e. members of the anthropologists culture with little knowledge of the foreign culture).

N.B. Novice here is not restricted to the definition of 'complete novice', it refers to one less knowledgeable than a member of the foreign culture.

> The knowledge engineer approaches an expert domain (foreign culture) as a novice of that domain (culture). S/he investigates, gains a deep understanding of that domain (culture). The knowledge engineer then encodes his/her findings into a KIS (writes up his/her understanding of the culture) in a way understandable to the end user (to novices of that culture).

> Collins contends that end users are less skilled than the experts from whom the expert knowledge was explicated.

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[8] Although the knowledge engineer is closer to a sociologist (they share a culture with the group that they are researching) than an anthropologist the connection is easier to explain in terms of knowledge engineer and anthropologist.

N.B. In a similar way, novice here is not restricted to the definition of 'complete novice', it refers to one less knowledgeable than a domain expert.

8.5.1.3   Radical Shifts of Context Explicate Tacit Knowledge

Collins (1987) contends that the explication of the tacit or cultural aspects of knowledge is vital for the transference of knowledge in general and the advancement of expert systems in particular. He notes that *knowledge can move from implicit to explicit categories with radical shifts in context.* It is fortunate for knowledge acquisition that the implementation of a computer system is such a shift in context.

8.5.1.4   Method for the Explication of Tacit Knowledge

Collins (1987) contends that participant observation, or what he refers to as participant comprehension, the method of anthropology and phenomenological sociology will be extremely useful to knowledge engineers interested in explicating enculturational knowledge. Enculturational knowledge is tacitly held, therefore, if Collins is correct participant observation should be useful for the elicitation of tacit knowledge.

> *'Participant observation- that softest of social science methodology may oddly enough be of direct relevance to the new breed of knowledge engineers.' (page 345)*

8.5.1.5   Potential for the Elicitation of Tacit Knowledge

Collins work is important for knowledge elicitation for several reasons:

1)   Importance of cultural knowledge: by showing the inadequacy of the algorithm as a transfer of knowledge, Collins shows the importance of cultural skills by

which members (of the culture) tacitly interpret the world. Therefore, in all but extremely well defined situations knowledge acquisition will require the explication of at least some tacit knowledge.

2)   Overlapping disciplines: Collins demonstrates that knowledge acquisition and phenomenological sociology 'share a topic'. Knowledge engineers can therefore, benefit from the methodological and philosophical base established by sociologists working in this area.

3)   Methods: Collins points out that participant observation (comprehension) is the best method by which to understand cultural knowledge.

4)   Nature of knowledge: Collins notes that knowledge can transform from one classification to another. Tacit cultural knowledge can be explicated during radical changes of context. The transformation of a manual system to a computerized system seems to offer such a change in context and should be consciously exploited for this purpose.

While these findings are extremely important at a level of generality, Collins does not propose any practical way of eliciting tacit knowledge for a specific project (to be fair to Collins this was not the purpose of his paper).

Collins contends that knowledge engineers share a topic with sociologists, therefore, it seems pertinent to review how other sociologists have approached the explication of cultural knowledge.

8.5.2 The Grounded Theory Method

The sociological method which has the explicit aim of uncovering concepts that are unconsciously held by members of a sub-culture, 'Grounded Theory' was first

'discovered' by Glaser and Strauss (1967). It will now be briefly described and discussed in relation to is use in the explication of tacit knowledge. It is particularly pertinent to the main field work because the original formulation of grounded theory sought to uncover the unconscious concepts of medical practitioners.

The aim of grounded theory is to build from empirical data substantive theory i.e. patient care, race relations, delinquency, etc. This may or may not be later worked up into a formal theory of some conceptual area of inquiry i.e. stigma, status, power etc.

Good grounded theory must emerge from the data, therefore, Glaser and Strauss advocate a process capable of generating theory rather than a prescriptive method. In order to achieve this, it is important to look at theory in the following way,

8.5.2.1   Elements of Theory

1)   CONCEPTUAL CATEGORIES: the basic element of any theory is the conceptual category. A category stands by itself as a conceptual element in a theory. e.g. school children.

2)   PROPERTIES: A conceptual aspect of a category. Each category is defined and delimited by a set of properties which characterize the category. e.g. the category 'school children' would have properties such as :- less than 16 years of age, more than 5 years of age, immature, not in employment etc.

8.5.2.2   Constant Comparison Method

Glaser and Strauss suggest coding should first of all start with selecting a few gross features of the area of study to provide a foothold for the research. The relevancy of these gross categories can not be initially ascertained, some may form the central

core of a theory while others may prove useless. This method can rightly be criticized as just another type of interpretivism because the researcher subjectively chooses the original gross categories. However, from this point the data should take control of the direction of the research. The next step will emerge as more data is looked at to ascertain whether it fits into a particular the category. This has two effects

1)   The generation of new categories as new data will not fit into existing categories.

2)   The sharpening of the properties of the categories. (i.e. as more and more data is compared to the category the properties of the category will sharpen up). Data that originally 'fits' a gross category may no longer fit that category once its properties have been sharpened up, this data will then have to be placed in a more applicable category.

The formulation of a substantive theory is both facilitated and made more credible by systematically studying several comparison groups (Glaser and Strauss advocate testing generated theory by a form of falsification). The selection of the groups to be studied is guided from the logic of the emerging analytical framework (awkward groups are found to falsify the theory). e.g. In the study by Glaser and Strauss (1965), it emerged that a key variable was the 'awareness' of impending death, (who actually knew the patient was actually dying, including the patient). This variable was thought to have a dramatic effect upon the way the people involved (the patient, the staff and the family) interacted. Therefore, to falsify the proposition further research was carried out at a premature baby unit, in order to minimize the patients awareness while at the same time maximizing the staffs awareness (apparently most premature baby deaths are expected by the staff). This had the effect of isolating one variable:- the staff knew which patient would die while the patient would not, and was unlikely to have any effect upon the staff.

They then studied a cancer ward with varying levels of awareness of the impending death by staff, patient and families. Later, other diverse wards were studied in different hospitals e.g. geriatric, premature baby units, intensive care, emergency, cardiac and general wards in state, veterans, prison and private hospitals. Where ever possible the next step in the research is indicated by the logic of the method i.e. an attempt to falsify tentative hypothesis.

By comparing different groups the strengths and weakness of the theory will emerge. e.g. the comparison of groups might show that 'awareness' was a major factor in situation 'x' and 'y' but of little importance in 'z'. The detailing of the limits of a theory is very important if it is to be applied, i.e. if we are in situation 'z' don't try to force fit the 'awareness' variable. Knowing the limits of a theory will also indicate areas of further research.

The interaction of one category with another can result in a very complex situation. This point will be illustrated with and example drawn from Glaser and Strauss's (1965). Two categories common in nursing the dying are, 'professional composure', and 'perception of loss' (bereavement). A property of the category perception of loss, is 'loss rationalities' (i.e. ways by which nurses justify their perceptions of social loss). The situation is complicated because elements can interact. e.g. loss rationalities which arise amongst nurses to explain the loss of a patient of high social loss status (e.g. young mother), can also help maintain professional composure.

8.5.2.3   Assessment of Grounded Theory for the Elicitation of Tacit Knowledge

Grounded theory seems to truly have captured tacit knowledge of great power. Knowledge elicited is at the level of the concept and therefore, has the power to change how particular 'facts' are interpreted by individuals. In the above example,

the 'awareness of death' had a dramatic effect upon the way that individuals interpreted the situation. It was a key variable tacitly held by the participants, once explicated this variable became extremely useful in the practical treatment of terminally ill people.

An indication of this point arises in the naming of new hospices. When a project to raise funds for a hospice is formulated (the capital costs for hospices are almost always in the UK the result of voluntary donations) the fund raising committee are caught upon the horns of a dilemma about the name of the building. The committee divides into members who are concerned with the problem of fund raising and members who are interested in the running of the resulting hospice.

Members interested in the running of the hospice are concerned with overcoming patient resistance to entering a hospice, which many regard as a 'place where you go to die'. They point out (quite correctly) that this is not a fair assumption, a hospice can radically improve the patients quality of life (for the vast majority of the time, in the patients own home) for several years prior to end stage terminal illness. This faction (are concerned in overcoming the patients prejudice), may advocate calling the institution a 'Symptom Control Centre' or 'Pain Clinic'. Which is much nearer the true function of the institution.

Patients can receive treatment without reading the clue, 'I am being treated at a hospice, therefore, I must be dying.' Even patients deep in denial, who would not countenance entering a hospice, will usually submit to pain and or symptom control.

Conversely, the faction responsible for fund raising take a different point of view. They know that people will give generously to the establishment of a hospice, which they associate with lingering death in general and cancer in particular. A large proportion of the population have first or second hand experience of the hospice movement, a greater majority have lost loved ones to cancer and anybody could get

cancer and there is willingness to support hospice fund raising. The same people are unwilling to contribute to a pain or symptom clinic. Symptom or pain control is perceived as a responsibility of the NHS, which most people believe should be funded by Central Government not charitable donations. The dilemma is thus, if the institution is called a hospice, many patients (often in dire need) will perceive this as a 'awareness of death' clue and refuse help from the resulting institution. If the institution is called a symptom control clinic, more patients will be willing to use its services but it may not attract enough funds to be built.

8.5.2.4   The Potential for Using Grounded Theory for Knowledge Elicitation

Grounded theory has the ability to explicate tacit knowledge. Glaser and Strauss (1965) explicated several tacitly held variables of great power. This demonstrated

*   tacit knowledge exists

*   tacit knowledge can be explicated.

Although Glaser and Strauss had great success with the Grounded Theory method, it must be noted that this was a large scale research project funded by the American Health Service. They were able to employ a large team of researchers, to conduct in-depth qualitative research, in a variety of institutions, at a large number of sites, over a period of years. This amount of time, effort and money seems to be beyond the most ambitious knowledge acquisition project, it is certainly beyond the scope of the funding available for this research.

The author has contact with a number of colleagues conducting grounded theory in the context of health, they report that it is not a method for the 'faint hearted'. In practice grounded theory requires a vast amount of data and extremely skillful

researchers. This usually takes the form of a self contained research project running over a period of years, for other purposes. A researcher is then appointed to conduct grounded theory on the data while the rest of the team conduct the research proper. Data collection of this magnitude is simply not available to this research, therefore, although the method seems promising it is impractical for the purposes of this project.

In conclusion although grounded theory can explicate tacit knowledge, the investment required to use this method correctly seem to make it impractical for knowledge acquisition.

8.6 Phenomenology

Collins (1987) advocated the methods of Phenomenologists to explicate cultural knowledge. The philosophical basis and research methods of this branch of sociology will now be briefly discussed.

Phenomenologists are interested in the subjective way that individuals and groups (often unconsciously) categorize the world. As such the methods and philosophical basis of phenomenology seem to be directly applicable to the elicitation of tacit knowledge. Phenomenology is a branch of sociology which holds that the social world can not be studied in the same way as natural sciences. Aspects of social life do not have a separate existence but are socially constructed. Haralambos & Holborn (1991) note,

> *To phenomenologists, human beings make sense of the world by imposing meanings and classifications upon it. These meanings and classifications make up social reality. There is no objective reality beyond these subjective meanings. (page 710).*

8.6.1 Alfred Schutz

The basis of phenomenological sociology can be found in the work of Alfred Schutz. At the level of high abstract theory Alfred Schutz (1967) attempted to lay a philosophical base and methodology for what he contended was the topic of sociology i.e. the individual acting inter-subjectively in the world. The philosophical underpinnings for Schutz's work is the phenomenological philosopher Husserl (1931), who was concerned with describing how the activity of transcendental inter-subjectivity creates the world as we know it. Phenomenologists (as is commonly believed) do not deny the world exists outside our thoughts, however, they contend, when we view the world we are not simply viewing it as it actually is 'in the raw'. Humans exist in a life-world of significations, Husserl refers to this as a 'cloak of ideas' through which they routinely view the world. The cloak of ideas is used so routinely that it for the most part it is unexamined and becomes the individuals 'natural attitude', which allows subjective significations to become objectified as simply part of the natural world, external to the individual.

Building on Husserl's work, Schutz (1967) claims that societal order, arises from, and is maintained by the inter-subjectivity of the individuals belonging to that culture. Schutz also maintains that the topic of sociology is how inter-subjectivity or culture is constructed and maintained. If Schutz is correct his work will directly inform this research which seeks to elicit tacit aspects of an experts mini-culture.

Schutz (1967) argued that Weber (1948) was largely correct in trying to understand the world at the level of the actor, to gain *verstehen,* but failed to bring out the inter-subjective experience actors have of their social world. Schutz (1967) argued the everyday world is experienced individually (subjectively) but not privately, it is a shared common social world (objective) in which the individual is involved. For Schutz (1967) both objective and subjective are dimensions of the actors' common sense perspective in which they experience and construct the world. This world is

not tested but taken for granted, it is perceived as an unquestioned and unquestionable fact. Schutz argues that,

1)   Members possess a stock of typifications, which enable them to experience the world as mundane

2)   On the basis of these typification individuals can assume others will act predictably. Thus they can attribute reasons and intentions to other people and therefore, know how to plan their behavior.

The sets of typifications that individuals hold inter-subjectively about their culture appear to be extremely interesting for the purposes of this research. In many ways tacit knowledge can be considered a set of typifications that individuals (experts) hold inter-subjectively about their culture (domain).

It must be noted, however, that Schutz never tries to investigate this 'mundane world' and neither do his followers Berger and Luckmann (1967), who conduct their analysis of the mundane world at the level of high abstract theory. The investigation of the mundane was left to Harold Garfinkel and the ethnomethodologists (for an interesting investigation of the mundane world see Pollner, (1975)).

The empirical stance advocated by the ethnomethodologists, for investigations into the mundane world, make their methods relevant to the elicitation of tacit knowledge. Areas of Garfinkel's work applicable to this research will now briefly be discussed.

8.6.2 Garfinkel - Local Production of Order

Garfinkel attempted to answer perhaps the most fundamental question of sociology, the problem of order,

'Why do large numbers of individuals with their separate needs and interests join together to form integrated societies ?'

Post war sociology was dominated by structuralist theories based on the work of Parsons (1951) [9], which contended that order was imposed by an over-arching structure. Schutz (1967) rejected these theories in favour of the 'local production of order' by which he contended, that order was produced inter-subjectively by the members of a culture.

Garfinkel (a post graduate student of Parsons) set out to empirically test which theory was correct. It soon became apparent that the structuralist theory was untenable. If order is not constrained by an over-arching structure Garfinkel took the radical Schutzian step and concluded that it must come from within.

However, to investigate the inter-subjective world is problematic, due to its taken-for-granted or mundane nature. Here knowledge engineers interested in the explication of tacit knowledge share a problem with Garfinkel, to inform their research, some of the methods that Garfinkel devised to make the mundane world visible will now be discussed.

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[9] It must be noted that most of the debates of this period were conducted between two structuralist theories: the 'consensus' theory associated with Parsons and the 'conflict' theory based on Marxist Historical Materialism. Although at the time these were considered diametrically opposed, they shared many fundamental assumptions which differ radically from the Schutzian view. Therefore although arguments are discussed between Parsons and Schutz the same arguments could be constructed between Marxists and Schutz.

8.6.2.1 Garfinkel's Method for Investigating the 'Local Production of Order'

Garfinkel can be distinguished from other ethnographers by his insistence upon the praxeological rule, which states:

1) All sociologies must deliberately choose to account for human activity only in human terms. Therefore, explanations of human activity by either theology or reductionism are not applicable.

2) Activities in a social setting must be seen to be the accomplishment or achievement of the actors participating in it, therefore, for example the gender division of labour must be seen as an 'achievement' no matter how unpalatable the notion appears to the researcher.

Garfinkel also pointed out that it is extremely easy to construct 'cognitive models' of what people think, however, it is much more difficult to get empirical evidence for these models. Garfinkel was therefore, adamant that his studies would be strictly empirical in order to prevent the investigator importing their own cognitive models into the research.

8.6.2.2 Disruption of Social Order

A method that Garfinkel used, which seems fruitful for the purposes of this research became known as the 'disruption of social order'. Garfinkel encouraged his students to test the taken-for-granted reality of their own lives by acting as if they were anthropologists investigating a strange tribe. To the anthropologist the culture of a strange tribe is visible because of its 'strangeness'. In order to imitate this 'strangeness' when studying their own culture the students were told to challenge every assumption in order to break down the mundane world and make it amenable

to investigation. An example is given in Garfinkel (1967).

(S) = student and (E) = ethnomethodologist.

(S)   Hi, Ray. How is your girlfriend feeling?

(E)   What do you mean 'How is she feeling?' Do you mean physical or mental?

(S)   I mean how is she feeling? What's the matter with you? (He looked peeved.)

(E)   Nothing. Just explain a little clearer what do you mean?

(S)   Skip it. How are your Med School applications coming?

(E)   What do you mean, 'How are they?'

(S)   You know what I mean.

In this short transcript the researcher is deliberately being awkward in order to show the amount of knowledge that is taken for granted in every day talk. In this way the respondent (S) is forced to explain his ambiguous questions. The respondent soon gets frustrated because his meaning is clear, however, it is only clear if the researcher is equipped with the required tacit knowledge of the culture.

8.6.2.3   Potential for the Elicitation of Tacit Knowledge

The disruption of social order is a tried and tested method of eliciting tacit knowledge. However, it is very difficult to see how this method could be used for knowledge acquisition. The examples in Garfinkel (1967) reveal that respondents very rapidly become frustrated, bad tempered and often simply leave. Garfinkel was well aware of the position he placed his respondents, his second example begins,

'The victim waved his hand cheerily,'

It is difficult to imagine an expert submitting to this form of questioning for any length of time without an in-depth briefing of the disruption of social order method, such a briefing would unfortunately nullify the method.

Garfinkel's work seems promising for this research, but in order to be so, the mechanism for making mundane knowledge visible 'strangeness', must be disengaged from the method that Garfinkel employed 'disruption of social order'. The mechanism can be employed to elicit tacit knowledge but the method is inappropriate. Therefore, in order to utilize the mechanism of 'strangeness' for knowledge acquisition a 'softer', less confrontational method must be devised.

8.7   Summary of Chapter

The above indicates the explication of tacit knowledge is problematic. The methods of science and technology are inappropriate for the task, due to the nature of tacit knowledge. Established knowledge acquisition techniques were also found to be inappropriate for the task. Collins demonstrated that knowledge engineers and sociologists share a topic and advocates using sociological methodology.

Grounded theory was examined and found capable of explicating tacit knowledge, but impractical for knowledge acquisition in general and this research in particular.

Collins demonstrated the importance of the explication of cultural knowledge. He recommends the philosophical base of the phenomenology and the method of participant observation. Phenomenology was found useful at the level of abstract theory, the empirical work of Garfinkel was found to be capable of practically explicating tacit knowledge. Garfinkel was able to explicate the inter-subjectivity of mundane life by artificially manufacturing 'strangeness'. However, the disruption of social order is too confrontational for eliciting tacit knowledge for the purpose of knowledge acquisition.

Collins also pointed out that in situations of radical changes of context cultural knowledge can become explicated

Given the importance of explicating tacit knowledge and the dearth of methods for this purpose, methods capable of explicating tacit knowledge and appropriate to knowledge acquisition should be employed in order to investigate the process by which tacit knowledge is explicated, with the purpose of identifying further practical methods for its explication.

Therefore, the main field work will take the form of participant observation in a situation of radical change of context. Methods of creating 'strangeness' will be sought and when interviewing experts, areas of ambiguity will be specifically noted for analysis of potential tacit knowledge rather than negotiated away (by either the problem of 'shared penetrable horizons' or post hoc rationalization).

As and when other methods of explicating tacit knowledge emerge they will be evaluated in order to assess their practicality.

CHAPTER 9

Research Design

9 Research Design

The research design will consist of two broad strands: reading and contemplative; fieldwork.

9.1 Reading / Contemplative Strand

A literature survey has been undertaken. This widened the topic of knowledge acquisition and drew on other disciplines, especially research conducted in IS, Philosophy, Sociology, Psychology and Cognitive Psychology. The survey also gained a philosophical understanding of the assumptions that the various stances are predicated upon. The literature survey will be an on-going process in order to take advantage of the latest findings in the area. The survey gave a wide interdisciplinary understanding of 'tacit knowledge' and contributed to each of the four tasks mentioned in Chapter Seven.

9.2 Fieldwork Strand

9.2.1 Gaining First Hand Experience of Knowledge Acquisition

The philosophical stance of this research and its emphasis upon the human rather than the technical aspects of KIS made it very important that the researcher obtained 'hands on' experience of knowledge acquisition. This is important in order that the researcher gains an understanding, both of an expert domain culture and the culture of knowledge acquisition engineers. A pilot study will therefore, be undertaken to be used as a probe in order to test under realistic practical conditions, preliminary findings as to the character, mechanism and modes of explication of tacit knowledge. This experience is also an opportunity to equip the researcher with the social and technical skills required in the main field work of the research.

For this phase the researcher will become informally attached to the EDESIRL project, in order to observe the most up-to-date methods of knowledge acquisition and techniques of building Expert Systems. The EDESIRL project is concerned with building an expert system, EMMY which is a strategic expert system for the planning and costing of a maintenance schedule for 'new build' Housing Association properties, over a 60 year period. While the building of such a system is a worthwhile end in itself, the project was used to investigate knowledge acquisition methodologies for expert systems under real world conditions.

9.2.2 Field Work at the Maternity Units

Acquiring 'tacit knowledge' for an Expert System under development such as EMMY is potentially problematic for the purpose of this research. Tacit knowledge has a nebulous character and is held at an unconscious level. Once the knowledge is 'noticed', the knowledge engineer can easily take on it board *tacitly*, thus unconsciously influencing the further knowledge acquired. In practical situations this knowledge seems so obvious (once it has been 'noticed') that it seems impossible not to have taken it into consideration. However, once it has been noticed, its ubiquitousness causes it to disappear but not without changing the basic assumptions of the domain for the knowledge engineer.

Tacit knowledge has such a taken-for-granted obvious nature that once it is explicated it is very difficult to separate it from the knowledge collected by the other methods of knowledge acquisition. It is therefore, proposed that an existing up and running system is investigated. This system would be for all practical purposes complete and any 'knowledge' the research uncovered would be clearly defined in that it would not appear in the finished system.

In order to see the significance of the findings and to enable the researcher to 'escape' from tacit assumptions inherent to the system under investigation it seems more

fruitful to study a simpler technology, one in which little or no attempts at 'inference' have been incorporated, but one which is still knowledge intensive - *viz* a data base. The two uses of knowledge are still valid: knowledge encapsulated in the system, in the data itself and how it is structured; knowledge on how the users will use the data base.

It was noted that many of the 'expert' classifications were only made explicit where contradictions between an informed-layman's and the expert's view of the world occurred. However, such contradictions can only occur after a considerable amount of knowledge acquisition has taken place (the engineer must have amassed a considerable amount of knowledge to recognize an expert classification being contrary to common sense classification). In order to reduce the domain knowledge the engineer needs to acquire before contradiction can occur, it was proposed that the research should take place in a complicated environment where different types of experts with different occupational mini cultures interact. It is felt at such a juncture, the different world views of the different types of expert would throw up anomalies, which would reveal tacitly held knowledge.

It is therefore, proposed that a simpler technology in a more complex situation be studied. Two maternity units will therefore, be researched and compared. One maternity unit has been chosen as a pilot to test a computerized maternity record keeping system. This system is technically simple and although it contains a considerable amount of domain knowledge, very little attempt has been made at inference. The maternity unit is, however, a complex environment in that three distinct occupational or mini cultures, Doctors, Midwives and Managers are present. These groups although sharing the care of pregnant women and the new born, have different basic assumptions, classifications and priorities. A limited access to the maternity unit has been arranged for the purposes of this research.

A case could be made that a forth mini-culture, that of the mothers-to-be also exist in these maternity units. It could be argued with the Government policy of the New NHS that this group will become important players, as more choice is given to the mothers-to-be they are likely to choose maternity units which satisfy their needs. At the time when the fieldwork was conducted, although, choice was theoretically possible, in practice the vast majority of mums attend the maternity unit to which they are sent. Therefore, although 'customers' views are important this group are at present 'powerless players' and for this reason this research will concentrate on the occupational groups, i.e. doctors, midwives and managers.

CHAPTER 10

The Pilot Study

10 Pilot Study

10.1 Introduction to the Pilot Study

As noted in Chapter Nine, the philosophical stance of this research and the emphasis upon the human rather than the technical aspects of KIS requires the researcher obtains 'hands on' experience of knowledge acquisition. Firstly, it is important that the researcher gains experience of knowledge elicitation from an expert domain and secondly to gain an understanding of the mini culture of knowledge acquisition engineers. This latter point is important, the researcher must have a understanding of the form of elicited tacit knowledge that is of use to the expert system builders. To facilitate this, a pilot study was undertaken prior to the main fieldwork. The pilot study was used as:

* a probe under realistic practical conditions to test hypotheses of the character, mechanism and modes of explication of tacit knowledge;

* preliminary findings from the pilot could later be tested for generality in the main fieldwork;

* an opportunity to equip the researcher with the social and technical skills that would be required for the fieldwork proper.

This Chapter describes the pilot study at length and many of the results that were found. Many illustrations are given of issues encountered, with discussion of their relevance to the explication of tacit knowledge. The findings are summarized at the end of the chapter.

10.2 The Edesirl Project

To gain knowledge acquisition experience the researcher became informally attached to the 'EDESIRL' project at the University of Salford.

The EDESIRL project is a £1,000,000 research project sponsored by the Department of the Environment investigating knowledge acquisition methodologies for 'expert systems'. The project has undertaken to build an expert system 'EMMY' to be used as an 'engine' to test the various methodologies under real world conditions. EMMY is a strategic expert system for the planning and costing of a maintenance schedule for 'new build' (newly built houses) Housing Association properties over a 60 year period. Becoming informally attached to the EMMY project allowed the researcher to observe the most up to date methods of knowledge acquisition and Expert System construction in action.

10.2.1 The EMMY Expert System

Although at the time of pilot study EMMY was still under construction, many of the basic elements were in place and the system was in the modification and development stage. The EMMY interface, at this stage was very sophisticated and easy to use, enabling the system to have tremendous flexibility. An example of the flexibility was the ability of the users to create their own *'Groups'* of units and specify individual characteristics to such groups. These characteristics can be based upon an underlying knowledge about what the expert user considers to be the essential attributes of a particular group of buildings. For example, a maintenance manager might know that a group of houses on Smith Street is in a very exposed location. S/he can form these houses into a 'group' and allocate the 'exposed' attribute (which will have an effect on the life cycle of exterior components of the building). This will have the effect of adjusting the maintenance plan for this group. It is possible to 'bespoke' the

system to the requirements of the individual Housing Association. The interface allows this task to be completed by a suitably authorized user (i.e. programming knowledge was not required to achieve the task).

The system allows the visualization of many years expenditure, making it possible to move maintenance work from high spending years to low spending years in order to even out expenditure. Although the designer complained that the process to accomplish this task (at time of writing) was complicated, the researcher found it relatively was easy to accomplish because it followed a common sense sequence, similar to the sequence that would be followed using a paper system. At that time there were plans to improve this facility in the future using expenditure windows and icons. For example, each year over a ten year period would have a window with a small expenditure window and icons for the various maintenance jobs, these icons could then be 'dragged' from one box to another and the expenditure for each year would automatically change.

EMMY is capable of producing excellent expenditure reports which are of such quality that they could be used directly for managerial purposes. The reports were very sophisticated in appearance and were produced in minutes. A similar document would have taken several hours to produce using a paper system.

EMMY also allows the user the facility of making 'guesstimates' for future inflation rates, materials and labour separately. This facility could prove very important due to the dynamic nature of the building industry, where the swings of market forces and the mobility of the work force can have rapid effects upon costs.

10.3 Lessons Learnt by the Emmy Team

Although building EMMY was a legitimate goal in itself, providing a functional tool for maintenance managers, the *raison d'etre* of the researchers involvement was to

explore techniques of knowledge acquisition under realistic conditions. Traditional methods of knowledge elicitation had already provided unmanageable amounts of data for EMMY. This was further exacerbated by the large amount of qualitative data that the team had collected.

To illustrate this point the initial design of EMMY will be described. For technical reasons (limitations of software and hardware which have since been solved) it was decided to build EMMY in three modules. These followed a logical sequence, i.e.

Module 1

> *Description of the buildings*: in a form that could be encoded into software. Buildings were divided into their component parts, the characteristics of each of which were encoded into the module. This was an enormous task considering the number of parts or sub-classes (e.g. doors) in a building and the large variation that could exist in each sub-class, (e.g. interior, exterior, hardwood, softwood, solid, glass, partial glass, PVC etc.) The situation was further complicated by the fact that each variation in the sub-class had its own attributes.

Module 2

> *Devise and encode a maintenance plan:* this entailed gaining a detailed knowledge of the life expectancy of the various components of the building and drawing a plan of when each would need to be replaced.

Module 3

> *Costing module*: capable of matching the maintenance plan with the attributes of the sub-classes of the building components and allocate a cost to the year

on year maintenance of the building stock. This module was to offer considerable flexibility for the user and to allow 'what ifs' to be performed, indicate high spending years and produce the information in a variety of ways i.e. screen, hard copy or in a report form).

It was decided in the first place to describe (encode) the housing stock to provide a 'knowledge base' for the other modules to manipulate. This soon developed into a mammoth task. As mentioned above the sub-classes (which were numerous) could be found in many varieties each with its own set of attributes. The task was further complicated by the number of classes of building i.e. detached, semi detached, terraced etc. Which needed to be described and were perceived to also have an effect on the sub-classes. Allied to this were a set of perceived external conditions that would have an effect upon the life span of the sub-classes i.e. exposed position, sheltered position. The number of items of data required to estimate the life span of a door increased exponentially with the addition of each variable. It must be emphasized that this procedure was extremely difficult even with a relatively simple component of a building (e.g. door) which has an 'easily' estimated life span. If this procedure was to be carried out for every element of a building from foundation to chimney pot then the 'knowledge base' would be virtually unmanageable.

10.3.1   Further Complexity

In addition, the project had also elicited a considerable amount of 'thick' qualitative data, (for example the team had transcripts of many interviews with experts), however, analysis of this data, in a form useful to EMMY was proving problematic. Qualitative research of this kind provides large amounts of data, much of which is grounded in the background knowledge of the experts concerned, some of which is tacit. The EMMY team were finding it difficult to convert these transcripts into knowledge in a form capable of being incorporated into the EMMY Expert System. The sheer quantity of this data was difficult to manage and, in many respects,

irrelevant to the building of EMMY. Deciding when an item of expert knowledge is irrelevant for a particular instance and whether it can safely be left out of the EMMY system requires considerable expertise. However, the EMMY team had learnt several methodological lessons from their efforts. It is ironic to note that this 'complex' qualitative data was the key to reducing the complexity of the knowledge base.

10.3.2   Reduction of the Knowledge Base

As mentioned above, the problem for the EMMY engineers was not eliciting domain knowledge, but how to deal with the large quantities of data that they had already amassed. Attempts by the EMMY team to reduce complexity had taken two distinct courses.

10.3.2.1   Quantitative Reduction of Variables

In an attempt to reduce the number of variables, EMMY was being designed to cover only newly constructed (new builds) single family units. It was decided in the planning stage of the project, that old housing stock and multiple occupancy units were of such a variety that it was felt unrealistic to attempt to build all their potential variables into EMMY. Although this simplified the task for the expert system builders it dramatically reduced the utility of the expert system due to the fact that Housing Associations stock contains a considerable amount (up to 60%) of old and multiple occupancy units. In essence this,

> *reduced the complexity of EMMY at the cost of reducing its usefulness to potential purchasers.*

10.3.2.2   Qualitative Reduction of Complexity

The qualitative research had already indicated that there were large sections of buildings that were of no interest for the purposes of maintenance e.g. the foundations. Foundations are an important part of a building and extremely complex to describe, however, they require no routine maintenance. Foundations are constructed to last for the life span of the building and if they do fail for one reason or another it will require structural repair not maintenance. This was a very useful lesson, large areas of buildings could be safely ignored by EMMY without reducing its value as a tool to maintenance planing.

More importantly, the qualitative research also revealed that maintenance managers routinely simplify the way they classify buildings. For the practical-purposes of a maintenance manager the difference between a detached, semi detached and a terrace house does not exist. They are seen simply as a series of walls with openings. This simplified EMMY enormously, whole classes such as 'shape' and 'type of buildings' could also be ignored, reducing the number of variables and data exponentially. N.B. the importance of eliminating a variable at the class level has a dramatic effect on the reduction of complexity. The importance of these findings was indicated by the fact that several months spent trying to describe various types of buildings was abandoned and a simplified more relevant 'knowledge base' was set up.

> *Thus reducing complexity of EMMY without reducing its usefulness*
> *to potential purchasers.*

10.4 Areas of Focus for the Pilot Study

Maintenance managers have an in-depth knowledge of all aspects of the buildings in their care. However, their background knowledge enables them to ignore large amounts of their knowledge base. The process by which this is accomplished is very

difficult to explicate using traditional knowledge acquisition techniques which tend to elicit objective 'facts'. The way that domain experts in general, and maintenance managers in particular, selectively ignore large areas of their domain knowledge whether by the use of heuristics or other methods seems more amenable to a more subjective qualitative approach.

The researcher was attached to EMMY to try to gain first hand experience of knowledge acquisition in general and the elicitation of tacit knowledge in particular. The aim of the research was to test whether tacit knowledge could be elicited using sociological methods. At this stage it was felt that the way in which maintenance managers classify their professional world might be held 'tacitly' and therefore, it was proposed that while the knowledge elicitation should have no specific aims it would be interesting to the EMMY team if certain knowledge could be elicited.

10.4.1   Areas of Concern to the EMMY Knowledge Engineers

1)   **Logical Grouping of Tasks:** The idea of carrying out certain maintenance tasks at the same time (grouping) is common-sensical and cost effective. Certain jobs require preparation that could be utilized for other jobs. For example, to re-tile the roof requires that scaffolding is erected. Re-pointing the walls also requires scaffolding. It seems more efficient, therefore, to re-point the walls when the roof is being re-tiled. The two jobs could be completed and the cost of one set of scaffolding thus saving the cost of the second set of scaffolding.

If such groupings occur it would be a feature of EMMY to plan the maintenance in order that logical groupings of work coincide.

Prioritising of Tasks

A knowledge of the order of priority that tasks are carried out is essential. This is important for a future 'prioritising' function envisioned for EMMY. For example, assume that a plan has been drawn by EMMY for the years 2000-2200 and the cost is £29,000. If the budget for those years was only £25,000 it would be useful for a manager to have the facility of a 'button' which will allow the user to input, "The maximum budget for years 2000-2200 is £25,000", EMMY will then draw a plan that will include all the essential tasks and as many of the non-essential tasks in order of preference to a maximum cost of £25,000. To do this requires the elicitation of knowledge rather than data. The knowledge of how managers 'prioritize' i.e. decide which jobs can postponed till later and which ones cannot.

10.5 Fieldwork

The pilot field work took place at the West Pennine Housing Association. West Pennine is a small to medium housing association having in the year ending 31st March 1991 fixed assets of £41,573,547, current assets of £1,502,316 and a total annual income of £1,954,237. The association had a wide range of properties in the Oldham and Ashton areas. The EMMY team had found that this size of organization was most fruitful for knowledge elicitation being large enough to warrant a maintenance manager and requiring a maintenance plan, while at the same time being small enough to allow each member of staff to have direct knowledge of their colleagues' responsibilities.

The initial interview to assess the feasibility of carrying out research was with Stuart Mansell, Maintenance Manager, who is responsible for amongst other things assessing the future maintenance requirements of the Association's housing stock, costing these requirements, (putting a case to the finance department for the money), allocating the budget between the Area Housing Managers and monitoring the progress of the maintenance plan. It appears that the Maintenance manager is the ideal end-user for the EMMY expert system.

The researcher was granted full access to the whole office and given access to policy meetings and tenants committees etc., in order to gain an understanding of how these bodies operate and effect policy making. The main area of interest to the researcher was to gain an understanding of how the manager and his colleagues actually go about or to use sociological terminology *'construct'* their work. The manager showed an intuitive understanding of the task when he remarked,

'You mean you want to sit here and watch how information comes into
the office and is transformed into a maintenance scheme'

This was exactly what the researcher wanted, and over the next several weeks spent time observing the procedures in the office and shadowing various members of staff as they went about their every day work. It should be noted that the researcher has had many years experience in the construction industry which considerably facilitated communication with the maintenance staff about their duties. The point must be made that spending time watching people going about their work and asking questions to account for their actions cannot be said to be a sociological method (pace Garfinkel) [10] because clearly this is a natural part of the human condition, 'we are all doing it all the time'. It is only when it is used for sociological purposes that it becomes a sociological method. In the case in point what the researcher was trying to explicate was the social construction of 'facts' in this case a maintenance plan. The researcher differed from the knowledge engineers of the EMMY project in that he was not concerned in uncovering the underlying essential facts of a domain but with trying to understand how the domain was socially constructed. This would reveal not simple objective 'facts' but the dynamic relationship between the elements of the domain as it creates, maintains and recreates itself over time and space.

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[10] Garfinkel describes participant observation rather ironically as 'hanging around with folks'.

The dynamic nature of the domain was illustrated by the following conversation,

Researcher: At the moment EMMY is basically a strategic tool, i.e. it could be used to estimate the replacement times of various items in a building and the likely costs of maintaining the property over the next 60 years. However, at Salford we were well aware that due to limited resources sometimes it is just not possible to carry out maintenance to a strict plan.

Stuart: That's true we have to make a detailed plan of work every year but invariably it is altered and amended as the year goes on.

Researcher: That's inevitable its just part of living in the real world.

Stuart: How can you make a plan when people change their minds half way through. You know those wall mounted balanced flue heaters, well many of our properties don't have central heating or have partial central heating, well we started a scheme of using the wall heaters to get some heat into as many properties as quickly as possible. We set aside £20,000 a year for this and at first all went well, everybody loved it. However, once they got used to the better heating they started to complain that it was not as warm as central heating, it was also more expensive to run.

Researcher: Was it?

Stuart: No are they heck in fact they are very efficient at warming a bedroom to an adequate temperature, its no good heating a room if you don't use it, and many people are scared of fiddling with timers etc. but these (wall heaters) were felt to be awkward, you had to remember to switch them on half a hour before you went to bed, anyway now everybody has changed their minds and want to stop installing these heaters in favour of central heating. But where does that leave our strategic plan with a budget of £20,000 we can only do 4 or 5 properties a year, it'll take forever. How can we possibly formulate a strategic plan when they keep moving the goal posts in this way.

This conversation graphically illustrates the collection of objective facts is not adequate for a strategic planning expert system. In this case wall heaters by objective criteria are both economical and adequate. A strategic plan was therefore, drawn up to install all the terraced properties with wall heaters and £20,000 pounds per year was budgeted for this task. However, once these heaters were installed they were subjectively deemed by the tenants as expensive (compared to no extra heating) and inadequate (compared to central heating). There is a mounting pressure from the tenants to stop the installation of wall heaters, in favour of full central heating.

There appears to be two sets of criteria in action here: the objective attributes of the wall heaters; the subjective evaluation of the tenants. While the former is relatively static in nature the latter can be extremely dynamic. It should be noted that as in the case above the subjective notions have the power to transform the same objective criteria (N.B. the efficiency and economy of the wall heaters did not change) from adequate to inadequate. Strategic expert systems that are not designed to incorporate such subjective and inter-subjective notions are unlikely to be flexible enough for real world situations.

10.6 Results of the Pilot Study

It was mentioned above that domain experts have the power to reduce the complexity of their decisions by ignoring large areas of their domain. The problem for knowledge engineers is how to decide which elements can be safely left out of the knowledge base and which can not. This problem is exacerbated by the fact that experts ignore different areas of their domain in different situations. However, the experience of the EMMY team show that with effort it is possible to dramatically reduce the complexity of the knowledge base. The pilot study at the West Pennine Housing Association also revealed how experts tacitly reduce the complexity of the domain. The explication of tacit knowledge is important because experts reduce the complexity of their decisions by ignoring irrelevant areas of their domain by the

unconscious use of tacit knowledge.

By gaining an understanding of the tacit knowledge of the domain, this research was able to:

*   reduce the complexity of the knowledge base;

*   increase the accuracy of EMMY by uncovering key variables, which although not part of the construction domain had a dramatic effect on maintenance planning and costs;

*   increase the scope of EMMY to cover a much larger percentage of the housing stock.

10.6.1   Reducing Complexity

To reiterate the EMMY team had discovered (above) that for the practical purposes of building maintenance the size, type and shape of the building were of no importance, therefore, the description of a 'model house' would be sufficient for the purposes of EMMY. It was further discovered that for the practical purposes of building maintenance large parts of a building e.g. foundations are also irrelevant and could, therefore, be ignored. The pilot study further reduced complexity with the discovery of the 'prior to paint' document.

10.6.1.1   Documents as a Repository of Tacit Knowledge

A key document for the elicitation of 'hard facts' was what was known in the West Pennine Office as the 'prior to paint' document which contains all the external maintenance work on a given group of units. The prior to paint provided all the essential basic information for a maintenance plan, while at the same time eliminating

masses of information which only *appear* to be of importance. For example the prior to paint mainly concerns itself with items that keep the building water tight, mention is made to the pointing (the mortar joints between the bricks) but not to the actual bricks. This is because the bricks are held to be a barrier to water and needing no maintenance (they might need repairing due to damage, but they don't wear out) whereas the pointing is only a barrier if kept in good repair. The action of the weather can cause pointing to fail. Careful study of the prior to paint revealed that it contained all the necessary elements for a maintenance plan. Anything not appearing in the prior to paint could be safety left out of the data base. The prior to paint document reduced the vast construction domain into a list of maintenance jobs.

10.6.1.1.1   The Prior to Paint

The prior-to-paint is at one level a list of jobs that have to be carried out to the exterior before it is painted. However, the prior to paint is not simply a list of the jobs needed to prepare the external woodwork for painting but what is in effect an external survey of all the units to be painted in a particular year. The West Pennine stock is painted every 4 years, approximately 1/4 of the properties each year. This survey is conducted because it is pointless painting, for example a window frame which will need replacing within the next 4 years. Any window that will not last until the next 'paint' is therefore, replaced. This also allows the manager to know the condition of all the properties and will alert him to any property requiring major spending. It is not unusual for properties to be found to have structural deficiencies, these properties are not painted until a decision as to their future is decided. The prior to paint for these years will give an indication of how the Maintenance Managers redefine their total construction knowledge into what is necessary to produce a maintenance plan i.e. what is not contained in this document can, for all practical purposes of maintenance planning be ignored.

N.B. Once the importance of the prior to paint had been identified it could be studied

at the laboratory and therefore, avoid many of the time wasting problems associated with knowledge acquisition, e.g. finding experts, gaining access, travelling times, arranging appointments etc. It also offers opportunity for a longitudinal study to test the quality of the plan and if other Housing Association produce a similar documents, comparisons could be drawn and knowledge verified.

The Maintenance manager does not need or even want to have a plan of each building or a detailed description, all he needs is a list of maintenance jobs. For all practical purposes the housing stock for these managers has been redefined into a series of maintenance jobs, for them, all other aspects of the dwellings can be ignored.

The prior to paint conveniently provides such a list and for the purposes of EMMY can be regarded as the essence of a building maintenance manager's knowledge. It is not the sum of his knowledge, but the essential knowledge remaining after non-relevant knowledge for this specific purpose (i.e. the construction of a maintenance plan) has been tacitly filtered out. This is similar to the process Galliers (1987) describes whereby data is transformed into information with the addition of meaning. The importance in identifying documents such as the prior to paint is that it circumvents the more difficult task of trying to explicate tacit knowledge of the expert. Documents such as the prior to paint are the physical embodiment of the application of tacit knowledge.

This is not to say that the prior to paint provided the total knowledge that was required to be elicited. The prior to paint in many ways reifies how maintenance managers tacitly reduced their domain for the purposes of building maintenance. The claim that prior to paint is a reification of tacit domain knowledge might seem to cut across the argument that the building maintenance plan is a social construction. This, however, is not the case, the prior to paint is a reification of a social construction and is like all social constructions contingent, and is liable to change.

The following example illustrates this contingent nature by describing how components of a building can be redefined not only by the officers of the Housing Association but also by external bodies such as the tenants association. A group of tenants had requested some security walling to be erected around their properties. It was pointed out that if the walling was erected that there would be no money left for kitchen improvements for the next five years. The tenants chose the security walling, which was duly erected. This is an important consideration for knowledge acquisition, for in this case the subjective wishes of the tenants took precedence over the maintenance requirements of the building. This to some extent makes the quest for 'deep' knowledge of the life span of particular components of a building somewhat pointless, if once this knowledge is collected (at considerable effort) it can be over ruled by the wishes of the tenants. In many ways the search for objective 'facts' in the 'open system' in which technology operates, is a chimera. Although objective definitions are essential, they should always be regarded as contingent, only true under existing conditions and thus liable to change if and when said conditions change. In this case the life span of a kitchen had less to do with any objective measure of its inherent qualities and more to do with how long and under what conditions, the tenants find it acceptable.

This example, illustrates a more fruitful avenue to pursue is to view 'facts' as socially constructed and to investigate their construction accordingly. Once this step has been taken it allows facts to be viewed as artificial constructs and to try to reconstruct them from their various elements. For example the sub-class 'good_door' can have many 'slots' to define itself. In this hypothetical example, a good_door should be:-

1)   watertight.

2)   not_rattle.

3)   painted_every_4_years.

4)   not_stick.

5)   be_less_than_15_years_old.

However, if at a tenants meeting a priority for security may be raised, security may be added at the class level 'external_openings' this will be inherited by the sub-class 'good_door' giving a negative result for what was once using the objective inherent qualities of the materials been defined as a 'good_door'. Thus, what was once defined as a 'good_door' will have been socially redefined as now being a 'not-good_door' and this will therefore, require maintenance, i.e. work would be required to make the door secure even though it is still watertight etc.

The flexibility by which what was considered a 'good_door' at one point in time was redefined as a 'not_good_door' at a later time, seems to mitigate against the idea of tacit knowledge being reified in the prior to paint. This is not the case because as the social construction of the building maintenance plan changes, so will the components of the prior to paint. Therefore, any KIS which claims to contain domain knowledge, should have the facility to redefine 'facts' as an when required. The prior to paint will provide a useful indicator of when such a redefinition has occurred.

This facility is available in the EMMY package but is at present 'protected', however, should such a change of definition occur, the changes could (by a suitably qualified person) be made with comparative ease.

10.6.2   The Identification of Key Variables

The pilot study also revealed what managers consider a key variable. In the experience of managers the main determinant of the cost of maintaining a unit is not the type of buildings, the material of which it is constructed nor its location but different types of tenant. While every tenant is different they tend for the purposes of maintenance to fall into a small number of categories. These categories of tenants by and large inhabit separate areas (as far as maintenance costs are concerned). This is manifest in area differences of the prior-to-paint. If the painting cycle is every 4 years there are four documents which can be compared (this rolling scheme seems to

concentrate for logistical reasons in concentrated areas where possible). For example, the average cost of 'prior-to-paint' for a unit in area 1 was £400. The average cost of 'prior-to-paint' for a similar unit in area 3 was £1000. The tenant variable is more important than the 'type of house' for maintenance purposes. A semi in area 1 required much less maintenance than a semi of a similar type and age in area 3. This is a highly significant variable and should be built into any maintenance expert system. The prior-to-paint document, therefore, provides a tool for identifying key variables, which (as in this case) may be external to the formal domain knowledge. More importantly, although it may be possible to elicit from the maintenance managers that they tacitly know that the type of tenant is a key variable (to the amount of money that is required to maintain a property), the prior-to-paint provides a tool for calculating the effect of the variable.

10.6.3   Calculation of the 'Area Variable'

This variable can be calculated by taking the lowest spending area as a 'bench mark' and calculating the ratio, required by other units by reference to the prior to paint document. Care must be taken to check whether high spending areas in one cycle become low spending areas in the next. If this is so, then in a long term plan high spending cycles can be predicted and forecast and provision made in the associations budget. Logic would indicate that this is likely but it was not the case for the West Pennine Housing Association, where high cost areas are always high cost areas. If this is the case then when the prior to paint takes place in a high cost area this can also be predicted and provision made in the budget. A close study of the prior to paint schedules should, therefore, be undertaken to see which is the case in each particular Housing Association. The ratio could be calculated for individual Housing Associations offering a powerful 'bespoke' element, which could be updated as conditions change. For example if it turns out a high spending cycle followed by a low spending cycle this knowledge could be built into the system. Another possibility is the condition where for various reasons ('gentrification' or 'planning blight') the

category of tenants change in an area the variable for the area could be changed.

10.6.4   Extending the Scope of the EMMY System

EMMY was designed for the maintenance of a specific type of property, i.e. 'new build' (newly constructed properties) single family units. However, just as the maintenance managers do not (for-all-practical-purposes) seem to distinguish between different types of units, they do not distinguish new builds from referbs or even for 'external' maintenance purposes small multiple occupancy dwellings and single family units. To be more accurate they consider all the categories to be the same except for what can be described as a 'honey moon' period. After this period for the purposes of the managers 'new builds' and 'referbs' (old property completely refurbished) become a part of the general stock of the Association.

The honey moon period at the West Pennine Housing Association is approximately 15 years for new builds and 7 years for refurbs. These figures could be checked with other Associations and implemented accordingly. This could considerably extend the use of EMMY, considering the ratio of new builds to existing properties on the books of Housing Associations.

Much thought must be given to how to use the fact that after 15 years a new build unit is for-all-practical-purposes simply redefined as old stock for maintenance purposes. There is a possibility that by judicious use of the honeymoon variable it might be possible to extend functionality of the KBS to cover most of the single occupancy housing stock.

10.6.5   Who is the Expert?

The pilot study also uncovered instances of how facts are actively constructed by the staff at the housing association. This raised the questions about choosing a suitable expert for the elicitation of domain knowledge. This is usually accomplished in a common-sense manner. To elicit expert knowledge in a given situation it is simply a question of finding a suitable expert and applying (with varying degrees of success) the tools of knowledge acquisition. There are various problems associated with particular individual experts (Hart 1989) (Welbank 1983) but the expert tends to be identified as the person making expert decisions (Hart 1989). For example, in the case under study, if knowledge of how the maintenance plans of Housing Associations are constructed is required, it seems logical to go to the person responsible for making decisions as to what work will be done this year, cost the work and produce a budget for the coming year. The logical place to elicit this knowledge is therefore, Stuart Mansell the Maintenance Manager i.e. the man who is making these expert decisions daily and with some success. The choice of expert prompts such questions as 'how verifiable is this knowledge', would Stuart's decisions be corroborated (more or less) by other Managers from different Housing Associations, in short is the knowledge elicited, objective knowledge of his area of expertise.

This approach is basically a search for facts which exist out side the expert and the rules s/he applies to these facts to produce his expert decision. If this assumption is examined and the constructed nature of 'facts' is recognized the selection of the expert becomes more complex. The social construction of facts moves the focus of knowledge acquisition from the 'expert decision maker' to the 'constructor of the facts' from which expert makes decisions.

10.6.5.1   The 'Constructors of Facts'

The importance of identifying the 'constructor of facts' can be illustrated by the following example. The researcher accompanied Craig the maintenance surveyor to a house in which damp patches around the bedroom windows had been reported. They were shown into the house and around the window were damp patches, which had caused the wall paper to peel away. After a brief inspection Craig pronounced that the patches were not damp penetrating from outside but condensation. The tenant had not used the upstairs storage heaters and three people were sleeping in the room.

Craig: Do you know that everybody breaths out about half a pint of water vapor into the air during the night.

Tenant: No.

Craig: That's a pint and a half a night, it's got to go somewhere. If you don't heat upstairs it turns to water on the coldest wall, in your case by the window. There is only two ways to cure this either heat upstairs or open a window or preferably do both.

Once outside Craig started to write up his notes.

Researcher   Do you get a lot of condensation?

Craig: Yes, what can you expect, poor people can't afford to use the heating, it's bound to happen.

Researcher: What will you do?

Craig: Nothing we can do. What it really needs is window gutters so that the condensation will run down the windows and outside. But that will cost £x and I know the budget for them is used up already.

Researcher: If the money was available would you recommend window gutters?

Craig: Yes, of course. You see if we do nothing, she is not going to heat the room and the condensation will get worse. Eventually it will attack the plaster and we will have a plastering job on our hands.

This is an example of 'black holeing' a method by which facts are constructed. If for instance as in this example the budget has been spent then the damp problem would be diagnosed as condensation, no action would be taken and the job would be placed in the 'black hole'. If there is a possibility of the budget being underspent then the job can be taken out of the 'black hole' at a later date and window gutters fitted. By the use of the 'black hole' work can contract and expand to suit the budget requirements.

Once facts are recognized as being socially constructed, who has the power to 'construct' facts must be addressed if 'knowledge' is to be captured. The importance of the 'expert decision maker' is drastically reduced when it is recognized that data is not simply collected and presented but is activity constructed and the mode of this construction can have a considerable effect upon what decisions these 'experts' make.

10.7 Summary of the EMMY Pilot

The pilot was undertaken Firstly, in order that the researcher obtained 'hands on' experience of knowledge acquisition, and thus gain an understanding both of an expert domain culture and the culture of knowledge acquisition engineers. Secondly the pilot was to be used as a probe to test under realistic practical conditions preliminary findings as to the character, mechanism and modes of explication of tacit knowledge. The pilot was successful in both of these endeavors. Work by the EMMY team indicated the following

10.7.1   Findings About Tacit Knowledge

The pilot study highlighted the importance of tacit knowledge, and showed some of its nature and effects

1)   Tacit knowledge pervades even apparent structured tasks such as building maintenance

2)   Experts classify their domain differently than laymen, (e.g. for the practical purposes of building maintenance, a detached house and a semi are the same entity). From this we see that tacit knowledge is often problem orientated.

3)   The domain is classified by experts using a tacit knowledge understanding, rather than a formal knowledge of the domain. From this we see that tacit knowledge is often used in creating classifications and tacit knowledge does not respect formal disciplinary boundaries.

4)   The common sense way that experts understand their domain considerably simplifies the knowledge base required for decision making. Simplification of the knowledge base (especially where it does not reduce the power of the KIS) is extremely important for the design of expert systems. From this we see that the tacit knowledge can simplify without reducing power.

10.7.2   Findings about the Explication of Tacit Knowledge

The pilot study also suggested several fruitful avenues for the explication of tacit knowledge and (more importantly) that at least some tacit knowledge can be explicated.

1)   The tacit knowledge of a domain is subjective, therefore, the knowledge engineer must not focus too intently on the inherent objective characteristics of the domain.

2)   Decisions are often made using knowledge external to the domain. The knowledge engineer must be aware of this and seek it out.

For example, the maintenance plan is not based on a survey of the jobs that need doing, followed by a costing of the jobs which are budgeted in the following years. In fact the budget is agreed and the maintenance plan is designed to fit the budget. Therefore, knowledge of the budget is external to the domain but essential for the construction of a KIS.

3)   Official documents can indicate simplification of domain knowledge, and these often reveal tacit knowledge.

e.g. Prior-to-paint distills the knowledge base into a list of maintenance jobs.

4)   Tacit knowledge often dictates key variables which are external to the domain knowledge base. The knowledge engineer should actively seek such variables.

e.g. A key variable was the area variable. The cost of maintaining a property had more to do with the type of tenant than the type of building. The prior to paint showed that a property in area 'A' maintenance would cost £400 whereas the prior to paint for the same type of property in area 'B' would cost £1,000.

5)   The constructor of 'facts' is of interest to knowledge acquisition as well as formally recognized experts.

e.g. Most KIS concentrate on expert decision making. In doing so they seek to capture the relationships that experts use to make rational decisions. The above indicates that often this is at too high a level for knowledge elicitation. Much of the domain knowledge exists at a lower level i.e. the constructor of the facts, upon which decisions are made.

These Findings indicate an in depth study into the nature and characteristics of tacit knowledge and it's explication is warranted.

Chapter 11

The Main Study

11   The Main Study

The pilot study showed some useful aspects of tacit knowledge, and that at least some of it could be explicated. It also suggested some techniques for the explication of tacit knowledge.

A larger study was then undertaken, which forms the main study of the research. The main study took the form of action research which was deemed appropriate for the following reasons:

*   Tacit knowledge is problem orientated, the researcher should be involved in problem solving.

*   Tacit knowledge is not accessible to formal knowledge acquisition techniques, the researcher must be immersed in the activity, rather than an observer of it.

*   Immersion would allow the researcher to gain the trust of the respondents, who would be more likely to 'open up' and reveal tacit knowledge.

*   Participation would make the identification of key variables easier.

*   Immersion in a cross disciplinary area not only removed possible ambiguities by gaining *Verstehen*, it allowed the researcher to utilize ambiguities as a research tool, for the explication of tacit knowledge.

The main study was conducted in a maternity unit in which the researcher acted as a consultant and software developer.

11.1 The Structure of the Main Study

Based on the experience of the pilot study it appeared that the traditional Ph.D. format (whereby, once the research question is identified and the research designed the Findings are presented in separated chapters of 'Data Collection', 'Discussion') would not be possible. This is due to the fact that tacit knowledge is an inter-disciplinary topic and as yet no consensus of its characteristics, or methods of explication has emerged. In practice, during the fieldwork tacit knowledge often emerged in unusual places, e.g. while interviewing a midwife about the interface a point emerged where tacit knowledge became revealed and was discussed. It is therefore, proposed that points where the tacit knowledge emerged will be discussed as discrete episodes, in order to gain a better understanding of the phenomenon. It is hoped that this fuller understanding can inform more systematic research conducted in the future.

11.2 Outline of the Main Study

The main study is now described at length, it is structured in the following way.

*   The effect of culture upon the process of childbirth is briefly outlined.

*   A description a Area 1 and Area 2 Maternity Units.

*   The similarities of the units are outlined in order to show that a comparison of the two units is appropriate.

*   A description of the Area 1 Maternity System.

*   A description of the Area 2 Maternity System.

*   A description of giving birth at Area 1 maternity unit.

*   A description of giving birth at Area 2 maternity unit.

*   A comparison of the Area 1 and the Area 2 maternity unit.

*   A discussion of the differences in the management of pregnancy between Area 1 and Area 2 maternity units.

*   Method One, for the elicitation of tacit knowledge at the macro level (world views of organizations).

*   Method Two, for the elicitation of tacit knowledge at the level of the organization (criticality of tasks).

*   Method Three, for the elicitation of tacit knowledge at the micro level (interface design).

*   Method Four, for the elicitation of 'extra mural tacit knowledge' (key variables tacitly held that are external to the domain knowledge.

11.2.1   Cultural Background

In order to place the main study in context the cultural background to pregnancy will now be briefly outlined. Pregnancy and the act of giving birth, can be considered as a biological act, however, the effect of culture on the process can be very dramatic. Anthropological studies reveal great diversity of how the pregnant woman is regarded, the special status (or other) a pregnant woman receives, the length of time seen appropriate to the recovery from giving birth and by whom and how the children are raised. There is a temptation to take an ethnocentric view of the process,

whereby cultural differences are explained by reference to primitive mind sets of less advanced societies which will disappear, once they are exposed to the advantages of modern Western medicine. However, this does not explain the diversity in the way the pregnancy is managed by modern industrial societies. Oakley (1984) notes,

> *'53 per cent of babies are born at home in Holland, none in Sweden,*
>
> *1.3 per cent in Japan, 2 per cent in the German Democratic Republic,*
>
> *3 per cent in Canada and 15 per cent in Denmark.' (p. 16)*

A case could be constructed to account for this discrepancy being due to political economic policies of the different countries, i.e. richer countries can afford more hospital births. However, even if the purely biological aspects of the process are taken into account a considerable diversity exists. Oakley (1984) also notes,

> *'Instrumental deliveries, for example, made up 36 per cent of all deliveries in the United States in 1973, 11 per cent in England and Wales and 4 per cent in Norway.' (p. 16)*

Unless there is a physical anomaly that leaves over one third of American compared to only 4 percent of Norwegian women incapable of 'natural' childbirth then clearly other factors must be at work. The effect of non-biological factors is indicated by Chalmers and Richards (1977),

> *'Inductions accounted for 17 per cent of births in England and Wales in 1967 and 39 per cent in 1974. In Norway, the two figures were 11 per cent and 14 percent.' (pp. 39-40).*

11.2.2   Medicalization of Child Birth in the UK

Given the diversity in the way that pregnancy is managed in modern industrial societies it is pertinent to briefly discuss the situation in the UK. The 20th Century has witnessed the medicalization of child birth in the UK. This began at the turn of the century when midwives were first registered. The appalling numbers of infant and maternal deaths increasingly brought childbirth to medical attention. Gradually medical attention has been extended from the hospitalization of 'high risk' mothers to the hospitalization of almost all mothers. Minturn and Lambert (1964) note,

> *'In 1927 the hospital confinement rate was 15 per cent; in 1974 it was*
> *96 per cent.'*

Brown and Harris (1972) also point out that,

> *'In 1975, 99 per cent of first babies were born in Hospital.'*

The last 100 years have seen a remarkable reduction in infant mortality from 1560 deaths per 10,000 to 160 deaths per 10,000. During this period maternal mortality has dropped from 48 deaths per 10,000 to 1 death per 10,000. This improvement is usually attributed to increased medicalization although Chalmers and Richard (1977) point out up to one third of this improvement is probably healthier better nourished parents, better environment factors and smaller families. The medicalization of maternity and increasing hospitalization has had dramatic effects on organization of maternity units. This will be briefly outlined below in respect to Area 1 and Area 2 Maternity Units in order to gain a better understanding of the context of the domain.

11.2.3   The 'hospitalization' of Pregnancy

Improvements in medical technology in the 1970's and 1980's brought pressure to restructure maternity units. In an attempt to reduce the antenatal and perinatal death rate more modern technology was used to anticipate potential problem mothers. However, modern technology is very expensive and only feasible if concentrated in large hospitals capable of servicing large numbers of pregnant mums. Care during pregnancy was increasingly concentrated in hospitals, and the practice of putting all mothers in labour together in a 'high risk' area with a greater number of midwives per patient, resulted in the division of pregnancy care into separate ante-natal, intra-natal and post-natal elements.

The hospitalization of giving birth has transferred control of the process from autonomous midwives working in the community to hospital doctors. This change in control has been so marked that Davis and Evans (1991) describe modern midwives as 'doctors assistants'. This development is surprising when the division of labour is taken into consideration. Midwives are responsible for the facilitation of the vast majority of pregnancies. Doctors deal with the complicated, abnormal births (approximately 20%), however, they are also responsible for deciding which women fall into this category and therefore screen all women presenting at the ante natal clinic. The routine assessment of pregnant women by doctors and the increased hospitalization of giving birth (where doctors are always on hand in case of emergency) has resulted in the process of giving birth being regarded more and more as a medical 'problem'.

11.2.4   Critique of Medicalization of Childbirth

The trend towards medicalization of child birth has of late been vigorously criticized from two strange bedfellows, the Libertarian Right and the Feminists movement

demanding a new ethos for maternity management. This debate has been conducted around two discourses, that of 'risk' and that of 'control'. The doctors arguing for medicalization in order to minimize risk, while there critics argue that medicalization removes freedom of choice and takes control from the mothers.

In response to these criticisms in 1992 the Government has set up a Commission to investigate the whole area of maternity care. The Expert Maternity Group Report 'Changing Childbirth' was set up. The report recommended the following indicators of a successful provider of maternity care.

Indicators of Success

Within 5 Years:

1.   All women should be entitled to carry their own notes.

2.   Every woman should know one midwife who ensures continuity of her midwifery care - the 'named midwife'.

3.   At least 30% of women should have the midwife as the leading professional.

4.   Every woman should know the lead professional who has a key role in the planning and provision of her care.

5.   At least 75% of women should know the person who cares for them during their delivery.

6.   Midwives should have direct access to some beds in all maternity units.

7.   At least 30% of women delivered in a maternity unit should be admitted under

the management of the midwife.

8.   The total number of ante-natal visits for women with uncomplicated pregnancies should have been reviewed in the light of the available evidence and the RCOG (Royal College of Obstetricians and Gynecologists) guidelines.

9.   All front line ambulances should have a paramedic able to support the midwife who needs to transfer a woman to hospital in an emergency.

10.   All women should have access to information about the services available in their locality.

This was a considerable departure from past practice, regarding pregnancy for the vast majority of women to be a normal if 'altered state' rather than a pathological condition requiring medical management.

The report requires 30% of all births in the next 5 years are to be completely midwife managed. When a woman thinks that she is pregnant she will not go to her G.P. but consult a midwife directly. The midwife will have a case load for which she will have total responsibility. Within the 5 years up to 30% of pregnant women will not consult a doctor at all, her pregnancy from diagnosis to post natal care will be the responsibility of a midwife. This will have a dramatic effect on the funding of G.P.'s and Obstetric Consultants who are paid by the number of pregnant women on their register. The report also requires that,

'Within 5 years, 75% of women should be cared for in labour by a midwife who they have come to know during pregnancy'.

This will require a fundamental change in the working practice of doctors and midwives.

Having described the background to maternity care in the UK the maternity management at Area 1 and Area 2 Maternity Units can now be described, in context and assessed in the light of recent Government policy statements.

11.3 The Main Field Work

11.3.1   Introduction

This chapter describes in detail the Maternity Units and is thus lengthy. It was considered putting much of this in an appendix, but because much of the following is germane to the main Findings, it was decided that it should remain in the main text. On initial reading the reader might wish to skim the bulk of the chapter and read the specific differences and summary of the Findings at the end of the chapter, then return to the detail as and when needed. The sections are:-

* The similarities of the units are outlined in order to show that a comparison of the two units is appropriate.

* A description of the Area 1 Maternity System.

* A description of the Area 2 Maternity System.

* A description of giving birth at Area 1 maternity unit.

* A description of giving birth at Area 2 maternity unit.

* A comparison of the Area 1 and the Area 2 maternity unit.

* Summary.

11.3.2   Similarities Between Area 1 and Area 2 Maternity Units

Area 1 and Area 2 units are similar in many ways. They are both a part of the same Regional Health Authority. At present (1993) the Region is divided into District Health Authorities (DHA's), Family Health Service Authorities (FHSA) and NHS Trusts 4 of which provide all services for their catchment area. Two of these NHS Trusts are the Area 1 and Area 2 hospitals which are studied in this research. (It must be noted that NHS Trusts have considerable autonomy in respect to how they provide health care provision, however, at the time of the field work for this research the hospitals were newly created Trusts and the full implications of this new autonomy was yet to be felt.

Area 1 and Area 2 are both situated in the same District Health Authority are comparable in several ways.

Regional Health Authority

Both maternity units operate under the auspices of the same Regional Health Authority and have to meet the same standards and criteria within comparable budget restraints.

Type of Hospital Trust

Both Trusts provide all health services for their respective catchment areas (i.e. neither is a specialist unit).

Type of Community

.

The communities serviced by the Area 1 and Area 2 are remarkably similar. Both service towns in the same region. Historically both are industrial towns whose wealth

grew out of the same industry. Although this industry has all but disappeared of late it has left a legacy of a large Asian minority in each town. The communities are fiercely independent and have a strong pride in their town and its facilities. Area 1 and Area 2 contain all levels of social class. The catchment area for Area 2 is slightly more rural, but its core area is very similar to that of Area 1. The collapse of manufacturing industry in this area during the 1980's has left these towns with a large unemployed population, many of whom, are members of an under-class in that they have never worked and are unlikely to do so in the near future. There is a large amount of multiple deprivation (e.g. low income + bad housing + bad schooling + poor nutrition + big families etc.). Amongst this group there is a considerable amount of drug abuse and criminal activity to pay for this habit.

11.3.3   Similarities in Maternity Care at Area 1 and Area 2

The maternity care provided by both organizations has to comply with the legal criteria imposed by Central Government and policy requirements of the same Region Health Authority. Both organizations are required to provide ante-natal, intra-natal and post-natal care for the pregnant women of the area and their babies. They are required to keep records of these events, which constitute legal documents. The legal importance of these documents is fully recognized by the staff in both organizations. Both units categorize pregnant women as either 'high' risk mothers (who are under the care of the consultants and their team) or 'low' risk mothers (who remain totally under the care of the midwifery team). The routine ante-natal tests and ante-natal history taking are performed by the midwives in both organizations. In the community almost all the antenatal care for 'normal' or 'low' risk women is provided by community midwives of the respective areas. 'High' risk mothers receive antenatal care from the midwives under the supervision of consultants. 'Normal' births are attended by midwives and 'problem' births are attended by doctors assisted by midwives. Postnatal care is provided by midwives, in the hospital and community midwives when the mothers return home.

5.3.2 Philosophical Considerations

In order to illustrate the nature of domain specific tacit knowledge it is necessary to briefly discuss certain philosophical considerations. The nature of explicit rules of social institutions are first discussed, in order to inform the discussion of the nature of the tacit knowledge of social institutions (for example, expert domains).

5.3.2.1   Explicit Rules

Winch (1958) contends that the study of human society is fundamentally different than the study of the natural world and thus requires different methods of investigation. Winch (1958) uses Wittgenstein's (1953) notion of *'following a rule'* to show the relation between thought and reality. Winch (1958) will be extensively quoted in this section, due to his elegant and extremely economic style. Winch (1958) notes that,

> *'[T]he notion of following a rule is logically inseparable from the notion of making a mistake.'* *(his emphasis page 32).*

One can only be said to be following a rule if it is possible to tell when one has transgressed the rule. This seems at first contradictory, however, if it is not possible to break a rule (even theoretical) then all actions are possible, in such a situation no rule can exist. Furthermore,

> *'[T]he point of the concept of a rule is that it should enable us to evaluate what is being done.'* *(his italics page 32).*

For an individual to follow a rule there must be external checks on his/her actions. Such external checks require that the rule be publicly accessible. Therefore, Firstly, one can be said to be following a rule if it can be broken; secondly, evaluation of whether a rule has been broken requires the rule to be publicly accessible.

```
      "PREV PERINEAL DAMAGE"
      OTHER
   END
END

SUTUREDEPI
   Legal
      "MIDWIFE GRADE E"
      "MIDWIFE GRADE F"
      "MIDWIFE GRADE G"
      "MIDWIFE GRADE H"
      "MIDWIFE GRADE I"
      "MIDWIFERY TUTOR"
      "STUDENT MIDWIFE"
      "CONS. OBS."
      "SNR. REG."
      "SHO. OBST."
      GP
   END
END

SUPERVIS01
   Legal
      "MIDWIFE GRADE E"
      "MIDWIFE GRADE F"
      "MIDWIFE GRADE G"
      "MIDWIFE GRADE H"
      "MIDWIFE GRADE I"
      "MIDWIFERY TUTOR"
      CONSULTANT
      "SNR. REG"
      REG
      "SHO. OBST."
      GP
   END
END

SUTUREMATE
   Legal
      SOFTGUT
      DEXON
      OTHER
   END
END
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relatively 'pure' state i.e. the tacit knowledge that the 'modern' system of maternity care is predicated upon taken to its logical conclusion, unsullied by the tacit knowledge of other world views. The situation is doubly fortuitous in that it appears that the domain is in the throws of a paradigm shift, a situation where a new consensus has yet to emerge. Latour (1983) maintains that construction of knowledge is characterized by long periods of consensus and short bursts of controversy. At points of controversy the social construction of domains and the tacit knowledge it is predicated upon become visible, as the domain is contested. Therefore, the situation in Area 1 was particularly suitable for the study of tacit knowledge.

11.6   The Area 1 System of Childbirth

The New Maternity Unit is now located on three floors. The ground floor is given over to ante-natal care, the first floor accommodates the post-natal care and the Central Delivery Suite (CDU) is located on the second floor close to the operating theatre. Locating the maternity unit on three floors has completely transformed the provision of maternity care to the mums of Area 1 and radically changed the working practices of the maternity staff.

11.6.1   The Central Delivery Unit (CDU)

The CDU is the hub of the maternity provision at Area 1. This is the area where all mothers deliver their babies. It is a modern, light, tasteful, and professionally decorated unit, which gives the appearance of a high class hotel rather than a hospital. The CDU is situated on the 2nd floor which affords easy access to the operating theatre should an emergency occur. The CDU has taken advantage of the 'late developer effect, and the latest technological and logistical advances which have been incorporated in its design. The central delivery unit contains an open office area from which the midwives work and a row of delivery 'suites'. The 'suites' are self

contained areas with every aid to the facilitation of child birth is on hand, including such luxuries as 'en suite' bathroom. The CDU gives the impression of a state of the art facility upon which no expense has been spared.

When the mothers in labour arrive at the CDU with their partners they are quickly 'booked in' their records retrieved and allocated a midwife and a delivery suite. If all is well the midwife facilitates the mother in child birth. If problems occur the doctor is called and s/he has all the equipment needed for a 'difficult' birth at hand in the delivery suite. If complications occur then the theatre is prepared and the mother is wheeled the short distance to the theatre and operated on. This system is helped by the fact that a core team of about 8 midwives work on the CDU, and at any one time at least 2 will be on duty. This core of midwives see all the births at Area 1 and are extremely well experienced (compared to a normal midwife) and therefore, have great expertise when complications occur. If the birth is normal the mum is transferred with her baby to the post natal ward.

11.6.2 Post-Natal Ward

The post natal ward is situated on the first floor. When the mother has given birth she is sent down from the CDU with her baby to the ward where she is given post natal care. If she has had a complicated birth such as a cesarian section she is given post operative care as well as post natal care. In such cases the baby may be sent to the ward but is often sent to the Special Care Baby Unit (SCBU), which is an intensive care unit for the new born. Low weight, premature or babies with a medical problem are sent to the SCBU.

If the birth is uncomplicated and the mother is well enough she will usually be discharged with her child after approx 6 hours. In such cases the woman will receive her post natal care at home by the community midwife. If the birth has been exhausting or the woman has problems at home (e.g. no social support at home or a

number of small children for whom she is responsible) the mum might remain on the ward for 48 hours where she is given post-natal care. If the birth has been problematic the baby may be transferred to the Special Care Baby Unit (SCBU), the mother is transferred to the post natal ward where she is given post natal and or post operative care. After 2 days the mother is usually discharged home where she receives post natal care from the community midwife.

11.6.3   Ante-natal Clinic

The ante-natal clinic will be described in more detail. The systematic nature of this area allows the researcher to draw many inferences about the tacit knowledge of the domain. The ante-natal clinic is the area of pregnancy over which the staff have the most control. They can be pro-active during ante-natal period in a way not possible during other areas of pregnancy. For example, when women go into labour they contact the CDU, which then reacts to their needs. The post-natal wards are a similarly reactive. Although to design an integrated maternity system both these areas would have to be investigated, for the purposes of this research the ante-natal process was focused upon. The pro-active nature of the ante-natal process made knowledge acquisition less problematic. It was easier to conduct because much of the 'noisy environment' associated with other parts of the process was not present.

The ante-natal clinic is situated on the ground floor of the maternity unit with an entrance that opens directly on to the street. The position of the antenatal clinic in the maternity unit is symbolic, in that it is a 'half way house' between the outside world and the hospital proper. This is a practical consideration in that the antenatal clinic is essentially an 'out patient' service, thus, affording easy access to members of the public. The ante-natal clinic also acts as a barrier to prevent members of the public entering the hospital 'proper', to which for security reasons, must have access restricted. Figure 11.1 provides a plan of Area 1 ante-natal maternity clinic.

Floor Plan of the Area 1
Antenatal Clinic

| Blood Testing Room | | Dressing Room | Examination Room (1) |

Corridor to Scan, Wards and Outside

Dressing Room | Examination Room (5)

Row of Chairs

Parent Craft Room and Creche

Dressing Room | Examination Room (6)

Sister's Office

Toilets

Office | Reception Area

Interview Room

Waiting Area | Benches

Snack Bar

Interview Room

Street
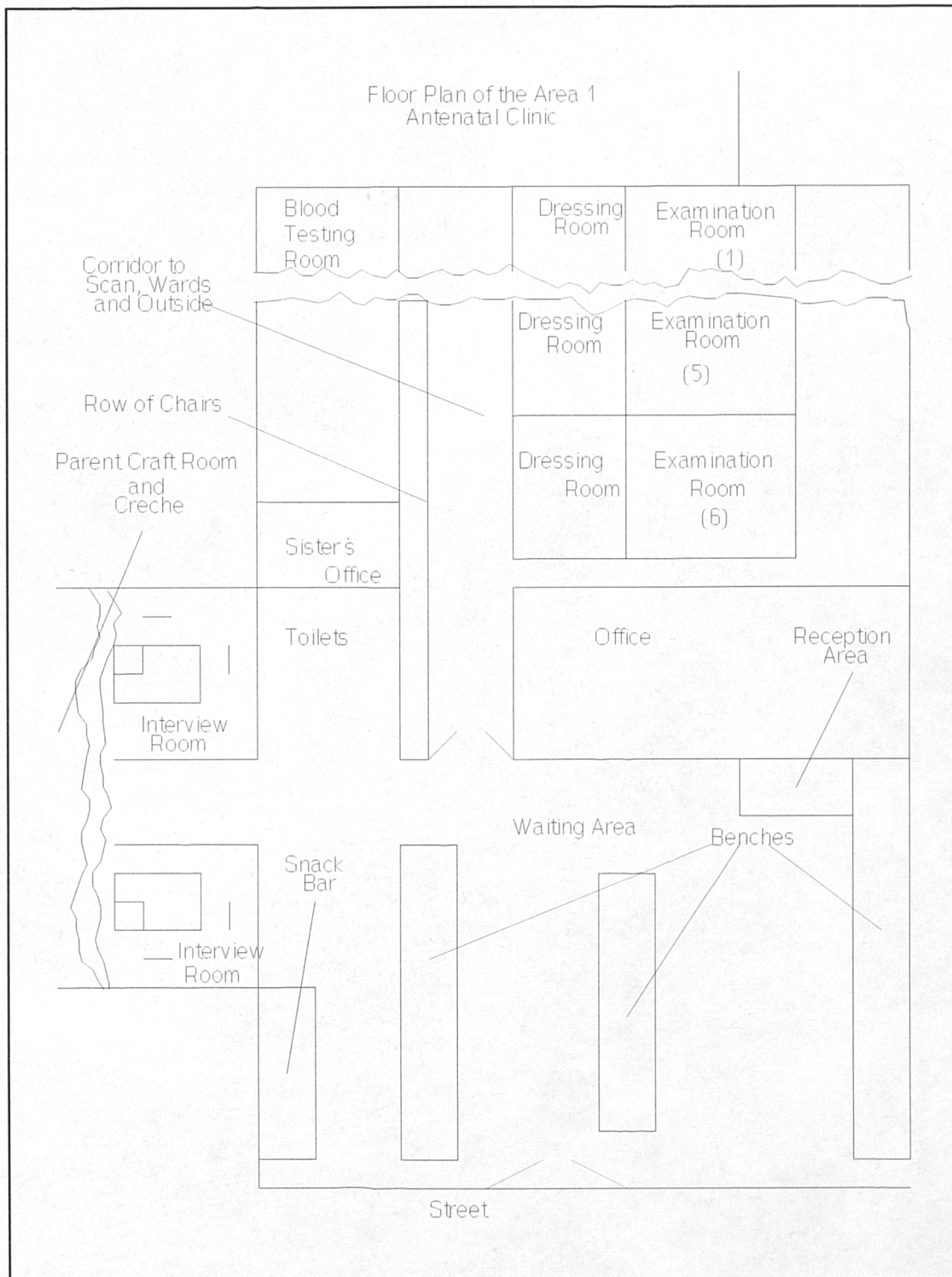
Figure 11.1   Area 1 Ante-natal Clinic

The first impression of the ante-natal clinic is the high activity level. The waiting room is crowded with pregnant women, some clinics handling up to 130 women at a time. There is an appointment system but everybody gets a 9:30 appointment. Many of these women already have children and are forced to bring them to the clinic, others understandably bring partners or friends. There are no creche facilities so these children (simply being children) add considerably to the noise and stress level of the already noisy overcrowded waiting room.

The women then begin queuing, they queue to book in with the clerk, they are then sent queue for the toilet to provide a urine sample. They then weigh themselves on a machine which provides a print out (this seems to have run out of paper so a midwife stands and records the weight on a piece of paper which she gives to the woman to take with her to where it is 'booked in'. The women then queue to have her blood pressure taken and then queue again to have blood taken. Finally she has her medical and obstetric history taken and recorded on the Gynecological Information Technology (GIT - a computerized database system). She is then sent to a long corridor which contains a long row of cubicals where she queues to be examined by the consultant or one of his/her team of doctors. This process takes a considerable time 4 hours is not unusual but most can expect to wait at least 2 hours for the initial booking clinic. This is not taking into account the traveling time to and from the hospital. Many of the mother-to-be us public transport. There are no refreshment or creche facilities and no facilities for confidential consultation and counseling (some women especially very young girls might not want to be seen by neighbors in a maternity unit). It must be noted that the midwives are well aware of these problems and have to deal with them daily. The mothers-to-be are understandably considerably dissatisfied with this system. In a recent questionnaire they made frequent illusions to cattle markets and being 'herded' from place to place.

11.6.4   The Staff in the Antenatal Clinic:

11.6.4.1   Consultants

The consultants with their backup team run several clinics per week. The consultant seems to be at the hub of the whole activity. The mum moves around the various sections of the clinic, giving information and being subjected to various tests finally to arrive with the results of all this activity to be assessed by the consultant. The whole unit appears to function around the consultant, providing him/her with the information required to make his/her assessment of the mother-to-be. The consultants have a great deal of autonomy as to how the clinic functions. This is revealed in the different ways that individuals organize 'their' clinics. (N.B. the consultants actually regard the clinics as 'theirs'). This autonomy extends much further than particular opinions regarding medical practice and extends to the minutiae of organizational procedure. For example, one consultant refused to have an interchangeable name plaque placed outside the cubicles so the mothers-to-be would know which consultant was on duty. N.B. this is in the face of NHS policy.

11.6.4.2   Midwives

The midwives tend to take responsibility for a single task in the clinic. For example, one of the midwives is responsible for taking the blood pressures of all the pregnant women. The women queue up in order for her to carry out this task, because each midwife is confronted with a queue of 'mums' make them appear extremely overworked. The fact that queues are a part of the normal running of the system means that if for any reason somebody is delayed the queues become intolerable. The midwives seem to be performing a reactive role, rushing around trying to elevate the inevitable bottle necks as they occur. An indication of the work load is the fact that the staff often have no time for a meal break or for restocking the clinic. Staffing clinics from the wards on an *ad hoc* basis is also an inefficient practice. When a

'bottle neck' occur for various reasons or when staff are absent midwives from the post natal wards are used to alleviate the pressure. However, these midwives are not used to the work in ante-natal and it is often counterproductive to bring them down (the wards are on the first floor). They need instruction about the task they are required to perform, this has to be given at a time when the ante-natal staff are already overstretched. The new maternity unit has radically transformed the working practice of the midwives from the 'integrated care' system of Mat1 and Mat2. The work of the midwife has been 'atomized' into discrete compartments, and individual midwives tend to specialize for various reasons in one or two of these compartments. There is a system of internal rotation between the three floors, but individuals have inevitably made niches for themselves. This results in highly qualified experienced midwives spending all day executing a single task such as, taking blood pressure.

11.7 Structure of Area 2 Maternity Unit

Given the fact that Area 1, and Area 2, provide the same service under the same constraints to the same standard, one would expect a considerable resemblance in the delivery of said service. However, although there are similarities (e.g. the fragmentation of care into ante, intra and post-natal care etc.) there were considerable differences between the two organizations, which might prove useful for the explication of tacit knowledge. The Area 2 ante-natal clinic will be described below and the differences between the two clinics will be discussed in the next chapter.

11.8 The Area 2 Ante-natal Clinic

The first difference noticeable to the researcher was the ease of assess to Area 2 ante-natal clinic. Given the problems of gaining access to Area 1 when the senior midwife at Area 2 was first contacted it was emphasized that any research would be conducted around her staff, the researcher was willing to come at any convenient time in order

that the clinic would not be disturbed. She said that in any time that was convenient to the researcher was convenient with her. An appointment was arranged for 2pm on the following Tuesday, and an artificial ante-natal booking was arranged. The midwife (MW2A2) showed the researcher and the 'dummy' mum-to-be, Donna around, the researcher remarked

R: 'I'm glad that we are not interrupting anything, arriving
              on a non-clinic day.'

MW2A2   'What do you mean the clinic is running now.'

The difference between the hectic, noisy, busy clinic of Area 1 was remarkable the room was almost empty, one or two members of staff were wandering around and there was a single woman and her child in the waiting room. (please compare this situation to the Area 1 ante-natal clinic above). To reinforce this point the Midwife seeing that the researcher had noticed the woman, remarked that although they have an appointment system sometimes mums have to wait a short while, but the staff regard a 30 minute wait unacceptable. I told MW2A2 that far from noting a woman was waiting, I simply thought after my experience at Area 1 that it was inconceivable that a clinic was running. The difference between the two clinics striking and it was difficult to believe that the two clinics were performing the same task with the same ratio of midwives:mothers-to-be. Figure 11.2 is a plan of the Area 2 ante-natal clinic
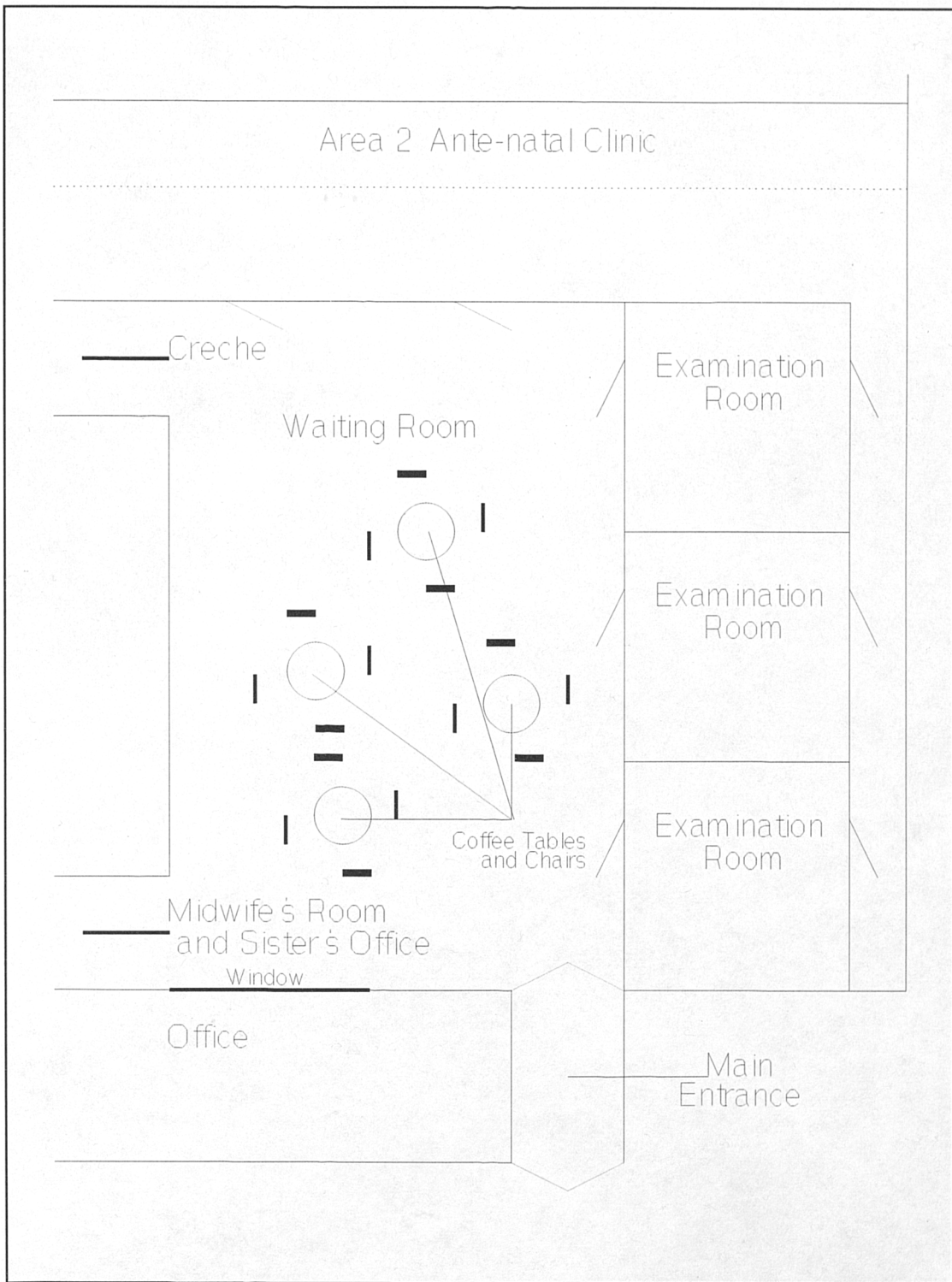
Figure 11.2   Area 2 Ante-natal Clinic

Donna was shown into a side room where the interview was video taped. MW2A2 explained that at this stage Donna would normally be assigned a 'named' midwife. This midwife would come to the reception room and escort the mum into a similar side room (see Figure 11.2). MW2A2 began by introducing herself and explaining to Donna that she was her 'named' midwife.

All procedures (taking blood, blood pressure, weighing, urine sample ante-natal history taking etc.) would be conducted by MW2A2 in the side room. The bulk of the procedures would be conducted by MW2A2, the doctor would come into the room and carry out several medical procedures, then MW2A2 would finish off the interview. The details of the antenatal history-taking can be found later in this chapter.

11.9 The Process of Giving Birth in Area 1

The vast majority of women in Area 1 give birth at the Area 1 maternity unit. Recently home births are becoming more popular, however, these are restricted to women who are considered to use Oakley's (1984) term,

> '[N]ormal enough to give birth with the minimum of midwifery attention'.

Even such women are nominally under the care of the Maternity Unit, they have to be judged 'suitable' for a home confinement by a consultant.

The majority of women in Area 1 give birth in hospital. This process will now outlined below.

N.B. The process outlined below is only for 'low risk', mum who are expected to give birth without complications. 'High' risk mums or mums who are experiencing

or expecting complications are treated on an *ad hoc*, individual nature.

Antenatal Process

6 - 8 Weeks

Usually women who suspect they are pregnant 'present' to the G.P. at about 6 weeks. Until recently the doctor would not 'test' if they are pregnant until after 12 weeks or after they had 'missed' three periods (menstruation cycles). Advances in pregnancy testing has reduced this time lapse and many women are presenting to the doctor if they have only missed one menstrual cycle.

This has had two effects which by and large are not recognized by the doctors as problematic. These effects are briefly noted here and will be brought into the discussion later. Firstly, early presentation has increased the span of being positively pregnant, from 6 to 8 months, with all the restrictions that a pregnant woman now has to endure, e.g. no smoking, no drinking, healthy eating etc. Secondly it has increased the number of known and grieved miscarriages. Many pregnancies spontaneously abort in the first 12 weeks. Before the advance in pregnancy testing when this happened and the woman tended to treat the event as a 'false alarm' and feel that they weren't really pregnant but for one reason or another they had missed a period. Now they know positively at 6 or 8 weeks that they are positively pregnant and if they then menstruate they know that they have had a miscarriage and often feel a great sense of loss).

On the first visit, the doctor will take the mum's urine sample and tell her to ring for the result in 3 days. If the woman is confirmed as pregnant, she is from this point seen as being under the responsibility of the G.P. for which he receives a fee from the NHS. The G.P. may or may not examine the woman at this stage but s/he will recommend a consultant and write for an ante-natal appointment. The woman

becomes one of the consultants 'patients' for which he receives a fee. (N.B. both the consultant and the G.P. are paid for the number of pregnant women on their register rather than for the care that they provide for these women). The woman is then made an appointment at the consultants ante-natal clinic usually at 12 weeks.

12 Weeks

The G.P. may or may not choose to see the woman at this stage. G.P. care may be provided by the G.P. personally but it is much more usual for this care to be provide by the community midwife. At 12 weeks the woman will also attend her first ante-natal clinic or 'booking clinic' (this is an anachronism and recalls the time when the woman would 'book' her hospital bed at this visit). She is weighed, has her blood pressure taken, her urine tested and has her medical and obstetric history taken by the midwives. The mum is then examined by the consultant. At this 'booking clinic' she is assessed and categorized as a 'low risk' or 'high risk' mum.

16 Weeks

The mum is subjected to the above tests (with the exception of the history taking). At 16 weeks the mum also provides a blood sample which is subjected to various tests (fetal abnormalities, venereal disease, haemoglobin etc.). The results of the blood test can re-categorize the woman from 'low' the 'high' risk. The mum's dates are usually confirmed (i.e. the exact number of weeks the woman is pregnant) at this time using the ultra sound scan.

20 - 28 Weeks

The woman receives ante-natal care from the G.P. clinic which she attends every 4 weeks during this period for assessment. In practice, however, most G.P.'s hand this work over to the community midwives who provide the ante-natal care.

32nd Week

The woman attends the antenatal clinic at the Area 1 Maternity Unit where she is seen by the consultant or one of his/her team.

34th Week - 39th Week

Between weeks 34 - 39 the mum attends the ante-natal clinic once a week where she is seen by the consultant or one of his/her team.

40th Week

The 40th week is the date when the baby is due to be delivered. The woman attends the ante-natal clinic where she is seen by the consultant or one of his/her team. She is made an appointment for the following week.

41st Week

The baby is now a week 'late', the woman attends the antenatal clinic where she is seen by the consultant or one of his/her team. She is usually urged to 'get a move on' and given some practical tips on how to achieve this. This injunction is made for a medical reason: once the baby is two weeks 'late' the efficiency of the placenta is reduced. Therefore, after the 42nd week intervention is considered. The injunction often has the required effect and the woman will give birth during the week.

42nd Week

The woman is usually admitted for observation and or intervention.

Intra-Natal Care

When the woman begins labour she goes to the Central Delivery Unit (CDU) where she receives her intra-natal care.

Post-Natal Care

After giving birth the woman recovers on the post-natal ward until she is rested enough to return home. The mother and baby receive post natal care from the community midwife in the family home.

In Area 1 a 'normal' mum who gives birth, on time (40 weeks), can expect to attend the hospital on nine occasions.

11.10   The Process of Giving Birth in Area 2

As with Area 1 the vast majority of women in Area 2 give birth at the Area 2 maternity unit. 'High' risk mums or mums who are experiencing or expecting complications are as in Area 1 treated on an ad hoc, individual nature. The process for 'low risk', mums is, however, different.

As in Area 1 a woman who suspects that she is pregnant will provide her G.P. with a urine sample and receives confirmation or other within 3 days. If the woman is confirmed as pregnant, she is from this point is regarded as being under the responsibility of the G.P. The G.P. may or may not examine the woman at this stage but s/he will recommend a consultant and write for an antenatal appointment. The woman is then made an appointment at the consultants antenatal clinic usually at 16 weeks.

Ante-Natal Process

16 Weeks

At 16 weeks the mum is weighed, has her blood pressure taken, her urine tested and has her medical and obstetric history taken by the midwives. The mum is then examined by the consultant or member of his/her team. A blood sample is taken which is subjected to various tests (fetal abnormalities, venereal disease, haemoglobin etc.) The mum's dates are usually confirmed (i.e. the exact number of weeks the woman is pregnant) at this time using the ultra sound scan. At this 'booking clinic' she is assessed and categorized as a 'low risk' or 'high risk' mum.

The mum periodically visits her G.P. (about once a month) and receives ante-natal care from the community mid-wife.

38 Weeks

At 38 Weeks the mum returns to the ante-natal clinic for final assessment before her delivery. At this time her high/low risk category is re-assessed. After this assessment the procedure is the same as for Area 1.

40th Week

The 40th week is the date when the baby is due to be delivered. The woman attends the antenatal clinic where she is seen by the consultant or one of his/her team. She is made an appointment for the following week.

41st Week

The baby is now a week 'late', the woman attends the antenatal clinic where she is seen by the consultant or one of his/her team. She is usually urged to 'get a move on' and given some practical tips on how to achieve this, the injunction often has the required effect and the woman will give birth during the week. If not she is booked into hospital.

42nd Week

After the 42nd week the woman is usually admitted (into hospital) for observation and/or intervention.

Intra-Natal Care

When the woman begins labour she goes to the Central Delivery Unit (CDU) where she receives her intra-natal care.

Post-Natal Care

After giving birth the woman recovers on the post-natal ward until is rested enough to return home. The mother and baby receive post natal care from the community midwife in the family home.

In Area 2 a 'normal' mum who gives birth, on time (40 weeks), can expect to attend the hospital on two occasions.

11.11   Ante-natal History Taking in Area 1

Area 1 Maternity Clinic take ante-natal histories using a computerized system. Area 2 is still using the manual system of history taking, however, based on the Findings from Area 1, Area 2 expect to use the computerized system and are preparing for the change over. Collins (1987) points out dramatic changes in context often force cultural skills which are tacitly to be explicated. The computerization of a manual system is perhaps a change in context *'par excellence'*. The computerization of maternity records was therefore, closely analyzed and compared with the manual system used in Area 2 in order to ascertain whether the tacit knowledge of the domain experts responsible for its design would be revealed. The computerized ante-natal history taking will now be briefly described.

11.11.1   Ante-natal History Taking

Traditionally midwives have interviewed mums on their first visit to clinic in order to gain knowledge of their previous obstetric history and any medical condition (from which the mother and or her relations might suffer), which might affect the fetus. The results of this interview were written on a standard form which provided a two page synopsis of the mums obstetric and medical history. The standard form has a section for the mums' ante-natal history and also a section in which the results of later ante-natal visits can be entered. For various reasons it has been decided to computerize the ante-natal records and the Area 1 has chosen the Gynecology Information Technology (GIT) Maternity System. This system has proved to be extremely useful for the purposes of this research.

The following is a simple description of a demonstration 'clerking in' of a 'dummy' mum', Donna. It was felt pertinent to use a 'dummy mum' for this purpose in order to get a true (or as true as could be achieved) comparison of the ante-natal history

taking between Area 1 and Area 2. The use of a 'dummy mum' also overcame several ethical considerations and did not require Research Ethics Committee Approval. Donna was a mum in her mid thirties with two children to date and therefore, was well aware of the problems of giving birth. Both her children were born at Area 3 some distance from the sites of the main fieldwork, but in the same District Health Authority.

The GIT System

The GIT system is the result of pioneering work at a leading teaching hospital. There was concern that the way that midwives conducted ante-natal interviews was very haphazard. There was no standardization in the questions asked and it was easy for the midwife to miss a vital question. Paper records were very difficult to use for the purposes of research because various health care workers would write information all over the records using various and idiosyncratic abbreviations. For example EDD (estimated date of delivery) used at Area 2 means the same as EDC (estimated date of confinement) at Area 1. In the promotional video great play is made of how a busy midwife could be interrupted and miss a vital piece of information. The GIT system sought to systemize the interviews into a standard set of questions which would be capable of eliciting all relevant details from any pregnant woman. This would standardize all such interviews in order that every woman would receive the same quality of assessment. Every question would be asked every time and the system would not allow a question to be missed. In order to ensure data integrity the use of the key board was reduced to a minimum and a system of bar codes and light pens used. The aim of the system would be to standardize the interview and store the results in a form that would be easily accessed for research purposes. The system was promoted as 'user friendly' in that staff needed little or no training and the bar code light pen input device made the system 'midwife proof' (sic).

The system uses a book of questions which also appear on the screen, data is entered by drawing a light pen across the appropriate bar code in the book. The client sits to the left of the midwife with the key board in front of the midwife and the screen to her right so they can both read the questions and answers imputed. The book was held with the Sisters left hand on her left leg and the pen held in her right hand. When the midwife asked the questions she read them from the book stroked the appropriate bar code with the pen checked the screen and looked back at the book. If the question was difficult to answer the midwife looked at the client and offered advice, at one time she had to put down both the pen and book in order to explain the point properly.

There appear to be many problems with the system. The use of the light pen was a constant problem because often the pen would not enter the data without multiple sweeps. Often the package 'commanded' the midwife to go to a certain question she had to search through the book to get the appropriate question. Questions were usually one or at most two per page, necessitating an interruption while the page is turned before the next question could be asked. This makes the questions seems very disjointed and the relationship between the questions is difficult to maintain. Many of the questions appear irrelevant to both the mum and the midwife. The midwife started of the interview by saying,

> *'I am going to ask you a series of questions, some of them seem irrelevant but we've got to ask them for our records'.*

Indeed many of the questions are redundant,

> *'Have you had German measles, don't worry if you don't know, the blood test will tell us'.*

The midwife who demonstrated the GIT system was very friendly and cheerfully worked through the book of questions, explaining, prompting and asking the questions in different ways. This seemed pleasant, however, on many occasions she seemed to lead the mum. Finally the questions were completed and Donna was asked if she had any questions, she didn't (not surprisingly). The whole procedure lasted approximately 30 minutes.

The interface was a definite barrier to the interaction of the midwife and the client in what would be their first interview. It must be noted that because first impressions are extremely important to the subsequent relationship, the midwife and pregnant mum build up, any barrier to smooth friendly interaction must be avoided.

In summary the whole experience was in fact extremely problematic,

The book was very heavy and awkward to use, the interface is extremely user 'unfriendly' and offered little indication of how to overcome snags as they arose. More seriously was the fact that it altered the whole interaction between the midwife and her client. The midwife was so busy with the awkward book and pen, reading out an extensive list of often irrelevant questions and checking the answers on the screen that for most of the interview no eye contact was established, resulting in an impoverished interaction.

This has not only a social significance (a friendly relationship is felt to be fruitful to interaction) but also has a medical significance, i.e. it forms a barrier to the midwife drawing on her experience to plan the pregnancy. There are many things that can take place during the initial interview, here the midwifes role is reduced to the central task of 'risk evaluation'. Risk evaluation is further reduced to the logging in answers to a list of questions. This is seen as superior to the old method whereby the midwife drew on her experience to evaluate whether the mum-to-be is of high risk or not.

'Before we had computer bookings, ante-natal history taking was a chancy affair. Different midwives would ask different questions some would ask a lot and others hardly any, so it was a matter of luck whether you got a good assessment or not. The computer ensures that all the questions are asked every time so improving the risk assessment'. (MW1A1).

11.12   Ante-natal history taking in Area 2

The ante-natal history is taken at Area 2 using the traditional manual system, (for the full transcript of the interview see Appendix XI). The midwife is responsible for the whole of the ante-natal examination unlike the midwives of Area 1 who are responsible for single tasks. The ante-natal history taking is therefore, one part of the examination rather than a separate element conducted by a midwife that the mum sees specifically for this task.

At the start of the interview the midwife spent quite a long time explaining that she was Donna's midwife, any problems that Donna encountered she should phone and ask for the midwife by name. The midwife first explained what was about to happen.

MW2A2:   Now I tell you what I want to do first. I want to fill this sheet in [she outlines the sheet with her hands]. Just for statistics, then I want to sit and talk to you about this pregnancy.

From the midwife's tone, she indicates that first she must get the form filling completed and then get down to the important work of, talking about Donna's pregnancy.

The midwife asked a series of closed questions pertaining to demographic details and previous pregnancies. MW2A2 then straightened up the paper, slapped the pen down

leaned back in her chair away from the table and said,

MW2A2:   Right you tell me about your pregnancy now. You tell me how you've
           been this pregnancy?

This is a dramatic change of tack, she asks Donna an open question about how she
feels her pregnancy is progressing. This is an empowering statement, Donna's
subjective feelings are given importance.

Donna: Erm, just tired.

MW2A2:   Anything else?

Donna: No.

MW2A2:   You, we need to know why?

Donna: Erm (nods).

MW2A2:   Well it's all theory this, there is no proof it's just theory. There is a
           big change, a big hormone change, going on in your body there's a big
           change, the biggest one is during the first 12 weeks of pregnancy. It's
           just natures way of saying 'Put everything down'. So don't be
           frightened about being tired. And don't jump to the conclusion
           automatically that you are anaemic. Lots of people are tired and not
           anaemic. We test your blood, I'll speak to you about that in a minute.
           Very (indistinct).

MW2A2:   But are you eating well?

Donna: Yea.

MW2A2:   What did you have yesterday?

This is an open question by which the midwife assesses Donna's eating habits. The
choice that Donna makes reveals both her dietary knowledge and eating habits. If
Donna was asked a series of closed questions such as 'do you eat fruit every day' to

some extent leads the respondent into giving the 'correct' answer i.e. yes

Donna:	Erm, branflakes, and err cheese on toast, two satsumas and an apple, pork chop, roast potatoes (laughs)
MW2A2:	It's a good diet this (laughs) its good for you
Donna:	Carrots and my supper.
MW2A2:	That's a good diet that is. It's a good diet. I'm sure that you don't need me to tell you that's a good diet. But urm, I ask some people that question and they'll come out and say 'alright'. Well tell me what you are eating and err its not what it should be. What we do like to say [pause]. Do you eat brown bread, you say you had cheese on toast, is it wholemeal you eat?
Donna:	Sometimes.
MW2A2:	If you can, if you can go on to wholemeal bread well it's just more beneficial really, with vitamin B's you know for your pregnancy. And err, cereals, your taking cereals, ok and I thought you said two fruits.
Donna:	Three fruits.
MW2A2:	Three.
Donna:	Three.

It is obvious that Donna knows what is a good diet and therefore, MW2A2 spends no more time on this topic. Once the form has been filled in the interview takes the form of a chat by which the mum's lifestyle is assessed and at the same time the midwife can educate the mum in areas about which she is unsure.

11.13 Comparison of Area 1 and Area 2 Maternity Units

It has been noted above that both units operate under the same objective constraints (biological, same RHA etc.) and there are considerable similarities (division of

pregnancy into ante, intra and post-natal elements) at a macro level in the delivery of service. However, it must be noted that at a micro level there are considerable differences in the provision of the service. This is particularly evident in the ante-natal clinics, which as noted above is the element of pregnancy over which the professional staff have most control. It is in this area that is that the staff can be most proactive because they are least restricted by the biological constraints of the situation.

The difference in the 'feel' of the two units was most aptly, if rather poetically described, by a Midwife (MW1A2) who had worked at Area 1 and moved to Area 2 maternity unit as,

'To me it was like walking out of a thunderstorm in a forest into a peaceful poppy filled field.'

The difference in the way that pregnancy is managed in Area 1 and Area 2 will now be described.

11.13.1   Waiting Room

11.13.1.1   Area 1

The Area 1 ante-natal waiting room is large, containing many rows of bench seats. The room was full, with up to 130 mums (all of whom have a 9:30 appointment) plus their friends or partners, plus their children. The noise was intense, lists of names were being called by the midwives and the mums directed to one queue after another. Although these women can expect to be in the clinic on average 2-4 hours (over 4 hours is not unusual), no refreshments were available and there is no creche or even a play area for the children.

11.13.1.2   Area 2

Area 2 waiting room is large and contains several coffee tables around which are three or four chairs. The room is quiet and groups of people sit around the tables waiting to be attended too. Each mum has an individual appointment, which is adhered to within 15 minutes. Although the mums are expected to attend the clinic for less than one hour, a creche and refreshments are available. From time to time a midwife would enter the room and ask for a particular mum and then escort her to a side room. At this time if the mum has brought a child it can be left at the creche and the mum can be accompanied by her partner or friend to the consultation room.

11.13.2   Consultations

11.13.2.1   Area 1

In order to assess the mum and plan her pregnancy the doctors require several types of data from her (biographical and physiological). This has been atomized so that each piece of data is provided separately. The mum has her blood pressure taken by one midwife (who takes every bodies blood pressure), she will then have her weight taken by an other midwife (who takes every bodies weight). Each element requires the mum to move to the queue for the next midwife. When all the information has been collected the mum (with her data) finally queues for the doctor who will make an assessment of her.

11.13.2.2   Area 2

The mum is taken into a side room and introduced to her 'named midwife'.

Sister S: *Now I'm your midwife here, so I'm the 'named midwife' so anything that you need you should see me, OK.*

This midwife conducts all the tests and attempts to establish a rapport with the mum. When all the tests have been conducted the midwife sends for the doctor who conducts several medical tests (in the midwife's presence). The doctor leaves and the midwife concludes the interview and asks the mum if she has any questions.

11.13.3   Time

There is a significant difference in the amount of time that Area 1 and Area 2 ante-natal clinics require to process the mums.

The 'booking clinic' at Area 1 will take on average 2-4 hours, but a wait of over 4 hours is by no means exceptional.

The 'booking clinic' at Area 2 takes from 3/4 of an hour to 1 hour.

11.13.4   Subjective Impression

The mum's impression of Area 1 was less than satisfactory, they talked of being treated like 'cattle' and being 'herded' from one place to another. They complained about the long waiting times and lack of facilities and often 'vote with their feet' by missing appointments.

The mum's at Area 2 on the other hand appreciate the more individual attention that they receive and appreciate the fact that they only have to deal with one midwife. This gives them a chance to raise issues more easily.

11.13.5   Donna's Subjective Impression

Donna: Well I really liked Area 2, it was so different than when I had my girls. I felt that it was freer and I could ask her anything. Whereas in Area 1 it was like, well we have the power and we are going to do you a favour. You know they were much more formal and stand offish, you felt that you were there just to give them the information they needed to help them to, well not deliver. But you know like you couldn't have the baby without them and they just needed you for information. Whereas I feel that I could talk to Sister S. and raise questions. Sort of as if my feelings were an important element in the birth of my child.

11.14   Attendance of Ante-Natal Clinic

Area 1 Maternity Unit requires a mum who is having a 'normal' pregnancy to attend the ante-natal clinic 9 times between being confirmed pregnant and the 'due date' for the delivery of her child. i.e. on the 12th, 16th, 32nd, 34th, 35th, 36th, 37th, 38th, and 39th week of her pregnancy.

Area 2 Maternity Unit require a mum who is having a 'normal' pregnancy to attend ante-natal clinic twice, between being confirmed pregnant and the 'due date' for the delivery of her child. i.e. on the 16th and 38th week of her pregnancy.

11.15   Ante-natal History Taking

11.15.1   Area 1

The ante-natal histories are taken in Area 1 using the GIT computerized system. The

layout of the screen is such that two questions appear on each screen. The first question e.g. 'A' is to be answered and the next question, 'B' which is not. When question 'A', has been answered a new screen appears in which question 'B' must be answered plus the next question, question 'C'. There is no attempt to arrange the questions in meaningful 'chunks'. The ante-natal history takes the form of a check list. Great importance is laid on the fact that computer offers a standardized format in which every mum receives the same quality of interview. The GIT system is set up so that each question must answered before letting the midwife move on. Information is taken from the mum and input into the GIT system. The function of the midwife is to ask the questions and input the answers. The midwife has little opportunity to initiate rapport because the questions are preset. This is not perceived as a problem, for rapport is felt to be advantageous but not essential. The fact that the questions are 'atomized' rather than in meaningful chunks, is also of little importance, because it is the computer rather than the midwife, that analyses the data in the form of a two page synopsis.

11.15.2   Area 2

The ante-natal histories in Area 2 are taken using the more traditional manual system. There is a short standard form that the midwife fills out but the questions that she asks for this purpose are in many ways her prerogative. She is able to tailor the interview to match each mum. For example, she can use more or less sophisticated analogies and examples to suit the particular mum. She can spend more time explaining area where the mum indicates particular need or has requires clarification (e.g. see the section concerning eating liver in Appendix XI). The midwife is called upon to make judgements when filling in almost every question. For example in Area 1 the woman would be asked how often she ate green leaf vegetables, fruit, types of fruit, etc. The midwife simply inputs the data, and the computer does the rest. In Area 2 the midwife will be left to make a judgement (from questions that she chooses to ask) about whether the mother is receiving adequate nourishment for herself and

her baby.

11.16   Consultants and Their Medical Teams

For the purposes of this research the consultants and members of their medical team will be referred to as the 'doctors', it must be noted that this is simply a shorthand term and will be used to refer to the consultant and all the doctors working below him or her (e.g. Senior Registrar, Senior Houseman etc.). The use of this term will reduce confusion for although some consultants have the title of Mr. they are all doctors.

11.16.1   Area 1

The doctors seem to have a tremendous amount of autonomy about all aspects of the mums' care. This is indicated by the difference between individual consultants clinics. While there might be a case for this, where medical judgement is concerned, their authority seems to encompass the minutiae of the running of the clinic. The doctors are particularly conspicuous and basically regard all mums as their responsibility which they do not seem willing to delegate. As noted above the doctors will see 'normal' mums 9 times before her due date. Clearly the doctors at Area 1 regard pregnancy as a period of risk to the health of the mum and her baby. A period where things can soon deteriorate and thus, requires constant expert surveillance. The doctors at Area 1 concern themselves with ALL mums both 'normal' and 'problem'.

11.16.2   Area 2

The doctors seem to take less of a visible role at the ante-natal clinic. The clinic seems to be run by midwives and the emphasis is more on the social and

psychological rather than the medical needs of the mum. This is not to infer that the medical needs are unimportant, however, unlike Area 1 they are not regarded as paramount. The bulk of the work is carried out by the named midwife. The doctor 'pops' in to perform some routine physical tests at the 'booking clinic'. If all is satisfactory the doctor will not see the mum again until her 38th week, in order to check every thing is satisfactory with the mum for a 40 week delivery. All other ante-natal care for 'normal' mums is carried out by the midwife or the mum's G.P. or the community midwife. The doctors at Area 2 concern themselves much more with 'problem' mums and delegate responsibility for 'normal' mums to midwives and their G.P.'s.

11.17   Midwives

11.17.1   Area 1

Area 1 clinic is arranged in a 'task orientated' fashion and the midwives take on the role of 'expert data collectors'. In this function it is possible for the ante-natal clinic to be atomized into separate tasks. An overall understanding of a particular mum is not required by the midwife, they simply collect the data and present it to the doctors for collation.

11.17.2   Area 2

There appears a distinct division of labour operating in Area 2, whereby the midwives take responsibility for the 'normal' mums and the doctors take responsibility for 'problems' mums. Taking responsibility for 'normal' mums rather than simply being an 'expert data collector' requires a different role for the midwife. This role requires an overall understanding of the individual mum, in Area 2 the midwife has to be both collector and collator of data. For this purpose task orientated approaches to ante-

natal care are not appropriate. The midwife completes all data collection, has rapport with the mum and is thus, able to form an overall assessment of the mum. This is important in that it is her assessment that can alter the mum from 'normal' to 'problem' status and refer her to the doctors for special care.

11.18   Consideration of the Mums

11.18.1   Area 1

Consideration of the convenience of the mums seems to be a very low priority at Area 1. Long queues and no facilities seem to be the order of the day.

11.18.2   Area 2

The feelings of the mums seem to be at a high priority, everything is set up to relieve stress and make the visit as friendly as possible

11.19   Summary of Findings

Area 1 and Area 2 maternity units are similar in the following ways: they are units within the same type of hospital; serve the similar socio/economic populations; are units in the same Regional Health Authority; both separate the process of giving birth into ante, intra and post natal elements; 'low' risk mums in both units are attended to by midwives; 'high' risk mums in both units are attended to by doctors.

However, Area 1 and Area 2 maternity differ in the following ways: Area 1 is task orientated Area 2 is patient centred; Area 2 mums get a 'named' midwife, Area 1 mums do not; the layout of the ante-natal clinics is very different; the work of the midwives is very different; the mum/midwife relationship is very different; 'low' risk

mums at Area 1 are required to attend the ante-natal clinic nine times before the 40th week. Area 2 mums are required to attend ante-natal clinic twice in the same period.

On the basis of these Findings we will now examine why such differences occur, and find that much has to do with tacit knowledge.

CHAPTER 12

Why the Difference?

12 Why the Difference?

Given the similarities of the two units (in terms of type of hospital; socio/economic catchment areas; Regional Health Authority; role; etc.), Area 1 and Area 2 maternity units manage pregnancy in very different ways. Some of the reasons which could account for the differences must first be discussed, because the differences could help to elicit tacit knowledge. This requires the introduction of a new term *'divergence'*, which is defined as,

> **diverge.** . . *To tend in different directions from a common point or from each other......   New English Dictionary (1932)*

Divergence is important because:

*   Divergence can be exploited as a tool, for the identification of areas where tacit knowledge could be elicited. If the objective criteria in two organizations are the same then the difference must be due to other reasons, such as subjectivity and inter-subjectivity, it seems reasonable therefore, that a proportion of these reasons are due to tacit knowledge. Once such an area has been identified the engineer can focus his/her efforts in this area in order to explicate tacit knowledge.

*   Identifying of the repository of domain knowledge. Divergence presents a problem for knowledge acquisition, if as in the above example, the two maternity units are conducted in very different ways, the knowledge engineer must first decide in which unit should knowledge elicitation take place.

*   The choice of knowledge elicitation methodology.

*   The generality of the resulting KIS.

Divergence can be due to several reasons, these will now be briefly discussed and the reason for the divergence between Area 1 and Area 2 identified. There may be other equally valid classification schemes, but the following framework will prove fruitful in order to identify the correct repository of domain knowledge, select the most appropriate method of knowledge elicitation and assess the generality of the resulting KIS.

12.1 Reason for the Divergence Between Area 1 and Area 2 Maternity Units

There could be many reasons to account for the divergence between the two maternity units, however, most fall into the following be three categories: temporal sequence; difference of style; difference of form. These terms will first be described and their consequences for knowledge elicitation discussed.

Temporal Sequence

This thesis defines temporal sequence to be: technology advances in an uneven manner, therefore, certain organizations will be technologically more advanced than others. To illustrate this point with the above example, some hospitals will be providing 'state of the art' maternity care with the most up to date techniques, while other hospitals will be providing maternity care using more conservative techniques, while still other hospitals will be providing maternity care in a somewhat out-dated manner. A certain amount of temporal sequence can, therefore, be expected between similar organizations. It must be noted that the reason for temporal sequence is not

important[11] for the purposes of this research, it is the classification of divergence rather than its reason that is of consequence to knowledge acquisition,

In situations where divergence occurs the knowledge engineer must identify the correct repository of domain knowledge. If the reason for divergence is temporal sequence, it seems logical (though somewhat technologically deterministic) to conduct the knowledge acquisition in the more advanced unit. This provides a degree of generality because the less advanced unit can, take advantage of the resulting KIS if and when they modernize.

In situation where the most 'advanced' organization can not be easily identified other reasons must be investigated.

Difference in Style

A difference in style occurs when two (or more) organizations appear to be doing very different tasks but are in fact doing the same thing. The appearance of divergence can occur where there is a confusion between ends and means. Area 1 and Area 2 might appear to be managing pregnancy in very different ways but the difference is in *approach* rather than *objectives*. Winch (1958) uses the example of ice and water to illustrate this point. Although ice and water appear different entities, the difference in one of degree (no pun intended) and they are *mutatis mutandis* the same, i.e. they are both H$_2$O.

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[11] The reasons for temporal sequence are many and various, e.g. charismatic leadership, bad management, high funding unit, high/low profile organization, high/low status organization, 'sexy project', etc.

If the reason for divergence is due to difference of style then knowledge acquisition using a 'scientific' method is more appropriate. Such a mode of inquiry would concentrate on the objective facts of the domain (and pertinent to both units), rather than becoming 'bogged down' investigating confusing issues which are the result of the difference in the style of the two organizations.

In such a case either unit would be suitable for knowledge elicitation (the objective domain facts are the same) and a degree of generality would exist, in that a KIS designed for Area 1, will with minor modifications be suitable for Area 2, and for that matter any other maternity unit in the region if not the country.

Difference in Form

Difference in form, is the opposite to difference in style and refers to the situation where two organizations (e.g. maternity units) appear to be the same, but are in fact fundamentally different entities (both units claim to be maternity units, but the 'appreciation system' (Vickers 1984) of each organization defines a maternity in fundamentally different ways). Winch (1958) illustrated this difference by the example of comparing the reactions of a dog which has been taught a trick and a man who has been taught a rule of language.

> *'Certainly the latter is very much more complex, but what is more important is the logical difference between the concepts which are applicable. Whereas, the man learns to understand a rule the dog just learns to react in a certain way.'* *(page 74)*

Where a difference of form occurs the two organizations (despite appearances) are conceptually and fundamentally different entities. In a superficial way the man and the dog are doing the same thing i.e. 'learning', however, the definition of learning is conceptually different in that the dog 'learns' to react whereas the man 'learns' to

understand. These points will be discussed in greater detail below.

If the reason for divergence is due to a difference of form, then knowledge acquisition using a human scientific methodology is most appropriate. The reason for this assertion is, if the objective constraints of the two units (as was this case) is the same and the two units are different in form, then the different way that maternity has been conceptually defined must be the product of the inter-subjectivity of the two organizations. A human scientific methodology is the only type of inquiry capable of eliciting the inter-subjectivity of the two organizations. If the reason for divergence is a difference of form, then each is the repository of different domain knowledge, as defined by that organization. The different ways the domain is conceptually defined by the different organizations will preclude the generality of the resulting KIS.

12.1.1   Order for Investigating the Reason for Divergence

Some reasons for divergence are both easier to identify and less problematic for knowledge elicitation than others, it is therefore, recommended that they are investigated in the following order. Temporal sequence is the easiest, and can be ascertained using overt, relatively easily obtainable, objective data. 'Difference in style' is more difficult in that covert objective data must be sought. Most difficult is 'difference in form', which relies on an analysis of inter-subjectivity of the members of the organization. This sequence was employed in order to determine the reason for the divergence between Area 1 and Area 2 maternity units.

Although three classifications for divergence have been proposed, what follows is not a three cornered debate. In practice and in line with the above prescription, divergence due to temporal sequence was initially assessed (see below) and was quickly eliminated from the situation at the maternity units. Therefore, the bulk of what follows is a discussion of whether the difference between Area 1 and Area 2 is

a difference of 'style' or 'form'.

12.1.2   Temporal Sequence

In many situations the most technologically advanced organization is easy to identify using objective criteria, i.e. most advanced machinery, newest plant, most progressive management, unit cost etc. This might be true for manufacturing industry but is more problematic for service industries such as the case in point. For example, both Area 1 and Area 2 would claim that they were offering the most advanced maternity service to the women of their areas. Area 1 staff would point to the new building with the latest equipment, the CDU and even the computer ante-natal history system. However, Area 2 would claim that they are nearer the cutting edge of maternity care offering a 'named midwife' and a more personal service, in line with Government policy. The situation has of late been further complicated by the fact that Area 1 are trying to change their ante-natal practice so that the tasks of weighing, taking blood pressure and ante-natal history taking will be performed by a single midwife, (rather than by three separate midwives as is the present case) resembling at a superficial level at least the practice at Area 2. Whereas Area 2 are preparing to incorporate the GIT ante-natal computerized system that is used in Area 1.

It must be noted that the above is not put forward in a judgmental manner, there can be many reasons for one organization being more progressive such as temporal discontinuity whereby one of the units have had a change of leadership which introduced a very different concept of maternity care. The point is that temporal sequence does not seem to be the reason for divergence in this case.

12.1.3   Difference of Style

With the elimination of temporal sequence, it is not correct to assume, as seems the case of the GIT designers, that the divergence in the way that pregnancy is managed in Area 1 and Area 2 is simply a difference of 'style'. There is a temptation to assume that although the maternity units appear to be providing very different services, they are basically performing the same function. This could be due to the fact that giving birth is essentially a biological phenomenon, the management of pregnancy is, thus, constrained by the objective biological facts of giving birth. Once this assumption has been made a 'scientific investigation' would be the most appropriate, in order to eliminate phenomena which are the product of different approaches and concentrate on eliciting the objective facts of the domain.

Before embarking on this route, perhaps it might be prudent to analyze whether these assumptions are valid. The two maternity units can only be viewed as the same, by reducing pregnancy to human reproduction, it is questionable, however, whether such reductionism is valid or a 'methodological trap'.

12.1.3.1   Hierarchy of Comprehensive Entities

Reductionism has been a highly successful method of investigation in natural science, but is it appropriate for the task of deciding the reason for divergence between two organizations? Polanyi (1966) points out that there is a hierarchy of what he refers to as comprehensive entities, and that

1)   The principals controlling a comprehensive entity would be found to
rely on their operations on laws governing the particulars of the entity
in themselves;

2) *At the same time the laws governing the particulars in themselves would never account for the organizing principles of a higher entity which they form'* *(page 34)*

EXAMPLES

FIVE LEVELS OF SPEECH:		SUBJECT TO LAWS OF
1)	Of Voice	Phonetics
2)	Of Words	Lexicography
3)	Of Sentences	Grammar
4)	Of Style	Stylistics
5)	Of Literary Composition	Literary Criticism

'These form a hierarchy of comprehensive entities, for the principals of each level operate under the control of the next higher level. The voice you produce is shaped into words by a vocabulary; a given vocabulary is shaped into sentences in accordance with grammar,' *(p.36)*

A similar classification of levels for pregnancy could look like:

1)	Body Structure	Anatomy
2)	Body Function	Physiology/Biochemistry
3)	Reproduction	Biology
4)	Human Reproduction	Obstetrics
5)	Maternity Process	Management

Therefore, if Polanyi is correct it is illegitimate to reduce two higher level entities to a lower level and claim they are similar. The laws governing human reproduction,

can not account for the organizing principles of the maternity process. It is therefore, illegitimate to claim that Area 1 and Area 2 are similar organizations because they are both concerned with human reproduction.

To illustrate this point it would be as inappropriate to claim that the difference between the maternity systems of Area 1 and Area 2 is one of style because both are based on the same rules of human reproduction, as it would to claim the works of Shakespeare and a 10 year old child are the same because both use sentences in accordance to the rules of grammar.

12.2 The Use of Idea Systems to Ascertain Whether the Difference is one of Form or Style

The above while pointing out a methodological trap, eliminates many confusing notions (confining comparisons to the same level in the hierarchy of comprehensive entities), does not determine whether the difference between Area 1 and Area 2 is one of 'style' or 'form'. The above indicates that determining the reason for divergence between style and form is problematic: divergence due to a difference of style is difficult to identify due to the potential of confusing 'ends' with 'means' or 'objectives' with 'approach'; divergence due to a difference of form is difficult to identify due to potential confusion of the level of comprehensive entities. Therefore, this thesis proposes to use the notion of 'idea systems' (Winch 1958) to decide the reason for divergence,

Difference of Style: When two (or more) organizations are operating within the same idea system.

Difference of Form: When two (or more) organizations are operating in separate idea systems.

Winch (1958) points out that logic is context specific i.e. has an internal relationship with the idea system in which it occurs. Therefore, logic can be used to ascertain whether one or more idea systems is in operation.

Logic often like mathematics appears to be de-contextualized.

e.g.   Major premise

          Minor premise

          Conclusion

At a formal level logic can be used to test the validity of arguments, but it is problematic for deciding whether behavior is logical or illogical. For example, is praying illogical behavior? One could make a case that: it can not be proved that God exists; even if God exists (and we have as yet not mastered the techniques for proving His existence) there is no causal link between praying and the desired effect; therefore, praying is illogical. Winch (1958) contends that statements of this type are not valid because the criteria of logic operates from within an idea system.

> *'[C]riteria of logic are not a direct gift of God, but arise out of, and*
> *are only intelligible in the context of, ways of living or modes of social*
> *life.' (p100).*

Therefore, the above statement that praying is illogical is illegitimate because logic internal to one idea-system is being used to judge the logic of behaviour in a different idea-system. In such a case the logic of the system being judged will always be found to be faulty. To use an analogy of choosing the best game between monopoly or scrabble, and concluding that monopoly is far superior because scrabble does not use dice, have little houses and hotels or use imitation money. Clearly by using criteria internal to monopoly, all other games will always be found to be inferior.

Winch (1958) uses the example of two idea systems, science and religion and points out that within science it would be illogical not to accept the results of an experiment, whilst within religion it would be illogical to pit ones strength against God. Thus, there is no such thing as an illogical action *per se*, (the same behavior can be described as both logical and illogical), it is only by reference to an idea system that an action becomes either logical or illogical. For example, if one believes in God it is logical to pray to Him to intercede, whereas, it would be illogical to pray to God to intercede in a scientific experiment.

Winch here is constructing a case against the 'epistemological high ground' being accredited to science, and therefore, science being the arbitrator of all knowledge claims. This it must be noted is not an attack on science, but a recognition that what science can tell us is limited to a subset of the physical world and has little to teach about the social world.

12.2.1   Logic can be used as a Tool to determine the Reason for Divergence

The notion of logic being contextually dependant can be useful to determine whether the difference between the two maternity units is one of style or form. If the two organizations are conducting themselves in a way that is different but does not seem illogical (e.g. the prayers of Buddhists and Christians) to each other the difference in one of style. If, however, the two organizations are operating in ways that appear quite illogical to one and other while at the same time internally logical (e.g. the importance of prayers to religion and science), the difference is one of form, for each can only remain logical if operating within different idea systems.

12.2.2   Analysis of the Reason for Divergence between Area 1 and Area 2 Maternity Units

There appears to be a considerable difference in the way that pregnancy is managed by Area 1 and Area 2 maternity units, this provides a convenient real world situation by which to test the efficacy of logic to determine whether the difference is one of 'style' or 'form'. However, in order to use logic in this way it is first necessary to uncover the basic assumptions of the ideas-systems operating in each organization. This is a difficult endeavor because basic assumptions are ubiquitous and often tacitly held. Therefore, before it is possible to use logic to decide whether the divergence is due to 'style' or 'form' one must first explicate at least some of the tacit knowledge of each organization.

The following section will illustrate how such knowledge can be explicated. The tacit knowledge from each organization will then be tested using the tool of logic, in order to assess the reason for divergence. The reason for divergence will have direct consequences on the generality of a KIS and the methods of knowledge acquisition.

CHAPTER 13

Method One

13 Method One: The Elicitation of Tacit Knowledge at the Macro Level

13.1 Introduction

To recap, the reading/contemplative strand of the research has pointed out the importance of tacit knowledge. The field work has gone further and shown that the explication of tacit knowledge is vital to the building of a KIS. The remainder of the thesis is a discussion of the methods by which the tacit knowledge of the maternity units was explicated and the implications for the design of KIS.

This research has identified one method by which areas of tacit knowledge might be identified (divergence) and four methods by which tacit knowledge may be explicated. The knowledge explicated by each method is different in nature, therefore, all methods may not be appropriate to every situation.

The reading/contemplative strand of the research and the initial fieldwork suggested two methods for the explication of tacit knowledge which were as follows:-

Method One: seeks to explicate tacit knowledge at a macro level i.e. the tacit knowledge of an organization [12].

Method Two: seeks to explicate tacit knowledge at a lower level i.e. the tacit knowledge of groups within an organization.

However, while the research was in progress two further methods suggested

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[12] N.B. The Method One refers to the 'first method' and has no connection with the Arthur Andersen developmental methodology of that name.

themselves. These were:-

Method Three: seeks to explicate tacit knowledge at a micro level i.e. the level
                    of interface design.

Method Four: is a modification of Method Three but seeks to elicit extra
                    mural tacit knowledge (key variables, tacitly held and external
                    to domain knowledge).

The results will therefore, be written in the following (if unorthodox) manner.
Chapter 13 & 14 will discuss Method One and Method Two. Chapter 15 will
describe the part of the work from which Method Three and Method Four emerged.
Chapter 16 & 17 will discuss Method Three and Method Four.

Chapter 18 takes a different tack and explores how knowledge acquisition can be used
as a tool for sociological investigation.

13.2 Tacit Knowledge of a Domain is Reified in its Formal and Informal Systems

If the objective conditions and criteria are the same for both maternity units, much
of the difference must be due to inter-subjective notions of the members of each unit.
These inter-subjective notions are tacitly held and appear to the members as reality
(see Berger and Luckmann 1967). Therefore, it could be contended that,

tacit knowledge is reified in formal and informal systems.

This is an important contention, for if investigating conscious thought processes of
individuals or groups is difficult, investigating the tacitly held thought processes of

individuals or groups is even more problematic. However, if tacit knowledge is reified in formal and informal work systems, (for in this example the management of pregnancy), such systems actually exist and are thus amenable to conventional investigation i.e. observation, measurement etc. These reifications can, therefore, be investigated in order to illuminate the tacit knowledge responsible for their construction and maintenance.

Investigations of this kind are extremely difficult, due to the logical entailment of 'thought processes' and the structures they produce, and the often extremely complex and dynamic in nature of this process. Investigations into the logical entailment of tacit knowledge and the formal and informal systems of work can be considerably informed by the work of Giddens (1984) who sought to explain the logical entailment of an individuals 'free will' and the constraining effect of society by the use of structuration theory.

13.3 Structuration

Giddens (1984) sought to answer a fundamental theoretical problem of sociology i.e. the integration of macro and micro sociology. This is very complex and long running debate in sociological circles which need not be discussed here. Giddens claims that 'action' (an individuals ability to freely 'act') and structure (social structures, which tend to restrict the ability for an individual to freely 'act'.) stand in an internal relationship, they are two sides of the same coin and can not exist independently.
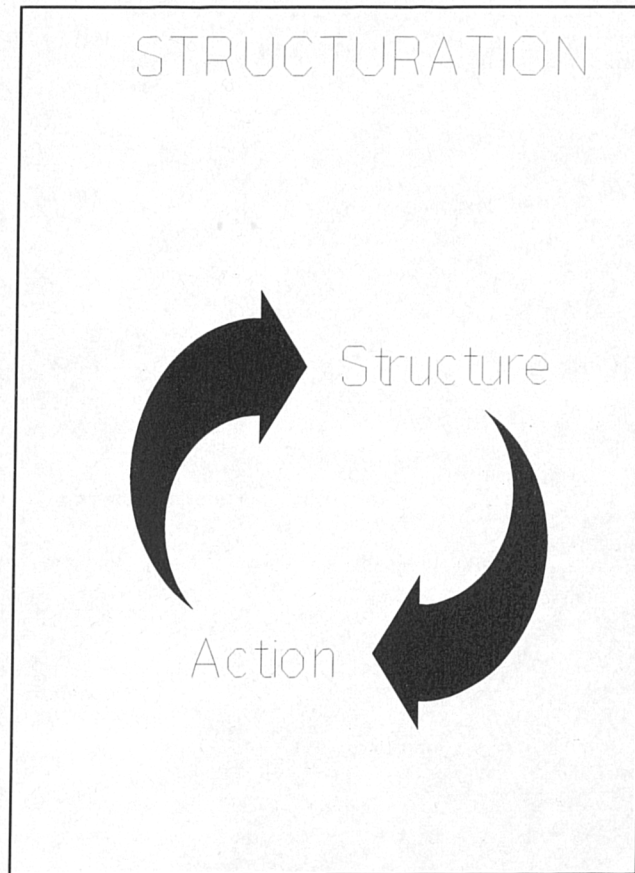
Figure 13.1   The   Dynamic   Process   of
Structuration

The internal relationship between 'structure' and 'action' implies an understanding of the 'structure' can reveal a great deal about the 'action' responsible for its construction. Conversely an understanding of 'action' can reveal a great deal about the 'structure' by which it is constrained.

This seems directly applicable for the elicitation of tacit knowledge, because structure is far easier to investigate than action. The structures of organizations can be measured whereas the cognitive processes of an individual cannot. Giddens' work indicates that an understanding of the structure of an organization will inform the researcher about the action of individuals that create and are constrained by the structure. Therefore, by gaining an understanding of the structure the tacit knowledge

responsible for the building of the structure can be explicated.

For example, the organizational structures of the maternity units are visible, easily identified and can be measured. The layout of rooms, what takes place in each room, by whom, the formation of queues, the official forms, etc. can easily be observed by an outside researcher. Whereas, the thought processes of the doctors, midwives and managers remains invisible, 'locked' inside their heads and not directly observable. Structuration offers a taxonomy of terms by which to analyze the complex relationships between the various forces that construct and maintain systems.

Structuration offers a framework by which, observation of a structure can with careful analysis reveal a great deal about the tacit knowledge responsible for its formation. For this reason a lengthy outline of structuration will now be given, followed by an analysis of the maternity units using Giddens taxonomy of terms. The possibility of placing this outline in an appendix was considered, however, although Giddens work might be known to IT readers, the detail of his definitions might not. Therefore, to prevent ambiguity over terms such as structure, system, rules resources, capability, knowledgeability which are to be used in the analysis it was felt to be more useful to leave the outline in the body of the text. Readers more acquainted with Giddens work are advised to pass directly to the analysis of the maternity units and refer to the summary of structuration included at the end of this section.

13.3.1   The Theory of Structuration

Giddens (1984) notes that much of social and philosophical theory is based upon a of dualism[13] i.e. micro and macro theories. In social theory a division of labour has arisen whereby theorists 'bracket' areas of the social world off for study. This is a legitimate practice, however, such practice incorporates the trap of mistaking a

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[13] Dualism: theory recognizing two independent principles

'bracket of analysis' for an ontology. The duality has resulted in theorems that are good on *action* but very weak on the *structure* and vice versa. The division of labour has led to a state of affairs where instead of the two perspectives (which embodying different basic assumptions), confronting each other directly they simply ignore each other.

Giddens notes that structuralism has fallen into this trap by consigning virtually all micro sociology (reasons, etc) to psychology. This leaves just a rigid constraining structure as the topic of social science. Giddens finds this unhelpful because the social world is characterized by renewal and change. Giddens also notes that much of micro sociology seems to ignore the institutions which constrain the 'free will' of the actors. Giddens proposes *'Structuration'* as a meta theory, a sensitizing device which attempts to incorporate both macro and micro theory to enable social life to be studied as a subject rather than a two 'bracketed pseudo-subjects'. Giddens (1984) notes,

> *'The theory of Structuration was worked out in an attempt to transcend without discarding altogether three prominent traditions in social theory and philosophy: hermeneutics or 'interpretive sociologies, functionalism and structuralism.'* (page 26)

Giddens (1984) conducted an in-depth study of all the *'great men'* of social theory and concluded that much of their work was partially mistaken. (it must be noted that Giddens has the aid of hindsight and contemporary authors to help him in his task). However, he takes from many of the authors ideas that he finds useful (the voices of these 'great men' can be metaphorically heard speaking in Giddens' syncretic work).

13.3.1.1   Micro Sociology

Giddens first of all addresses of the *'Actor'*. For a definition of the actor Giddens

draws heavily on Erving Goffman who, for Giddens,

> *'Lays bare the tacit rules and resources which competent actors employ in their day to day life'.*

For Goffman individuals are *actors*, they are capable of making decisions and therefore, are capable of *action*.

DEFINITION:

ACTION = CAPABILITY + KNOWLEDGEABILITY

13.3.1.1.1 Capability

Capability is not restricted to the narrow utilitarian definition of making rational choices. Capability can be summarized as

> *'could have done other'.*

An extreme example of this would be a situation where a person is held at gunpoint and told to stand still or be killed. The power relations in such a situation means that the victim has no practical/rational choice to do other than what s/he is told, therefore, the individual has no 'capability' in the situation. However, for Goffman it is still possible to 'do-other' even if the end result is the death of the individual. Therefore, even in such a dire situation the individual can be said to have capability.

13.3.1.1.2 Knowledgeability

Actors have a knowledge of the workings of society and must have if the society is to be recognized as human. Although knowledgeability is tied to capability it is

mainly displayed in tacit ways, i.e. practical consciousness rather than discursive consciousness. The knowledge that an individual simply uses 'naturally' in a situation without conscious deliberation. It is here that tacit knowledge can be sought.

> *'Goffman treats human beings as capable knowledgeable agents who employ such capability and knowledgeability routinely in the production and reproduction of social encounters'*

Giddens (1984) agrees with Goffman's definition of the actor, while pointing out Goffman does not explain or try to explain the institutional framework the actors, act in. Goffman's work does not address the way that individuals are constrained by the pressure of societal institutions.

13.3.1.2   Macro Sociology

The above definition of the individual as an actor, seems to indicate much of the work of structuralists and functionalist's (which investigate how societal institutions constrain what individuals regard as 'free will') must be rejected out of hand. However, Giddens is unable to do this because for him it seems self evident that the culture that an individual is born into will have an important effect upon both the capability and knowledgeability of the individual.

13.3.1.2.1   Mistaken Model of Structure

Giddens (1984) contends the problem with most structuralism and functionalism is that it has a mistaken model of structure. Stucturalism in the English speaking world takes on a particular form, which Giddens refers to as the Anglo Saxon version of structure:-

STRUCTURE: A framework, a morphology analogous to the anatomy of the body.

SYSTEM: The dynamic element that makes the structure function, to extend the above analogy 'life' the difference between the living and the dead body.

This analogy has lead to the contention that it is possible to study the structure (body) independently from the system (life force), a type of societal post mortem. This analogy, has for Giddens, constrained macro sociological thinking into rigid unhelpful frameworks. Giddens contends that when a persons life ends, a body is left for study, albeit in a limited form, but the same can not be said for a society

'A society that ceases to 'function' - to be reproduced across time and space - ceases to be'.

Giddens (1984) finds this analogy illegitimate and leads to functionalist using structure and system interchangeably.

13.3.1.2.2   Giddens Model of Structure

Giddens contends that much of structuralist thinking can be 'saved' by a less rigid model of structure. He defines society thus,

SYSTEMS:

Social systems (not structures) consist of reproduced relationships between individuals and collectives situated in time and space, e.g. kin relationships.

STRUCTURE:

Giddens frees up the notion of structure by using the term in the manner of French structural linguistics of Saussure rather that the constraining Anglo Saxon version.

Saussure contends that when a language is analyzed a distinction between *'la langue'* (the total language itself) and *'parole'* (any and all uses of the language) can be drawn. Saussure uses the analogy of the game of chess to explain the difference. i.e. the complete rules of chess plus its conventions represent la langue. Particular moves made in a particular game represent parole. N.B. la langue constrains but does not determine parole, just as in chess the rules con the moves but do not determine them.

Giddens proposes that the structure of structural linguistics (la langue) can be applied to sociology because the language is an integral part of social practices,

'Structure then refers to rules and resources embedded in social systems but only having a virtual existence'

RULES:

Social conventions, knowledge of them including knowledge of their context and application.

RESOURCES:

The capability of making things happen. (N.B. the area of power relationships).

By using the more flexible model, structure is now both constraining and enabling. e.g. every language involves 'fixed' categories which constrain thought, however, language enables conceptual operations impossible without it.

13.3.1.3   Overcoming the Macro/micro Dualism

Giddens (1984) attempts to overcome the division of labour by assimilating what he regards are the best aspects of each perspective. He contends that before it is possible to understand social systems, an understanding of the structure by which the system is produced and reproduced is essential. The recursive nature of structure/system means that although the structure builds the system, the system can go off at a tangent of unintended consequences which can feed back and change the structure that built the system in the first place. Analogous to a two stranded rope,

'Action and structure stand in a relation of logical entailment: the concept of action presumes structure and vice versa.'

For Giddens structure has a duality in that it is both the medium and outcome of social practices. This complex concept can be illustrated with the example of language, the moment of the speech act (not temporal) contributes to the structural qualities that generated it.

Giddens concludes that if, the reproduction of society is due to actors (who could have done other), then it is a chosen order. Therefore, all laws or interesting generalizations will be short term or unstable, thus negating the idea of unfolding laws of history such as historical materialism. The hard form of methodological individualism (which holds that the individual is totally free to act) is similarly rejected. Giddens grants the actor capability, but this capability is always bounded by the structure within which the individual finds him/herself.

13.3.1.4   Summary of Structuration

Social Systems

These have a virtual existence and are structured *only* in their continual and contingent reproduction in every day life.

Capability/knowledgeability

Are always bounded in and through structure, and may result in unintended consequence influencing the system and having a recursive effect on the structure, as it continuously and contingently reproduces the system

Social Reproduction

Social reproduction must be explained in terms of 'structurally bounded' and contingently applied knowledgeability of social actors. Thus, there is no defensible viewpoint that attempts to separate the action of social actors from the long term institutions they inhabit. Conversely attempts to isolate the workings of a long term institution, from the actions of the social actors that produce and reproduce the institution, is similarly flawed. Thus, structure and action are two sides of the same coin.

13.4 Analysis of the Area 1 and Area 2 Maternity Systems Utilizing Giddens's Taxonomy of Terms

Area 1 and Area 2 maternity systems will now be analyzed using Giddens's taxonomy, in order to decide whether the difference between them is one of 'style' or one of 'form'. It must be noted that this analysis will for reasons given above

(ante-natal is the area over which staff have most control, problems of access to sensitive areas, and the ante-natal is the only area where the GIT system is up and running) essentially concern itself with the ante-natal care of the mums.

As Giddens (1984) notes above

> *'Structure then refers to rules and resources embedded in social systems but only having a virtual existence'.*

In the case of social systems all of these terms (structure, rules resources and systems) are ethereal and problematic to investigate. However, in the area of work many of the elements of the system have been reified into actual objects (i.e. buildings, staff ratio & mix, division of work, etc) which can be observed. It should be possible to work backwards from these reified elements to uncover the 'structure' responsible for their construction and maintenance.

13.4.1   Area 1 Ante-Natal System

At first sight the Area 1 ante-natal system appears to be chaotically run: It is extremely noisy and overcrowded; there are large queues; there are no facilities to relieve the long waiting time; the comfort of the mums seems to be of little concern; they feel 'herded like cattle'; the staff are overworked and under-utilized (highly trained midwives with single tasks e.g. taking blood pressures).

To an outsider the situation seems illogical, and many of the problems seem easily solved. For example a way of easily alleviating the situation would be to allocate the mums individual appointments. This simple action would, eliminate many of the queues; reduce the pressure on the staff, reduced the time the mums spent in ante-natal clinic, reduce the size of waiting rooms, which would allow the extra space to be utilized for as a creche or refreshment area etc.

A interesting question would be why has not an appointment system been implemented by the staff of the unit? Surely, if an outsider within 30 minutes can see the problem and what appears a simple answer, why haven't the staff who are working under these stressful conditions arrived at the same conclusion?

However, this is only possible by importing the basic assumptions tacitly held by the observer to a situation and finding it wanting. Winch (1958) points out that such an exercise is illegitimate. For Winch (1958) logic is not an objective criteria by which to judge the rationality of a particular behavior. On the contrary rationality is piecemeal and internal to idea systems. Therefore, it is advisable to assess the situation from a stance of ontological neutrality, in order to assess whether the situation is rational within the criteria of the idea system within which it exists. Perhaps the tacit assumptions of Area 1 idea system would make their organization of pregnancy rational. The following section will investigate this notion.

13.4.1.1   Analysis of the Tacitly Held Basic Assumptions Behind the Area 1 Ante-natal System

The Area 1 ante-natal clinic appears rational to its staff but can only be seen as rational to an observer if the tacitly held assumptions behind it's design are explicated. This is problematic because there has yet to emerge a consensus about tacit knowledge and its elicitation. The reader is therefore, reminded that this research seeks only to probe the subject in order to lay pointers for future more systematic research into the area. It must be noted that although the following methods of explicating tacit knowledge are presented in a logical sequence, (from world views to details of interface design) a rigid temporal sequence did not occur. Many interesting aspects of macro issues developed from discussing details for the interface design and vice versa. The recursive way that the tacit knowledge emerged made writing up the research in a logical sequence problematic, in that assertions will have to be made in the macro section which can only be defended with the evidence

that will be discussed in later sections. It is realized that although this will require
patience in the reader, to present the evidence as it emerged would not be possible
in a meaningful form.

13.4.1.2   Area 1: Basic Assumptions

As mentioned above the 20th Century has witnessed the increasing medicalization of
child birth in the Western world. At the beginning of the century child birth was a
dangerous period in ones life, large numbers of mothers died in child birth and the
infant mortality rates were unacceptable. In order to improve the situation doctors
were enlisted to use their medical knowledge to reduce the maternal and infant
mortality rates. To this end doctors employed techniques, which had proved
successful in combating disease, to childbirth with great success. However, the
doctors also brought with them the implicit assumptions of their profession, the
'medical model of disease' and produced a 'medical model of childbirth'.

The medical model of childbirth lead to the incorporation of two tacit assumptions.
Firstly, the medical model of disease seeks to link unifactorial causality and biological
individualism, seeking to find the cause of an illness within the individual (Armstrong
1989). Secondly, childbirth is seen as a potentially dangerous time (to both mother
and baby) where events can go drastically and rapidly wrong. It must be noted that
this view of doctors is not unreasonable. Doctors only attend 'problem' births and
this tends to reinforce the idea that pregnancy is a pathology. Therefore, while in this
'pathological' condition the mother requires constant expert surveillance by doctors.

13.4.1.3   Consequences of Area 1 Tacitly Held Basic Assumptions

Once these two implicit assumptions (the medical model of disease and childbirth is
a pathology) are recognized then the organization of the Area 1 ante-natal clinic
becomes rational. If pregnancy is a dangerous state, which can rapidly deteriorate

into a pathological state and the cause of the pathology is to be found within the biological individual, the body must be frequently and expertly monitored for biological indications of the onset of the pathology. The task is to devised more sophisticated ways of monitoring the mother, other considerations will necessarily be secondary.

Regarding pregnancy in this way explains why all pregnant women are seen by the ante-natal doctors at least nine times between conception and due date. This has a dramatic increase in the number of times a patient consults the doctor.

Initial Ante-natal Consultation	=	3,500 mums
Average 20% 'problem mums'	=	700 mums

N.B. the 'problem mums' receive care on an individual basis, however, the 'normal mums' visit the ante-natal clinic a further eight times.

'Normal Mums' = 2800 x 8	=	22,400 episodes
Total episodes	=	25,900 episodes

Logistically if the clinic worked 52 weeks per year the doctors would have to monitor 498 'normal mums' per week approximately 100 per day. To this must be added the 'problem mums', the number of these episodes (due to the individual nature of their care) is difficult to estimate. However, if they only visit the ante-natal clinic as often as the 'normal mums' this will increase the number of episodes to be monitored by the doctors by a further 5,600 episodes (700 x 8). Approximately 107 per week, increasing the number of episodes to 605 per week or 121 per day. It must also be noted that 'problem mums' necessarily are more complex cases and require much more of the doctors time for each visit.

Added to this workload it must also be emphasized that ante-natal clinic is only one aspect of the doctors work, and has to be fitted into a crowded schedule. In order to process this large number of mums each day the work has been fragmented in true 'modernist' fashion into a series of tasks, each of which provides the doctor with an indicator of the status of the mum. Each task is performed by the midwife (an expert data collector) and the mums progress from task to task eventually presenting to the doctor for the final examination and collation of the data (collected by each task).

It is only possible to fragment the ante-natal clinic in this fashion if the medical model of disease is generally accepted i.e. the cause for a pathological pregnancy will be a unifactorial cause within the biological individual. This organization locates the doctor at the centre. Information is collected as the mum progresses from task to task to be collated by the doctor.

The mums are all given a 9:15 appointment due to the fact that the time taken for each task varies. For example weighing the mum takes less than a minute, a blood sample takes considerably longer. It is important that the supply of mums from the tasks that take longer is sufficient to keep the midwives in charge of the tasks that take less time busy. This type of 'modernist' mass production has a basic requirement of mass supply, the fact that this requires the mums to queue for long periods is therefore, necessary, if regrettable. Most important of all is that the doctors do not have to waste their valuable time waiting for mums.

A case could be made for some kind of staggered appointment system to alleviate the time the mums spend in the clinic. However, because the doctors see both the 'problem' and the 'normal' mums this is very difficult to organize. The 'problem mums' can potentially take much more of the doctors time and there is no way of adjusting the flow of mums to take this into consideration.

13.4.1.4   Results of the Task Orientated Organization of Area 1 Ante-natal Clinic

In terms of the basic assumptions of Area 1 Maternity Unit the clinic is extremely efficient and well run, the maximum number of mums have been expertly monitored, the maximum number of times prior to the birth of their babies.

13.4.1.4.1   Adverse Consequences of task orientated organization

The task orientated organization of the ante-natal clinic, however, has the following consequences.

1)   All the mums must have a 9:15 appointment: this results in the mums attending clinic for 2 to 4 or more hours; the waiting room being noisy and overcrowded; the weight of numbers affects the style of seating (bench seating); there is no room for creche and refreshments.

2)   De-skilling of the midwives: the midwives role is that of skilled data collector. They perform the role of doctor's assistant rather than practitioners in their own right, e.g. taking blood pressure all day. An understanding of the individual mums requirements by the midwife is not required. It is the doctors function to collate the data.

3)   There is little chance for the mum to have rapport with any of the professional staff: the building of rapport is often felt necessary if the mum is to feel confident enough to ask questions about her pregnancy. However, if the function of the mum is to provide data as a biological individual, rather than a person individual then rapport is of little importance. This situation has been further exacerbated by the introduction of the GIT system which reduces

the evaluation of the mum by the midwife to a check list of questions. The GIT system has the effect of both de-skilling the midwife and interfering with the only area where rapport could take place.

4)   The 'feelings' of the mums are barely considered. The fact that they are forced to wait for considerable time with poor facilities and their subjective impressions of being 'herded like cattle' are of little consequence. They are regrettable but necessary if pregnancy is to be safely negotiated.

13.4.2   Analysis of the Tacitly Held Basic Assumptions Behind the Area 2 Ante-Natal System

To the outside observer the organization of the Area 2 seems much more organized, friendly and efficient. However, taking the ontological standpoint of Area 1 the clinic is badly organized and inefficient. It may be conceded that by giving the mums individual appointments they have less time to wait in the clinic. It is also true that allocating each mum a 'named midwife' is reassuring and organizing staff around the mum saves her the queuing associated with Area 1. However, the number of times the mum is monitored is drastically reduced. Can the convenience of the mum for several mornings during her pregnancy be worth the added risk in which she and her child are placed? The function of ante-natal clinics is to monitor the mums during their pregnancy in order to 'pick up' potential problems. Area 2 seems much more user-friendly but is not performing its core task correctly, in that Area 2 only allows a 'normal' mum one consultation with the doctor before her due date.

However, such conclusions are (as mentioned above) illegitimate [14] without first assessing the Area 2 system with reference to the tacitly held basic assumptions of that organization.

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[14] They are importing cognitive models from Area 1 and finding Area 2 wanting.

13.4.2.1   Area 2: Basic Assumptions

The increased medicalization of pregnancy in order to decrease infant and maternal mortality has come under vigorous attack in the last decade. It has been conceded that great advancements have been made but at a tremendous cost. Increasingly, the medical model is being found inappropriate for pregnancy. In recent years there have been a plethora of models (human needs model, holistic model etc.) which seek to provide a more appropriate model of child birth, viewing pregnancy as an 'altered state' rather than a pathology. An understanding of these various models requires in-depth domain knowledge but here is not the place to discuss the relative merits of various models. A flavour of the basic assumptions common to all the 'altered state' models is more easily explained with reference to a phenomenon of which we all have personal knowledge i.e. pain.

13.4.2.1.1   Somatopsychic Model of Pain

The somatopsychic model of pain, which emerged from the work of the hospice movement (working primarily with cancer suffers) has come to regard the patient not as simply a patient but a 'whole' person. This has lead to the realization that, for example, pain, especially in the case of cancer is a very complex entity, extending beyond the limits of the dominant medical model of disease. Twycross (1975) points out that a patients perception of pain can be intensified by other than purely physical factors.

Total Pain = Physical pain + Anger + Depression + Anxiety.

An increase in any one of these areas can increase the patients' perception of pain. The notion of somatopsychic pain (i.e. both physical and psychological) explains how a patient's pain threshold varies according to the patients mood. Griffin (1991) notes,

'factors which have been found to affect the pain threshold can be
listed as follows: discomfort, insomnia, fatigue, anxiety, fear, anger,
sadness, depression, time of day (worse at night), mental isolation, and
social abandonment.

If pain has a somatopsychic aspect, the management of pain will require controlling aspects beyond the body of the individual and the medical model of disease.

There are many social, psychological and economic issues which can effect pregnancy and therefore, the somatopsychic model can be applied to pregnancy.

13.4.2.1.2   Somatopsychic Model of Pregnancy

The mum is regarded as a person rather than a patient. She will have four types of needs that will have to be met if the pregnancy is to be unproblematic.

Physical Needs

Giving birth is essentially a biological act and as such certain biological needs must be met if this is to be successfully achieved. It is with this need that the medical profession has traditionally most concerned itself.

Psychological Needs

The psychological state of the mum can have a dramatic effect on the course of her pregnancy. If the mother becomes depressed or anxious she might not eat correctly, drink excessively or smoke heavily, all of which will have a deleterious effect on the health of both the fetus and herself.

Social Needs

A pregnant mum and a new baby have considerable social needs. She will need a partner for support (financial, morale and physical) and a network of people that she can call on for advice during and after the pregnancy. If these are lacking she can become isolated and this could result in her becoming depressed or anxious with the above psychological effects.

Educational Needs

The mum will need advice about how to satisfy the above needs, what to do if things go wrong, how to get help and even how to gain access to the benefits system.

The somatopsychic model regards the act of giving birth as a normal activity which women have been preforming for millions of years without medical intervention. Although the mortality rates of the past are no longer acceptable, the vast majority of pregnant women will have a normal delivery. Even by modern standards, approximately 80% of mums will go on to have a normal delivery. Pregnancy is still a time of risk and there is a place for medical intervention, however, this should be held in ready to aid the 20% of who require it.

Once these two implicit assumptions (the somatopsychic model of childbirth and that childbirth is an 'altered state' rather than a pathology) are recognized then the organization of the Area 2 ante-natal clinic becomes rational. Ante-natal care consists of separating the mums into 'problem' mums (those mums at a 'high risk' of requiring medical attention in order to give birth) and 'normal' mums (those mums quite capable of giving birth with the assistance of the midwife). 'Problem' mums are assigned to the doctors for ante-natal care based on her individual needs. 'Normal' mums are assigned to midwives (both in the clinic and in the community) for the ante-natal care listed above. It must be noted that although the 'normal'

mums do not attend the ante-natal clinic they receive care in the community, nominally from the G.P. but mainly from the community midwife. The community midwife can liaise with the 'named midwife' at the clinic if there are any problems with the mum.

13.4.2.1.3 Consequences of Area 2 Tacitly Held Basic Assumptions

Viewing pregnancy as an 'altered' state reduces the necessity for all mums to be monitored for the maximum number of times possible by a doctor. This reduces the work-load of the clinic in two ways

1) A division of labour can be implemented, where the doctors (except for the initial ante-natal visit) deal only with the 'problem' mums and the midwives deal with the 'normal' mums.

2) The number of times the 'normal' mums are required to attend the ante-natal clinic is drastically reduced. If the monitoring no longer requires a member of the consultants team of doctors, it can be carried out in the community by the G.P.'s and community midwives.

Initial Ante-natal Consultation   =   3,500 mums

Average 20% 'problem mums'   =   700 mums

The 'problem mums' receive care on an individual basis. The 'normal mums' visit the ante-natal clinic on the 38th week of their pregnancy.

'Normal Mums' =   2800 x 1   =   2,800 episodes
            Total episodes   =   6,300 episodes

Logistically if the clinic worked 52 weeks per year the doctors would have to monitor 67 'normal mums' per week approximately 13 per day. To this must be added the 'problem mums', the number of these episodes (due to the individual nature of their care) is difficult to estimate. However, if they visit the ante-natal clinic as often as the 'normal mums' in Area 1 this will increase the number of episodes to be monitored by the doctors by a further 5,600 episodes (700 x 8). Approximately 107 per week, increasing the number of episodes to 174 per week or 35 per day. It must be also noted that 'problem mums' necessarily are more complex cases and require much more of the doctors time for each visit.

The midwives attend only to 'normal' mums and their workload is

Initial Ante-natal Consultation   =   3,500 mums

38th week assessment   =   2,800 mums

            Total episodes   =   6,300

Thus the midwives would be required to attend to 121 mums per week or 24 mums per day.

The assumption that pregnancy is an 'altered state' means that the midwives in Area 2 will attend approximately the same number of mums per week as the midwives in Area 1 attend per day.

13.4.2.1.4   Extra   Requirements   of   the Somatopsychic Model

However, although the tacitly held basic assumptions of Area 2 drastically reduce in a quantitative way the work load of the ante-natal clinic, this is only possible by a qualitative change in the work of the clinic. The medical model concentrates on the

biological individual, and therefore, all the data that is required is within the body and therefore, available to direct testing. The somatopsychic model extends the area for data collection far beyond the limits of the mums body. Much of this information is difficult to collect and has to be elicited (with little opportunity for verification) by asking the mum. In order to gain an overall knowledge of the mum the midwife will have to employ considerable experience and a variety of questioning techniques in order to correctly classify the mum. This requires the midwife to build a considerable rapport with the mum. It is self evident that the task orientated organization of Area 1 is totally inappropriate for rapport building.

13.4.2.2   Relationship between Midwife and Mum

Building rapport requires the establishment of a very different relationship between the midwife and mum. Rapport is defined in the New English Dictionary (1932) as,

> *'rapport (ra port',) [F from rapporter (RE-AP-, porter, L. portaire, to carry)], n. Correspondence, sympathetic relationship, agreement, harmony.' (page 885).*

Rapport is a friendly dialogue between equals or friends, which is very different than the traditional doctor/patient relationship. It requires the midwife to be regarded by the mum as an ally, a friendly and knowledgeable advisor who will facilitate the birth of her child. Every effort has been made in Area 2 to encourage this belief.

The mum is given an individual appointment, she arrives at the reception and is expected. She (with whoever is accompanying her) is asked to sit down around one of the coffee tables. The room is relatively empty and quiet, refreshments and a creche are available. The midwife emerges and calls for the mum by name, she is encouraged to leave any children in the creche 'So we can have a quiet chat'. The mum is then shown to a room by a midwife who introduces herself as,

'Hello my names June, I'm your named midwife, I'm the one who will

be looking after you from now on. If you have any problems just ring

the clinic and ask for June'. (Appendix XI).

The midwife spends as much time as possible with the mum, only interrupting matters when she leaves to bring the doctor to the mum. The midwife is required to elicit certain information from the mum, how she does this is up to her. She seems to ask open questions which allow the mum to respond in other than yes/no answers. The interview takes the form of information exchange rather than data collection from the mum by the midwife. This interview, plus the experience the midwife has accumulated, plus liaison with her colleagues in the community midwifery service allow the midwife to be both an expert *data collector* (although in a qualitatively different way than her colleagues at Area 1) and *collator of information*

13.5 Is the Difference Between Area 1 and Area 2 Ante-natal Clinics One of 'Style' or 'Form'

The two clinics could hardly be more different, they could not be regarded as two extremes on a continuum. There is no way that the 'task oriented' organization could be employed to elicit the information required by Area 2, and there is no way that the 'client centered' organization of Area 2 could be employed to provide the type and quantity of information required by Area 1. The two organizations for all their objective similarities have socially constructed pregnancy in very different ways, to such an extent that they are performing different services.

Using Giddens' taxonomy the structures of the organizations are different, at the macro level,

Rules: The rules of the structure of both organizations are very different.

For example, at Area 1 pregnancy is seen as a pathology which needs constant monitoring by specialist doctors. Area 2 views pregnancy for the vast majority of mums as a normal state, only the minority require medical expertise.

Resources: The resources of both organizations are also very different.

For example, the power relationships are very different. At Area 1 the doctor is extremely powerful, showing considerable autonomy and being the only collator of the data of all the mums. The midwife is basically the doctors assistant and acts as a data collector. The mums' bodies are basically the source of data.

At Area 2 the midwife acts as a 'gate keeper' she collects and collates the data in order to classify mums as 'normal' or 'problem'. The midwife then takes responsibility for the 'normal' mums. The mums' body is not the only source of data, she has somatopsychic needs which require the midwife to relieve by first identifying and then acting as a source of information for the mum. Access to these external needs is only possible by the establishment of rapport between the midwife and the mum.

13.5.1   At the micro level

Although the actors of both organizations have a 'practical conscious' of the workings of their respective organizations, this knowledge is different because the workings of the organizations is different. The capability of the actors is also very different: in Area 1 the doctors have a great deal of autonomy to the point of eccentricity, whereas the midwifes have very little scope for capability; in Area 2 on the other hand both doctors and midwives are practitioners (although with their own areas of responsibility) and both have a considerable capability of action.

13.5.2   Consequences for Generality

The above illustrates, in terms of generality, how an understanding of the tacit knowledge employed by organizations is vital. By objective criteria Area 1 and Area 2 are similar organizations and a KIS designed for Area 1 should (with modifications) work for Area 2. An analysis of the tacit knowledge at the macro level, using Method One, however, indicates that these two organizations operating in ways that are illogical to each other but at the same time internally logical. Area 1 and Area 2 maternity units are therefore, different in 'form' and a KIS developed for Area 1 is unlikely to work at Area 2.

CHAPTER 14

Method Two

14   Method Two: The Elicitation of Tacit Knowledge at the Micro Level

14.1   Introduction

Method 1 explicated tacit knowledge at the organizational level, method 2 seeks to find ways of explicating tacit knowledge within an organization.

Collins (1987) drawing on his experience sociologically investigating technology observes ironically that,

> *'Participant observation- that softest of social science methodology may*
> *oddly enough be of direct relevance to the new breed of knowledge*
> *engineers'.*

Participant observation is a widely defined term, and depending on the author can consist of at one extreme a completely none interventionist observation of the action (fly on the wall) to the other extreme of observations by a participant actively involved in the action. The field work was conducted using a style of participation observation towards the middle of these extremes, primarily action was observed but questions were asked as and when clarification was required. The essence of the technique is to try to capture 'what' actually happened rather than what 'should' happen in a social activity. Therefore, initially everything was treated as data, failure as well as success. Collins (1985) makes use of an 'unusual source of data', Harrison's 'failure to make the TEA-Laser work', to reveal unexplicated knowledge which would have remained 'hidden' if only the 'usual sources of data' i.e. the successful attempt had been 'written into the report'. During the fieldwork one such 'unusual source' emerged.

14.2 Gaining Knowledge from Unusual Sources

Whilst conducting research, rapport is often built up between the researcher and the respondents. Gaining rapport with a respondent is felt to be important when conducting knowledge acquisition, because friendly respondents tend to be more forthcoming than unfriendly ones. Rapport is often important in providing a context for the situation under investigation. However, the subjective and often unsubstantiated nature of rapport, often leads to it being 'written out', or omitted from the final report. The purpose of this research is to elicit knowledge that is subjectively or inter-subjectively held. It seems fruitful, therefore, to investigate the possibility of transforming rapport in true sociological style from a 'tool' into a 'resource'. This section seeks to investigate the possibility of rapport being a resource for the elicitation of tacit knowledge.

Whilst conducting the fieldwork the researcher was struck by the fact that when respondents initiated topics, they would reveal their taken-for-granted assumptions in a more observable way than if they simply responded to questions. For example here is a short extract from Appendix IV, which is continued later in this chapter.

MW1A3 is a senior midwife of considerable experience. The inferences drawn from the conversation by the researcher are recorded in *'italics'*.

MW1A3:   That reminds me of something that happened one night when I was Night Sister on Maternity. Well this big Pakistani woman came in and she looked in a bad way. She was very fat and looked about 50 must have been in her late 40's at least.

* N.B. The criteria by which the midwife assess the mums' risk factor, Asian, fat and old. Any one of these factors could indicate a 'high risk' mum, the combination of all three confirm her 'high risk' status.

MW1A3:   The poor woman was having a terrible time and she told me that she had not felt the baby move for a day or two. You know that is a bad sign.

* A potential experiential heuristic indicating a problematic birth.

Researcher: How bad ?

MW1A3:   The worst, you know alarm bells time.

* The heuristic is an indicator of an extremely severe problem.

> Anyway I felt the baby and it was massive, much too large for her, so I kept my fingers crossed and hoped against hope that it was just too tight to move.

* Another risk factor i.e. the baby was too large for the woman to deliver.

Researcher: Surely she would have had children by that age.

* The researcher is indicating that this shouldn't be a factor. Prima Gravida (first birth) is seen as a risk factor. If she has given birth in the past she should be physically capable (her pelvis should be large enough) now.

After careful consideration the aspect of rapport which seemed especially fruitful for the elicitation of tacit knowledge was a type of personal anecdote which will be referred to in this research as the 'war story'. Such stories often contain 'thick' data which when analyzed can reveal the tacit assumptions of the social group of which the story teller is a member.

The problem of the unsubstantiated nature of such data was overcome with the by taking the definition of 'knowledge' advocated by Berger and Luckmann (1967), which was,

> *'The certainty (for the teller) that phenomena are real and that they possess specific characteristics.'*

14.3 Definition of 'War Stories'

A war story refers to a specific type of anecdote which individuals share. These stories refer to a shared interest, i.e. job, hobby, conditions etc and usually refer to the unusual experiences within a domain, which required unusual or informal solutions. The term 'war stories' arises out of the authors experience as a C.U.S.O. (Canadian University Service Overseas) volunteer in Africa. When volunteers or 'expats' would meet they would talk about experiences (usually humorous but sometimes horrific). These experiences were usually the result of the cultural differences between the volunteers and the African students. As the volunteers 'swapped' stories they began to sound like 'old soldiers' swapping stories about the war, and indeed these stories displayed many of the characteristics of the old soldiers tales.

1)   They were very interesting to fellow volunteers but they soon became
       boring to anybody that had not spent some time in Africa.

2)   The 'swapping' of the war stories tended to establish ones credentials
       as an 'old Africa hand' by excluding those without African experience.

The importance of the analysis of 'war stories' to this research is that they often force aspects of culture that are tacitly held by members of the culture (African and Anglo/American) to become 'visible' or explicated.

14.3.1   Difference between 'war stories' and the 'critical incident technique'

Many 'war stories' recount interesting past events, but these are qualitatively different than the accounts elicited by the 'Critical Incident Technique'(CIT). This is an

important distinction because the knowledge that each elicits is qualitatively different. CIT elicits Heuristics whereas 'war stories' reveal tacit knowledge (see Chapter 8).

CIT is too linear and the *post hoc* rationalization tends to eliminate tacit knowledge. War stories on the other hand spontaneously occur during informal meetings and are the result of a mismatch of tacitly held basic assumptions. The war stories highlight the mis-match of assumptions making them briefly 'visible' and therefore, open to explication by the researcher. War stories can, therefore, be used to highlight the mechanism that Garfinkel used to explicate the mundane world (see Pollner, 1975) i.e. 'strangeness' but by a much 'softer' and therefore, more appropriate method than the disruption of social order. To illustrate this point, a short 'war story' often recounted by the researcher will be described and analyzed.

14.3.2   Brickwork Practice at a Ghanaian Technical Institute

While working at a practical lesson of brickwork, two Ghanaian students were talking and an amicable dispute broke out just as the European teacher walked by.

Kwasi: Master, can we ask you a question?

Teacher: Yes, of course you can, but don't call me master.

Kwasi: Yes, master. Master is it true that people in England eat dog meat?

Teacher: Well yes I'm afraid that some poor people have to eat dog meat.

Kwasi: [Turning triumphantly to Kwabana with whom he was arguing] See I told you they eat dogs in England.

Teacher: [Horrified] Oh, no you don't understand.....When you said dog meat, I thought that you meant the meat that you feed to dogs.

Kwasi: [Looks at Kwabana and both smile broadly] Master do you expect us to believe that you give dogs meat to eat in England. [Both break up into laughter].

Kwabena: [Looks at Kwasi laughing and said] Brunie, Kwasi Brunie.

This war story employs a standard 'joke' format in which the listener is tricked into taking a statement at its common sense every day meaning. It is only when the pun on the word 'dog meat' in revealed in the punch line that the listener realizes that s/he has been duped and the situation becomes funny.

It is important to note that the humour in the above 'war story' arises not from a contrived situation but from the fact that Kwasi and the teacher coming from different cultural backgrounds have different common-sense definitions of 'dog meat'. However, a 'war story' is much more important than a joke, it is not an artifice it is an actual event that occurred and as such allowed the basic assumptions of the different cultural knowledge which was held at an tacit level by both people involved to be explicated.

14.3.3   Analysis of the 'War Story'

Although there are many inferences at different levels (e.g. the relationship between the teacher and his students) that can be drawn from this short passages. For the purposes of this research (the explication of tacit knowledge) only the inferences that can be drawn from the dislocation of culture will be highlighted in bold print.

The students were arguing, Kwabena was claiming that Kwasi's tribe is inferior because they are so poor that they eat dogs. Kwasi tries to counter this charge by claiming they eat dog meat because it tastes good. In order to prove this he takes it to a higher authority and asked the teacher whether people in England eat dog meat. Both students at a tacit level believe that if the English eat dog meat then it must be for reasons of taste not cost, they both assume that,

*   **All English people are rich.**

The teacher 'naturally' assumes that 'dog meat' refers to the meat that people feed to their dogs. He assumes that the student is in fact asking

> 'Are there people in England so poor that they eat the meat that you feed to dogs'.

The teacher assumes that,

*   **Ghanians have dogs, therefore, they must be pets and be fed meat.**

The students assume that eating dog meat can only refer to eating dogs. The teacher is appalled by this idea and seeks to explain the misunderstanding.

*   **To the teacher it is more acceptable to eat a 'dogs food' than to eat a dog.**

To the Ghanians the idea that anybody (even an Englishman) is so rich or foolish enough to feed meat to a dog, is so far fetched that they simply can not believe the statement, and assume that the Teacher is joking. The students (who were previously arguing) join together and laugh because the statement is so outrageous that nobody could be expected to be taken in by it. To the Ghanaians,

*   **The notion of feeding meat to a dog is unbelievable.**

The final statement 'Brunie, Kwasi Brunie' is a way that the Ghanaians refer to white-men and there crazy ways. It is used in a similar amicable but disparaging way indicating that white people are always good for a laugh because of the crazy things that they say. It was obvious to the teacher that this encounter would be repeated over and over again when the students went home. To the Ghanaians,

*   **White people are all mad, but they are good for a laugh.**

14.4 The Importance of the Analysis of War Stories for Knowledge Acquisition

Berger and Luckmann (1967) contend that the basic assumptions of a culture by which individuals interpret the world are for all practical purposes held and remain unexplained and unexamined by its members. In the case above it is only when the assumptions of one culture differ from the assumptions of another that dislocation occurs and what is can usually be taken-for-granted needs to be examined and explained. Cultural dislocation can also be used as a tool to force individuals to examine and explain tacit assumptions to themselves and more importantly for our purposes to the knowledge engineer.

In many ways cultural dislocation as a tool and resource is inherent to anthropological investigations.

i.e.   An investigator from one culture studies the members of another culture.

To the anthropologist the culture that is under study is 'visible' due to its 'strangeness' (to the anthropologist). This 'strangeness' can if the anthropologist is sensitive, also be used as a sensitizing device to make some of his/her own culture 'visible'.

14.5 Problems of Analyzing Culture Sociologically

The analysis of culture in anthropological investigations is possible due to cultural dislocation. However, the mechanism of 'strangeness' is not so readily available to

sociological investigation. This is due to the fact that the investigator and his/her subject share a culture. The tacit assumptions of the researcher will in most cases match the tacit assumptions of the subject. In such a case to use the above example the classification of 'dog meat' would be objectified and the tacit assumptions responsible for defining it as such would not be addressed.

14.6 Phenomenological Brackets as a Tool of Knowledge Acquisition

For the purpose of the knowledge acquisition of tacit knowledge it seems fruitful to 'bracket off' the expert domain in a similar way that Phenomenologists bracket off area of research. The members of an expert domain can be considered as a culture. More accurately they can be considered as a mini-culture (Collins 1982) in that the domain exists in an overall culture and is likely to be heavily influenced by it. Thus, cultural dislocation can occur, but due to the shared overall culture, it will be more subtle and the researcher will have to be more sensitive to identify it where it occurs. Cultural dislocation is likely to occur at two points,

1)   The interface between members of the mini-culture and outsiders.

In the case of the field work this will be between members of the ante-natal staff and the mums. Dislocation is likely to reveal the tacit knowledge of both groups.

2)   The interface between different groups within the mini-culture.

In the case of the field work this will be between different types of health care professionals, e.g. Doctors, midwives and managers. Dislocation is likely to reveal the tacit knowledge associated with each group.

14.7 Usefulness of Explicated Tacit Knowledge to the Building of KIS

The information drawn from the Ghanaian war story is interesting but how can such knowledge of use to the design of a KIS? Once the potential of war stories was recognized they were actively collected throughout the fieldwork. The analysis of these war stories revealed many items of tacit knowledge directly applicable to the building of a KIS. However, due to the spontaneous nature of the resource some of these items pertained only to specific details, whereas, others seemed to form general trends. For a detailed analysis of several war stories and the information that they yielded see the Appendices. In general war stories proved particularly useful in two areas of importance to the design of a successful KIS. i.e. how the expert tacitly delimits or defines the boundary of their domain and how various aspects of work are tacitly prioritized within these boundaries. These tasks seem amenable to simple overt questioning of the experts involved, however, in practice expert tacitly define the boundaries of their domain differently than formal domain distinctions would suggest.

14.8 The Analysis of 'War Stories' to Explicate How Experts Tacitly Delimit their Domain

Members of the maternity team were asked to delimit the area of responsibility of the doctors and midwives. There was a broad consensus that, while the doctors are nominally responsible for all births, in practice they take responsibility for 'high risk' mothers and all 'abnormal' deliveries. 'Normal' mums and deliveries are left to midwives. However, the story below indicates in practice the maternity team define each of these terms in a complex and flexible fashion.

The following is example is a continuation of the war story (above). MW1A3 continues the story of the complicated delivery of an overweight Asian woman of about 50,

MW1A3:   Anyway she was having a terrible time and we soon realized that we had a dead baby on our hands.

Researcher: What do you do then, knock her out (anaesthetize the woman).

MW1A3:   Do we heck, there's nothing you can do but let her give birth.

Researcher: What let her go through all that for nothing.

MW1A3:   We do all we can, but in all fairness it is the only practical solution. The trouble is that this woman wasn't progressing. After about two hours I said that we should phone for the consultant. The other midwife said that there was no way that she was going to wake up the consultant for a dead baby.

It is interesting to note that the midwives carried on delivering the woman without the doctors assistance or even informing the doctor. The fact the baby was dead didn't seem to define the birth as 'abnormal'. It was only after two hours that the delivery had become 'abnormal', because the woman was still not progressing. At this point MW1A3 suggested getting a doctor. It is interesting to note that if the baby had been alive and not progressing the doctor would have been called after 30 minutes. In this case second midwife refused to call the doctor because the baby was dead.

Later after much struggling.

MW1A3:   Any way it was getting past a joke now so I thought sod it and woke up the consultant. It was Mr Johnson he said what have I woken him up for a dead baby?

The consultant here reinforces the point that a dead baby is not his concern. N.B. the mum seems to have vanished from the conversation.

I said that we had tried everything and I was really concerned for her (the mothers) life. He said alright we'll section her (Caesarian Section) get the theatre ready I'll meet you there.

This story graphically illustrates the flexibility in the way that work is delimited. Formal boundaries of work: doctors are responsible for 'high risk' mothers and all

'abnormal' deliveries; midwives are responsible for 'low risk' mothers and 'normal' deliveries.

In the above case we have an extremely 'high risk' mother being delivered by midwives. Therefore, midwives take responsibility for all deliveries (high and low risk).

*   All deliveries are categorized 'low risk' until proven other.

*   Delivering a dead baby counts as a 'normal birth'.

During delivery 'failure to progress' for 30 minutes equals an 'abnormal' delivery and requires a doctor to be called, in this case 'failure to progress' for 2 hours in the mind of one of the midwives still equalled a 'normal' delivery, this categorization is confirmed by the consultants response. It was only special pleading and concern for the mothers life by MW1A3 that transformed the 'normal' delivery into an 'abnormal' delivery. Therefore, the above changes the delimitation of work.

Informal boundaries of work: doctors are responsible for 'high risk' mothers and all 'abnormal' deliveries. At delivery All mums are treated as 'low risk'; all deliveries are 'normal' unless proven 'abnormal'; an abnormal delivery is one in which the life of the mum or the baby is at risk.

Using the informal boundaries of work it is possible to understand why

1)   The midwives are facilitating the delivery of a 'high risk' mum. Therefore, during delivery all mums are 'low risk' until otherwise proven.

2)   Although the baby is dead the delivery is still 'normal', the life of the mother and baby was not at risk.

3)   The usual 30 minute 'failure to progress' rule did not transform the delivery from 'normal' to 'abnormal' birth. This rule usually indicates that the baby is at risk, which it clearly was not, in this case.

4)   It is only when the mum's life is threatened that the doctor reluctantly intervenes.

The way particular mums are categorized and allocated to either doctor or midwife draws a boundary around the work of each group. The following war story illustrates how boundaries of work are drawn in a much more subtle way, certain aspects of a particular mum are held to be of central importance, by one group are virtually ignored by other groups. Knowledge of this type is fundamental to the design of any KIS.

The boundaries of work are graphically illustrated in the following war story (for detailed analysis see Appendix III), where aspects that are of central importance to the midwife, are virtually ignored the doctors

14.8.1   Testing for Down's Syndrome

This is a story recounted to the researcher by Sister MW1A4, who was complaining about the effect the 'triple test' for Down's Syndromes was having on the mums. Area 1 was at that time 'blanket testing' all mothers to be. The Sister was particularly concerned in the high number of **false positive** results that were occurring [15].

MW1A4:   For a start they don't get proper counselling, you know they are just

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[15] This is a situation where a considerable number of women were screened for Down's Syndrome and the test was inconclusive. Later diagnostic tests indicated a negative result. i.e. the fetus did not have Downs Syndrome.

asked if they want the test and they all say 'well yes' and then they are tested.

* *The Sister sees counselling as an important process which is being neglected.*

> They are never sat down and told the ramifications of the test. For example they are never asked if the test proves positive are you willing to abort the baby etc.

The midwife indicates that her colleagues are tacitly defining that 'Downs is bad' and must be prevented. The validity of such an assumption is open to argument, however, nobody asks the mum. If for religious or ethical reasons the mum will not submit to an abortion then the triple test for Downs is redundant. Worse it is a lose/lose situation, if the test is a true positive the mum has her pregnancy ruined knowing that her child has Downs Syndrome, if the test is a false positive the pregnancy is again ruined with the added chance of amniocentesis triggering a spontaneous abortion of her baby (Downs or other).

MW1A4:   Any way what happens is a large number of the tests are inconclusive and the women are simply called up on the phone at work and asked to come in for re-testing because there is something not right with their test. Can you imagine getting a phone call out of the blue like that.

* *The use of the telephone as a way of recalling women for a re-test is seen as acceptable by the powers at be at the hospital. It is seen as totally inappropriate by the Sister.*

Researcher: What just like that out of the blue, I'll bet they are asked if they can come in for testing next week or longer.

MW1A4:   Yes and they have all that time to worry about it. It would be better if they were made an appointment and when they attended told and retested there and then.

* *The Sister considers the anxiety level of the mother to be extremely important.*

Later the Sister goes on to say

MW1A4:   Any way what follows is two very detailed scans on separate occasions followed by a amniocentesis test if necessary. But this is the worst part, every one of them, they all say no matter what the test says they never believe that the child will be OK until after it is born. Can you imagine the whole pregnancy would be taken up by that worry. I am interested on the psychological effect that this worry has on the

women. I mean given the large number of false positive tests I am really doubtful whether they are necessary at all.

She carries on recounting her experiences and goes on to say

MW1A4:   It is not just a case of estimating the worth of the test by statistically calculating the results. It has negative costs that are not brought into the equation. Look at the protocol that you mentioned before, this will tend to cause more women to be retested. But it would be hard to find a mum who would not rather be safe than sorry, so if in doubt retest.

Researcher: Yes, what's wrong with that, it must be better to pick up on the Downs that are slipping through.

MW1A4:   See you are falling into that way of thinking. What you say is true and hard to argue with. The test will help pick up on Downs babies that might slip through. It must be worth a few false positive if our practice can be improved. What's the problem, we can point out the numbers of Downs that this test has picked out. Now you tell us why we shouldn't use the test.

Researcher: Well what's the problem?

MW1A4:   The problem is that what we are talking about is mothers to be, not numbers or statistics. Women like Mrs Chew, and her husband have that Chinese chippie on North Street. She is in her late 30's and has got two kids already and her test showed positive. She is one of my mums (one of the mothers-to-be that MW1A4 is giving anti natal care), I knew that she didn't speak English very well, so I went round to explain to her what would happen. When I went I was immediately offered a meal, You know how polite they are. I sat her down and explained that the test showed that she was under 200 and that she would have to be retested, you should have seen the look on her face.

Researcher: But don't they usually just phone?

MW1A4:   Yes, and they don't know the woman and don't see their faces. They just assure the women that the positive result does not mean she will have a Downs baby and that's why the mum needs to come in to have further tests.

Researcher: Why did you go round then?

MW1A4:   Well I had delivered her other two children, I knew her, her English

is quite poor but more importantly she is very isolated. Just her and her husband, I don't know where the rest of her family is, but like many Chinese they open their business in areas where there are no other Chinese chippies which means no Chinese.

*   *The sister sees social isolation of the woman as a 'risk factor'*

Researcher: Is that why you wanted to see her, to be another woman for her to talk it over with.

MW1A4:   Yes I thought she would need an other woman to discuss it with. That's the point you should have seen her face, she was so hurt by the news. She had to go through a series of scans and have amniotic fluid tested. Can you imagine what that woman would have gone through during the two weeks before her tests came through. You know the anguish that she felt just never gets considered when the test is evaluated. Can you imagine all that pain for nothing in the case of a false positive.

It's easy to think that because the test proves a false positive the woman would be so thankful that everything is alright that she forgets all about the worrying two weeks. It is a painful necessary period. But I've asked many of these women and they all say that they never have confidence in the false positive result. None of them believe it until after the baby is born and they can see for themselves.

Researcher: That's understandable.

MW1A4:   Yes, but is it [the test] justifiable. Basically the false positive is ruining the whole pregnancy for all these women. Instead of a beautiful experience we are needlessly transforming it into a nightmare of worry for hundreds of women. That's what I want to research, just what lasting effect these false positive are having on the mothers and how they bond with the child later.

14.8.2   Analysis of the Test

The above illustrates how the areas of the work held to be central by the midwives are virtually ignored by the doctors. It must be noted here that no attempt is being made by the researcher to judge which is the correct view. It should be evident from

previous chapters that both are correct. The doctors appear to hold the 'medical model' of childbirth. Whereas, the midwives appear to hold the 'somatopsychic model'. The boundary of the doctors work is narrow but has a deep focus concentrating on the mum as a biological individual. The midwives have a much wider but shallower focus, seeking to balance the physical, psychological, social and educational needs of the mum.

14.8.3   Doctors

From the perspective of the doctors the test is a great success, it is a win:win situation: if the test is a true positive (i.e. the test indicates a strong possibility of Down's syndrome and subsequent tests prove the fetus has Down's syndrome) then the test is deemed successful. i.e. it has identified Down's syndrome. The mother can, therefore, be offered an early termination, the earlier the termination the less traumatic the operation. If, however, the test is a 'false positive' (i.e. indicates a strong possibility of Down's syndrome but subsequent tests reveal the fetus to be 'normal'), it is recognized that the mum has undergone a very traumatic 2 weeks, however, since the news is good she will be extremely relieved that she has a healthy baby. This is considered regrettable but a necessary consequence of screening.

14.8.4   Midwives

From the perspective of the midwife the success of the test is far more equivocal. Details of the midwife's story (see 'Testing for Down's' Appendix III) indicate that even by the doctors own terms the test is far from satisfactory. More importantly for our purposes she is concerned that the consequences of screening are not adequately discussed, she takes umbrage with the assumption that everybody with a Down's Syndrome baby will naturally chose to terminate the pregnancy. She is extremely concerned with the mums psychological state and the stress this test places on the

mum. She is concerned that this point is not held to be important by the doctors and the mums are not adequately counselled. Informing the mum by telephone takes no account her psychologic state and at the same time isolates the doctor from the impact the news may have on her.

MW1A4:   Yes I thought she would need an other woman to discuss it with. That's the point you should have seen her face, she was so hurt by the news. Far from a traumatic 2 weeks the false positive mums never believe the baby is 'normal' until they see it at birth, the whole pregnancy is ruined for the family casting added strain on the mum and all her family.

MW1A4:   *Instead of a beautiful experience we are needlessly transforming it (pregnancy) into a nightmare of worry for hundreds of women.*

                    Nobody seems concerned about how this might affect future bonding between the mother and child. Finally in spite of all this angst several Down's babies have been delivered at Area 1.

From the point of view of the midwife the success of the test is far more ambiguous. If the mother does not wish to abort the fetus the test is a lose/lose situation. If the mum is willing to abort the fetus the test is a win/lose situation. If the test is a true positive she wins, if the test is a false positive she loses. A true positive will allow the woman to have an early abortion. However, a false positive will ruin her pregnancy and the extra diagnostic tests has a significant incidence of causing a spontaneous abortion, of what might be a healthy fetus.

14.8.5   Consequences for KIS Design

In the previous section it was noted that Area 1 and Area 2 maternity units while having many things in common were in fact different in 'form' and (unless one of the organizations were to radically change) would require quite different KIS systems. This section seems to indicate

1)   The external domain boundaries of midwives and doctors are different. i.e. which group is responsible for which category of mum.

2)   The internal domain boundaries of the midwives and doctors are different. i.e. the aspects of a particular mum that each group finds significant is different. The doctors having a narrow but deep area of interest, while the midwives have a wide but shallower area of interest.

This seems to indicate that if a KIS was to be designed for the Area 1 maternity a decision would have to be made as to which group (doctors or midwives) it would serve within the organization.

14.9 The Analysis of 'War Stories' to Explicate How Various Aspects of Work are Prioritized Within Domain Boundaries

In the previous section 'war stories' were used as a resource to elicit the way the different groups delimit their domains. In this section 'war stories' will be used to illustrate how one such group informally prioritizes different types of work that they are routinely required to perform. Such prioritizing is important to assess the degree of 'criticality' assigned to the task. The criticality of the task will have direct consequences to the usability of a system and should be considered in interface design.

Eason (1984) contends the usability of a system depends on three major aspects, the system, the task and the user.

System: Is the system easy to use?

                Is the system easy to learn?

                Does the system provide appropriate information to 'match the task'.

Task: The frequency of the performance of the task.

                   Openness: are the informational needs of the user variable?

User: The level of knowledge the user has of the system and the task.

                   The level of discretion that the user has over the use of the system.

                   The motivation that the user has to complete the task.

Motivation is directly affected by the way that groups prioritize various aspects of their work. Booth (1992) notes,

> *'If the user has a high degree of motivation the more effort will be expended in overcoming problems and misunderstandings. Alternatively, if the user is not strongly motivated to complete a task on the system the users' commitment to the system may wane, and there may be reluctance to learn or use complicated parts of the system.'* (page 108).

A key motivating factor is the priority of importance or *'criticality'* the user attaches to the task.

14.9.1   Criticality

Work is not an homogeneous entity. The importance of tasks which make up the work is variable. When designing a computer system an accurate assessment of its *'criticality'* or relative importance to the other tasks in the work is essential.

An understanding of criticality will allow the designer to choose from several 'trade offs' which are available to him or her. For this purpose it is useful to categorize work into three priorities, in the following order of importance:- core, auxiliary and hindrance. These categories will be discussed in greater detail below, but briefly

these categories can be explained using the example of a University. The core work of a University is research, however, in order to fund the research the University must attract and teach students (auxiliary work). In order to attract and teach the students the staff are required to perform administrative work (hindrance).

If using the KIS is deemed by the users to be a core activity they will be willing to invest a considerable amount of time and effort in order to learn the system. This is illustrated in the following extract from Appendix VII.

The Senior Reg is recounting her previous experience using a data base in another area which indicates for her the power and flexibility of the data base is the main priority.

> *'For her own use she uses RBase and tells me that when she was at Area 4 she used a data base that was very difficult for the user to manipulate. It was a command line and if a comma was out of place it would not work. The system was very frustrating BUT if you got the command correct then it produced what you wanted. She told me of how she would spend hours struggling over the command line and then somebody would notice that she had missed a speech mark or made a spelling error. She said that it was frustrating but at least the results were rewarding. I sympathized with her and told her of the problems that I had trying to understand data base when I first went to the ITI.'*

The idea that anybody as busy as a Senior Reg. or a Junior Doctor could spend 'hours struggling over' anything, indicates that the activity is of utmost importance. In such a case the engineer can design a powerful system, allowing maximum flexibility to the user at the cost of a 'steep learning curve'. For example command line interaction. In the case of an auxiliary activity, power and flexibility will be sacrificed for ease of operation and a smoother learning curve. For example 'drop-

down menus'. In the case of a hinderance activity the priority must be to develop an easy to use (if relatively less powerful) computer system which will reduce its impact upon the work to an absolute minimum. For example a simple input interface with a limited number of pre-programmed macros activated by function keys.

14.9.2   Categories of Criticality

Categories of criticality are very difficult to elicit because they are often held at a tacit level and often contradict official/formal domain knowledge and/or job specifications. Therefore, a sporting analogy (boxing) will be used to illustrate the definition of the categories of 'criticality' used for the purpose of this thesis.

14.9.3   Core Activities

The core activity in any job is that which is seen by the participants as the 'real work', their *raison d'etre*. For them it is the essence of the work they perform and in some ways defines the occupation. Users will volunteer large amounts of effort, energy and time to anything that assists the core activities (see Appendix II). e.g. the core activity for a boxer is how he performs during a boxing match. Although it is only an extremely small element (in terms of time) of the boxing enterprise it is of vital importance, it is the *'boxing match'* which defines the activity of boxing. Other tasks do not have this defining function, in our analogy it does not matter how well a man performs the other tasks associated with boxing, if he does not fight well in the ring he will not be defined or define himself as a 'good boxer'.

It must be noted that there is a problem of 'performance measurement' of what is perceived as core activities. For example, research is perceived as the core activity of a University. When the Government identified 'research' as a core activity by which to judge universities, by counting the number of research papers published.

A number of papers with multiple authors began to appear. If a paper is published with four authors each would claim to have a paper published, thus one paper could count as four papers. Actions have since been taken to rectify this practice

14.9.4   Auxiliary Work

Auxiliary work is the tasks which help or assists the core activity. Auxiliary work is useful and enabling to the core activity, but of a lower status in that it does not essentially define the occupation. If a new task is deemed to lie in this area, some effort will be volunteered but there must be an obvious result in respect to the 'core activity' for the effort expended. The task must either aid the core activity or reduce hindrances and or ancillary work. e.g. In order to fight well in the ring the boxer must be extremely fit. Therefore, a large amount of time is spent training. Although training is extremely important it is not a core activity in that a man who trains well but can not fight is not a good boxer, whereas, a man who fights well and does not train properly is defined as a good boxer.

14.9.5   Hindrances

Tasks which do not aid the 'core activities' or reduce the 'auxiliary work' are considered 'hindrances' and are reluctantly executed. They are seen by the individuals as hindering them in what they regard is their real work. The amount of effort volunteered to these tasks will be minimal. The tasks will be executed in a perfunctory manner and little if no effort will be expended to overcome obstacles. e.g. Before a man can earn a living boxing he must first spend many years learning to box. In order to train during this time the man must earn a living. Although this is essential, it is in many ways it is an hinderance to the 'real work' (his ambition to be a boxer) in that it uses time and energy that could be spent training.

In the working situation criticality is extremely complex, for example, the difference between 'routine' work and 'trouble shooting' is a case in point. 'Trouble shooting' is seen by some individuals as a hinderance, in that it takes up time that could be spent on routine work. Other individuals conversely find 'trouble shooting' crucial, in that it solves problems and allows the routine work to proceed, such individuals find 'trouble shooting' a motivating factor.

Having discussed the importance of criticality in general, the practical problems of assessing criticality will now be discussed using the specific case of Area 1 maternity unit.

14.10 An Assessment of the Criticality of the KIS at Area 1 Maternity Unit

Area 1 used the GIT system, which as noted above is very cumbersome and inflexible, also its implementation was causing considerable difficulty. It was noted during the field work that the GIT system was viewed differently by different types of staff. These views ranged from the enthusiastic to antagonistic. While the implementation of any new technology is always difficult it was interesting to note the different amount of energy different groups were willing to invest in the undertaking.

14.10.1 Types of Users

In the Area 1 maternity unit the first problem of assessing the criticality of the KIS is the fact that it is used by several groups of workers. It was unproblematic to identify three major groups of users in the Maternity Units: Managers; Doctors and Midwives. While all three groups make up a team, it would be naive to assume that the interests of these groups are the same. This difference is likely to affect the

criticality of the computerized system to each group. Objective techniques and simple questioning was able to reveal much about the criticality of the system to each type of user.

14.10.1.1   Managers

Managers view the computerized record keeping as essential, it has the potential to be a powerful tool at their disposal which will directly affect their core activity. A computer system will be both useful to their 'real work' and reduce their 'auxiliary work' for little or no extra effort from themselves once they have learnt to use the system. This group is willing to endure a steep learning curve to understand and manipulate the system. Managers require a system of utmost flexibility to enable them to extract statistics for resource management (e.g. ratio of epidurals or referrals to SCBU), staff evaluation (section rate or through put of patients), etc. They also require a system that will automatically execute routine tasks.

14.10.1.2   Doctors

In all, but one area (doctors interested in research) the computer system will have little effect upon the doctor's 'core work', minimal effect on their 'auxiliary work' and does not constitute a hinderance. They do not expend energy on, and receive nothing extra from, the system. Using the manual system they receive a two page hand written synopsis of the ante-natal notes. Using the computer system they receive a two page computer written synopsis of the ante-natal notes. It is argued that the GIT system standardizes the ante-natal history taking thus eliminating the inconsistences of the manual system. However, an alternative thesis could also be proposed (see 'It Doesn't Matter if They Lie' Appendix V).

Both managers and doctors interested in research view the potential of an computerized maternity system very positively. After the initial training period, from

their point of view the system has the potential to be a valuable empowering tool, which they can utilize to great effect at the expenditure of very little personal effort.

For the above groups a objective analysis of the criticality of the task is sufficient, because their use of the system is in reality extremely limited. If they use the system they are basically manipulating data which has already been collected. The interface that they use will be basically one capable of statistical analysis. The vast majority of the work i.e. inputing the data is conducted by the midwives, and as such it occupies a great deal of their time (at the time of the field work taking an ante-natal history using the GIT system would take around 45 minutes, compared to 20 minutes by the manual system). It follows that in terms of time and energy by staff the input interface is the most important, therefore, it is the criticality of the input interface to the midwives that must be assessed in order to make the relevant 'trade offs'.

14.10.2   Problems of Defining 'Criticality'

The fieldwork soon revealed that gaining specific answers to questions of criticality were difficult to obtain. This was due to conscious (for various reasons the midwives were loath to provide this information) and unconscious reasons, tacitly held by the respondents. These reasons will now be briefly outlined.

14.10.2.1   Conscious Reasons for the Reluctance of the Midwives at Area 1 to Define Criticality

The following reasons are specific to the situation in Area 1 maternity units, however, some may be of use in other situations. The midwives are reluctant for various reasons to define 'core areas'. Here is a non-exhaustive list:-

1)   If the work is atomized, they might be doing a non-core activity on a full time basis. This will debase their status within their mini-culture.

2)   They are reluctant to downgrade non-core activities which might in certain circumstances become important.

3)   They are reluctant to downgrade work performed by colleagues.

4)   At a more macro level there is a considerable rivalry between midwives and doctors for control of obstetrics (uncomplicated childbirth). To this end midwives are 'professionalizing' their practice. They are in the process of building up a body of professional knowledge which 'belongs' to them rather than simply relying on doctors for professional clinical knowledge. The midwife's body of professional knowledge depends upon the somatopsychic model of childbirth (see above). This model emphasizes the importance of non-core work and there is a reluctance to downgrade such work.

N.B. This is a time of transition and therefore, perhaps the core work will change rapidly over the next few years. Such a move is already noticeable in powerful informal leaders at the unit.

14.10.2.2   Unconscious Reasons for the Midwives at Area 1 to Define Criticality

The criticality of different aspects of work is known to all members of the midwifery unit but often at a 'tacit level'. If a knowledge engineer asked for the midwife to define, for example, her core work she would find it problematic to identify such elements. This is not through awkwardness but something much more insidious. As Polanyi notes that although we 'attend from' proximal terms, if we concentrate on (attend to) these terms they lose their meaning. The core activities are tacitly held by the members and remain unexamined and unexplained. Once these are specifically referred to they have to be explained and thus become examined. Once explicitly examined the proximal term becomes inadequate (see above, 'people with red hair').

The midwife can draw on instances where work (not included in the unexamined definition of 'core work') was of vital, over riding importance. This experience changes the character of the proximal term, it can no longer simply for all practical purposes be the core activity without a series of qualifying clauses being added. This was illustrated above but is 'grounded' in the following example.

14.10.2.3   Tacit knowledge made explicit becomes qualified

It became apparent midwives tacitly consider the 'intra-natal period (the period just prior, during and after the mum gives birth) as the core area of her work. However, if questioned on this point it will be consciously examined by the midwife and found deficient. When ever this was attempted the midwife would at first agree, but on reflection would invariably qualify the statement with a series of qualifying statements such as:

if the ante-natal work has been carried out correctly; the mother is well nourished; physically strong; not a drug addict; not an alcoholic; not mentally retarded; the baby seems to be progressing and growing well; the birth is straight forward; the mother does not need intervention to give birth; the mum doesn't need stitches; the mum bonds well with the child; she is able to feed the child easily; she knows how to change and bath the child; has good at home and both mother and baby recover well from the delivery etc. *then* yes the intra-natal period is the core area of the midwifes work.

Therefore, when tacit knowledge is made explicit it changes. If this is so, knowledge acquisition techniques which involve direct questioning of any type are inappropriate. To explicate tacit knowledge in its original state, therefore, requires methods which make it explicit to the knowledge engineer without it becoming explicit to the

respondent. War stories allow such explications [16]. The following is reconstructed from field notes taken immediately after the interview. The following war story is replete with 'thick data', however, for the purposes of this investigation it will be analyzed in terms of the tacit prioritization of work by the midwife. This war story was first discussed in Chapter VI to show the importance of tacit knowledge. It is used here to show how tacit knowledge can be explicated in a form useful to both, building and using a KIS. The transcript is repeated here for the convenience of the reader, however, this time the researchers analysis is also included in italics.

14.10.3   'I Never Worry About Roughies'

MW1A3:   Oh what a day I've had. I've been running around all day making calls on my ladies. Do you know what ? I had to visit seven of them, six on Hillside [A large 'problem' estate notorious for crime and drug abuse] and guess where the other one was Parkside Road [prestigious area, the local 'millionaires row'].

Researcher: That's a bit of a difference.

MW1A3:   I know, but do you know what ? I spent longer at Parkside Road than I did at the other six put together, it was awful.

* The midwife brings up this point because her actions are in direct contradiction to formal domain knowledge, the mums from Hillside would normally be perceived to be the problem cases in need of her advice (see Appendix V, 'It doesn't matter if they lie').

Researcher: I told you the middle class always get more out of the Health

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[16] It is only during the explication process that tacit knowledge must be 'hidden' from the subjects. Once the tacit knowledge has been successfully explicated Glaser and Strauss (1965) demonstrated that it can be 'revealed' to the subjects to great effect. Glaser and Strauss (1965) identified that the 'awareness' of which patient was near to death was a key variable in the treatment of the patient. This tacit knowledge was revealed to the staff and gave them a powerful 'tool'. By controlling access to this information they could dramatically influence the care a patient received.

Service.

* Here the Researcher gently taunts the midwife by intimating that the woman on Parkside received extra attention because she was rich.

MW1A3:   Oh shut up this was different.

Researcher: Why? You would think that the mob on Hillside would need your care much more than her on Parkside Road. I'm sure that she is eating enough green leaf vegetables. [this is a reference to a joke about dietary advice to pregnant women].

                    Why was it awful?

* Here the Researcher probes the midwife by iterating formal domain knowledge, in contrast to MW1A3's actions.

MW1A3:   Well there I was perched on the end of this huge sofa, balancing a cup and saucer making polite conversation. I noticed the way I was talking changed it was very hard. You know I try to treat all my ladies the same.

Researcher: Well what was the difference on Hillside?

MW1A3:   Oh well you just go in and say 'hi-ya, how are you getting on' and you feel at home right away. You just sit down and start chatting.

                    For instance they [the ladies from Hillside] never ask you if you want a cup of tea. They know me and if I want one I just get up and put the kettle on. Well you don't do that in every house, you pick the ones that you know are quite clean, some houses you would never have a drink in.

Researcher: Yet you felt they were OK in spite of their problems and the woman at Parkside Road needed help.

MW1A3:   I never worry about a 'roughy'. I always know that they will be alright no matter what.

* The classification of 'roughy' might prove a useful heuristic i.e.
IF mum = 'roughy'
THEN 'social isolation' = non-problem variable.

MW1A3:   If you ask them, as they leave hospital with their baby, 'do you
                         have any backup at home? Is there any one to help you with
                         the baby or have they been able to get everything the baby
                         needs?' No matter what they say you just know that they will
                         be alright, when I go to visit them they are always OK.

                         It's that they are such social people. You know, if you get a
                         couple of middle class women in the hospital, they sit in there
                         on their own and mind their own business. After a couple of
                         days they might nod to each other but in general they just look
                         after their babies until they can get out.

                         You get two 'Roughies' on the ward, after about ten minutes
                         they are walking down the ward arm in arm like life long
                         friends. Probably going to the day room for a fag but never
                         mind.

** There are tremendous moral pressures placed on pregnant women in hospitals not
to smoke.*

                         When you go and see the girl on her own up on Hillside who
                         says she has no backup, you will find that far from being
                         isolated the house is full. Not the best environment for a baby,
                         lay in a room with four or five adults smoking like chimneys
                         and the gas fire on full belt, but the girl gets lots of support
                         from her neighbors.

                         That girl on Parkside Road had all the material advantages that
                         money could buy, but she was totally isolated. Her husband
                         has a high powered job which takes up most of his time, her
                         mother lives somewhere down South and her mother-in-law is
                         a headmistress and can give her little time. I can see I'm going
                         to have a lot of problems with her. But what can you do?

14.10.3.1   Analysis of the war story

This account points to the problems of trying to gain tacit knowledge through
interviewing experts. Such questioning would have revealed that there are certain
requirements that a new mother needs if she is to cope properly with a new baby.

MW1A3 would have quite cheerfully rattled off the standard needs. According to these needs the woman from Parkside Road would have been deemed well provided 'normal' mum, whereas the single girl from Hillside would have seemed a 'high risk' mother. It is MW1A3's expert knowledge and classification of 'Roughies', her first hand experience gained by her backup calls to these mothers that allows her to know that they will be alright. If a problem occurs that the young mum can not cope with there will always be a neighbor with experience of children will see that she gets help.

An alternative approach would be to simply observing MW1A3's movements over a period of time. The inconsistent way she treated her visits, would alert the knowledge engineer to the discrepancy between what actions the midwife would take according to formal domain knowledge (if the engineer has this knowledge) and her actual actions. As noted above such questioning is problematic and is likely to result in *post hoc* rationalization which will make the actions appear to be in line with formal domain knowledge.

The above story indicates that of all the post natal problem variables MW1A3 prioritizes social support of the mother to be of vital importance to the health of both baby and mother. The story reveals that MW1A3 regards social support of such importance that it outweighs even the multiple deprivation of Hillside.

In order to check that the above was not was not an example of the researcher 'importing cognitive models', MW1A3 was asked to read the above analysis for her comments. She agreed with the analysis, she replied,

MW1A3:   Well do you know I've never actually thought about it like that but now you point the fact out to me I must do. I don't actually think about it like that but unconsciously, yes, I think social support is vital. It can make all the difference to whether the mum copes or not.

Researcher: Do you think before I showed you this [document] if I would have

asked you what do you think the key post natal factor that you would have answered, social support.

MW1A3:   No I would have given you the standard list that we have to check for. I didn't actually know that I held social support as so important. How come you know more about the way I think than I do.

Researcher: You'd be surprised at what I know.

Both: Ha Ha Ha.

14.11   Analysis How Midwives Tacitly Categorize The Criticality of their Work

An analysis of how midwives tacitly categorize the criticality of their work will now be discussed. This will then be used to inform the design of an appropriate input interface. However, before proceeding to define each of these categories it is important to make a more global statement about the midwifes work. The midwife has a duel role, in that although midwives have a role in the birth process of all mums this role is different in the case of 'normal' and 'problem' mums. In the former she is an independent practitioner, in the latter she is a doctors assistant. The midwives have a much clearer definition of their area of responsibility than the doctors and willing to hand over responsibility when the situation warrants it.

MW1A4   *'Don't get me wrong, I'm not anti doctor, when things go wrong I am the first one to send for a 'white coat' [doctor] and I am glad to hand over the responsibility to them. But for the rest of the time I wish they would just piss off out of the way and let us get on with it.'*

Once the birth is diagnosed a 'problem' birth the midwifes role is reduced and the work is no longer core work. The fact that this work requires a great deal of expertise is not sufficient to give it core work status. In many ways the care of 'problem' mums by midwives is a separate job in which she follows the doctors

orders, more like a nurse than a midwife. Midwives point out this distinction by the fact that they will not tolerate being called nurses as the next example illustrates. It is difficult for a researcher, in a hospital surrounded by women in uniform not to call them 'nurses'. This is a difficulty of which such a researcher is soon disabused. The distinction was pointed out during the following conversation. N.B. this was not said in a humorous manner.

MW1A2:	*We have this consultant, he thinks he is really funny (inferring he is not) if he really wants to wind us up he calls us nurses, because he knows it really get us going. Any way we just don't rise to it, I wouldn't give him the satisfaction.*
Researcher:	*Why aren't you nurses?*
MW1A2:	*No we are not [emphatically]. We are professional practitioners with our own case load.*

The following classifications of work, therefore, refer to the work where the midwife acts as a practitioner i.e. the care of 'normal' mums. This, however, is a large percentage of women (see figure 14.1) the midwives attend as practitioners 80% of all mums. To this must be added her 'gate keeper' function of classifying 'problem' and 'normal' mums. All mums are 'normal' when presenting at ante-natal clinic until otherwise classified. Plus, all mums are 'normal' until classified otherwise during the intra-natal period. The classification of the mums is seen as a task for a practitioner. Therefore, the health care of the vast majority of mums comes under the authority of the midwife as a practitioner.

Health Care Providers During Pregnancy
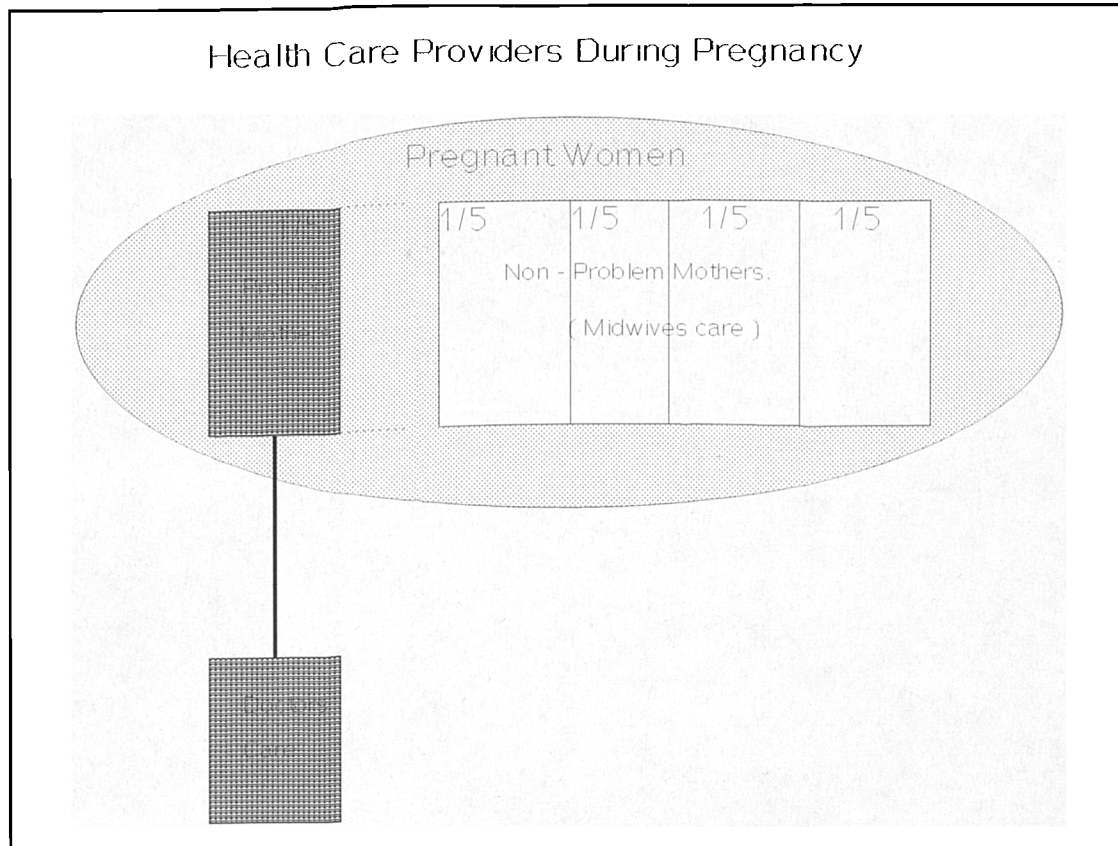
Figure 14.1   Ratio of 'Mums' Cared for by Midwives as Practitioners

14.11.1   Core Work

The core work of the midwives is the intra-natal period of normal deliveries, the period prior to, during and following the birth. Although this is an extremely small part of the birth process (usually up to one day out of a pregnancy of 280 days) it is by far the most important. Evidence emerged in many of the stories. An example of this is a quote from a midwife who had spent two weeks on the Central Delivery Unit (CDU).

Researcher: How are you liking your 'updating' at the CDU (central delivery unit).

* MW1A3 is a midwife, with the introduction of a pilot scheme of 'team care' each

midwife is required to spend 2 weeks per year on the CDU to update their midwifery practice. The importance of this as core work can be interpreted from the fact that in order to update her midwifery practice MW1A3 has to work on the CDU. Members of the CDU core team do not (at the time of writing) have to update their midwifery practice by practicing other aspects of the midwifes work such as working on the community periodically.

MW1A3:   Great I feel like a real midwife again. I suppose I should never have left, it's where I belong at the Centre of things.

* N.B. 'real midwife'.

Researcher: You look like you have been having a good time, how many have you delivered so far.

MW1A3:   Eight so far.

Researcher: Did you pull out any tricky ones.

MW1A3:   Not too bad.

The fragmentation of maternity at Area 1 is such that the Community Midwives are responsible for the ante-natal and post-natal visits in the community. The vast majority of mums give birth at the Central Delivery Unit and is assisted by the CDU staff. Thus, the community midwife will have little opportunity to participate in core work. Their status amongst the other midwives is lowered as a result. The community is seen as a place where midwives go when they can not handle the rigors of the job or are 'burnt out'. It is interesting to note that the midwifes' definition coincides with the public's opinion of core areas, for example, when a community midwife was taking a 'domino mother' into hospital to deliver her baby, the midwife was asked who would actually be delivering the child. When the midwife reassuringly replied that she was, the mum said that she didn't mean to be cheeky but was she (the midwife) up to it.

In comparison the midwives who are full time on the CDU are regarded an *'elite'* group. The importance of their performance during the intra-natal period for

midwives arises time and time again during conversations. The following will be used to illustrate this point. The importance of the CDU emerged through a minor case of 'cultural dislocation'.

A first draft of the description of Area 1 Maternity Unit had been completed and given to a senior midwife (MW1A3) for her comments. The CDU was described as being organized along the 'taxi' system, usually the first time the midwife will see the mother-to-be will be when she arrives at the CDU. Delivery rooms are used as they become available. The midwives have no prior relationship between the midwife and the mums or a territorial pride in the delivery rooms. The use of the analogy to a taxi system was to illustrate the arbitrary allocation of midwife to mum.

MW1A3 was given the draft for her comments. She said that the idea that the CDU was organized on a 'Taxi' system was simply wrong.

14.11.2 Taxi System

MW1A3:   What you said about the Taxi system just isn't correct.

Researcher: What I'm trying to point out is that the relationship between the midwife and the mum is irrelevant. You know I'll bet you never hear "Mrs. Jones is on the way in that's one of yours isn't it Jean".

MW1A3:   Well I've heard midwives say, I know her let me take her.

Researcher: Yes I am sure but if that occurs it must be almost by accident, a rare exception.

* Here the Sister is agreeing with the researcher that it is very unlikely that the mum will have met the midwife prior to her presenting at the CDU. This doesn't seem to be a problem and is clearly not why she said the notion of a taxi system is 'simply wrong'. Cultural dislocation has occurred and she tries to explain herself.

MW1A3:   Yes, but it happens, what I mean is you have to understand how the CDU works. For a start there is a core of eight high

grade midwives that form an elite.

* *'a core of 8 high grade midwives that form an 'elite'.' These midwives can stay on the CDU full time and still be considered an elite by the other midwives.*

> Other midwives from say ante-natal and post natal form a peripheral group. These go on the CDU for 6 weeks every 4 to 5 months for 'up grading', you know to keep up their practice.

* *''up grading', you know to keep up their practice.' This statement points out the relevant status of CDU and ante/post-natal functions.*

> The result is a core elite staff and a rapid turn over of 'up graders'. I've just been in and I have been observing what was happening. Well everybody is unhappy.

Researcher: Why is that ?

MW1A3:   Well you can imagine, when a mum comes on the ward the sister is almost duty bound to give the labour to one of the up-graders. You know she would think 'we are here all the time

* *'the up-graders are only here for a short while to practice their skills.' She seems to be saying only a short while to practice their skills as midwives.*

> so it only seems fair to give the mum to her for the experience. You can imagine if you didn't the up-graders would be saying 'we are supposed to be on CDU for upgrading and all we are doing is cleaning cupboards'.

> You see what I mean, it is not just first come first serve. The system works in favour of the up-graders, only when they are busy will a core member get a labour.

Researcher: What is the ratio core to up-graders ?

MW1A3:   Well there are eight members of the core team. Each shift has eight midwives.

Researcher: What ratio ?

MW1A3:   About two to six or at a busy period three to five.

Researcher: Why are they unhappy ?

MW1A3:   Well the up-graders feel that they are doing all the work and
                       the core feel that they are not getting enough, not making use
                       of their experience and skills. It's a double bind, **on a quiet
                       day everybody wants a labour**. So even though everybody
                       wants a labour it is not a taxi system the up-graders take
                       precedent.

** 'the up-graders feel that they are doing all the work and the core feel that they are
not getting enough.' There only seems one definition of 'work'. Everybody is
unhappy because the allocation of 'core work' seems unfair to both the elite and the
up graders. The elite are not getting a chance to use their vast experience while the
up-graders feel that they are doing the elite midwife's work for them.*

Researcher: But that's my point, there might be some bias in allocating the
                       midwifes but what I mean is that the name of the woman is
                       immaterial, who she is, is of no importance to the midwife she
                       is allocated, she won't be allocated to a midwife she knows.

** Now the Researcher is confused, he can not understand why the midwife has taken
exception to his description of the CDU as a taxi system. She seems to be agreeing
with him.*

MW1A3:   How could she, the core never leave the CDU so how could
                       she have met the mum ?

Researcher: That's what I mean, the relationship between the midwife and
                       the mum is seen as irrelevant. The midwife is simply a
                       medical technician, with a set of skills which facilitate
                       childbirth.

The dislocation occurred because the researcher took the viewpoint of the mum
whereas, the Sister took the viewpoint of the midwives. In this both are correct,
from the researchers point of view the CDU operate a taxi system and from the
Sister's point of view they do not. The mum arrives at the CDU and is cared for by
a midwife that they are unlikely to have seen before and there is no attempt to match
individual midwives to particular mums. However, from the point of view of the
midwife the allocation of midwives is not arbitrary. It is dependant on the whether

the midwife is a member of the elite or an up-grader.

14.11.3   Auxiliary Work

Auxiliary work is that work that helps the core work. For the midwife auxiliary work has three main aspects: where the midwife acts as a 'gate keeper'; where the midwife acts as an 'advocate'; and to a lesser extent, where the midwife acts as a nurse. It is interesting to notice that in the first two of these roles the midwife has the flexibility to act as an independent practitioner.

14.11.3.1   The Midwife as a 'Gate Keeper'

The midwives are always keen to tell stories of instances where drawing on their experience they noticed something about the mum that the others had missed and thus were able to make a more accurate classification of the mum. This can take the form of using their skills to transform a 'problem' mum into a 'normal' mum and vice versa.

14.11.3.2   Transformation of 'problem mum' into a 'normal' mum

This illustrated by a short story by Sister (MW2A3). The Sister received a note that one of her mums required special supervision. The mum had lost weight (a bad sign in a pregnant woman) and the Sister was to investigate the reason why, and offer nutritional advice to the mum.

14.11.4   'A Little Bit of What You Fancy'

MW2A3:   Well I went round to see her and she seemed alright. She was a sensible woman and as I questioned her I could see that she knew how to look after herself alright. You'd be surprised how many think that if they have had chips and curry that they

have eaten a proper meal. Any way I thought she looks ok to me, you know bright eyed and bushy tailed, not like she was ailing at all. I asked her if she was worried about anything but she said that she was fine and looking forward to having her baby. So I just said have you changed your eating habits as you seem to have lost weight. Then it came out, she had been 'fancying' [an obsessional craving for certain foods during pregnancy] Holland's meat pies.

Researcher: Oh no.

MW2A3:   Yes she had been eating them two at a time and often ate up to six a day. Well you can imagine how that would pile on the weight. Any way a few weeks ago she became very worried about her size and how she would get her figure back later, and she had cut down on the pies. So much so the craving had gone away and for the past two weeks she had not eaten any.

Researcher: So it was not that she had so much lost weight but had put on too much weight due to fancying and once she stopped eating the pies she was stabilizing at a more appropriate weight for her time.

MW2A3:   Precisely, but as long as she was putting on weight everything was ok. Nobody thought 'I wonder why she's piling on the weight'. It was only when her weight dropped that the alarm bells started to ring. There was nothing wrong with her, in fact she was a lot healthier losing weight than she was when she was gaining weight.

There was nothing wrong with her, but you should have seen that performance getting the doctors to believe me.

The Sister had used her experiential knowledge classify the mum as 'normal'.

'I thought she looks ok to me, you know bright eyed and bushy tailed'.

She then probed to find the reason for weight loss, thus she was able to re-classify the mum from 'problem' to 'normal'.

14.11.5   Transformation of 'normal mum' into a 'problem' mum

A graphic example of this occurs in the story 'It Doesn't Matter If They Lie' (For a full account of this story which highlights this and many other interesting points, not relevant here, see Appendix V). The Sister had seen a young mum and there was something not quite right so she determines to see the woman at home. After 8 attempts she finally gains entrance into the house and gets the mum to talk.

MW1A5:	Then it all came out she was a heroine addict but on the methadone treatment which was gradually being reduced. She was on tamazapan, she smoked heavily, and she drank eight cans of strong lager every night. Oh aye she was up on shoplifting charges, to pay for the habits I suppose. She said that, that was all over now because of him [her boyfriend]. She was coming off heroine and having the baby because of this new relationship.

* These are extremely high risk factors that might damage the fetus, however, the Sister sees all these surmountable because the mums relationship with her partner is supportive.

	The other child was not with her, she had not seen him since he was 6 weeks old, he was with the boy's family and would be about 8.

* This was her second pregnancy and the G.P. had told the Sister that the mum never brings the boy to the surgery. This seems to be regarded as suspicious by the G.P. and the Sister.

Researcher:	So the lads family took responsibility.

MW1A5:	Yeah I asked her if she wanted some help in order to see the child and she said that she was very young when she had him 15, and she didn't know him and he didn't know her so it would be better to leave things how they were.

* Here the midwife is offering to help the woman that has nothing what so ever to do with her pregnancy.

Researcher:	I suppose you couldn't argue with that really.

MW1A5:   No, anyway she said "We don't have to have a social worker involved do we?" I said that if she didn't mess me around missing appointment and things then no. But if she didn't keep up her side of it yes.

* The girl indicates that a social worker is a threat and the midwife uses the threat to get the girl to do what she (the midwife) wants.

Researcher: Seems fair enough she seemed to be making a go of what life had dealt her.

MW1A5:   Yes but you have got to keep your eye on them. But the point that I'm trying to make to you is I went to the hospital and got out the notes that they had taken on the computer, and I couldn't have believed it, you would have thought it was Princess Anne's notes,

Have you ever had a venereal disease?	'No' She has.
Do you take drugs	'Yes' - aspirin.
Do you drink alcohol	'Yes'
How much	'2 units per week'

It didn't even ask about the shoplifting, it simply is not seen as a relevant question.

* The fact that the girl is a shoplifter is not relevant to her pregnancy but clearly it is to the midwife. It is a key indicator of the type of mother that the girl would make.

The whole thing was a tissue of lies from beginning to end. I read on and there it was 'previous pregnancies' yes a boy weighing 5lb odd, it was simply assumed that the baby was with the mother.

* The midwife is pointing out that if a woman has already given birth then she is an experienced mother and low risk. It is assumed that because she has successfully raised her first child she will have no problems with the second. Clearly in this case the assumption was faulty.

Researcher: And that she would, therefore, be an experienced mother.

MW1A5:   Yes we would assume that she would be reading the notes.

Researcher: A perfect candidate for a 'domino' in fact.

* The Researcher is making an ironic point, the domino scheme is now being implemented in various parts of the country. This option is at present only available to pregnant women who are considered at 'very low risk' and has been criticized as being to selective. Many women who would like a 'domino' birth are denied one because they are considered at too high a risk.

MW1A5:   Yes just the job on her second child a low risk mother with no problems yes from these notes she would get a domino, why not. This is what I mean, they had asked her 200 questions and received a worthless pile of paper, I had spent a few minutes with her and I knew there was something more to this girl.

* This indicates that the interview can not be reduced to a check list of questions. The input from the questioner is of vital importance.

It's that damned computer it's stealing our skills I picked it up and what's more those girls from Area 1 (the midwives who have to take ante- natal histories using an computerized system) would have too.

They are too busy asking questions that they are not watching and listening to what they are told. You know here's a girl unemployed with £50 trainers on, makes you want to try to find out where she gets the money.

* The clothes that the women are wearing are an indicator to this midwife. Not are they expensive or cheap, clean or dirty but are they appropriate for a girl of her means. If not what is she doing to afford them?

The experience and enthusiasm of the Sister prevented a possible disaster, of this 'problem' mum with multiple risk factors being classified as a 'normal' mum[17].

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[17] It must be noted that the use of tacit knowledge in this way could (like the test for Downs Syndrome) produce 'false positives'. We cannot know the number of times the experienced (and even more, the less experienced) midwives draw false conclusion based on tacit knowledge. However, unlike the test for Downs Syndrome, the mum is unaware of her false positive classification and is therefore not psychologically affected.

14.11.6   The Midwife as an Advocate

The notion of being an advocate is also very important to midwives. Their conversations reveal this role time and again, they constantly refer to the pregnant women as, 'one of my mums', showing that they are responsible for the mum. The midwives often feel that they are expert representatives of the mums against what is often an overpowering arcane if well meaning organization. The more progressive and confident midwives seek to get their mums the maternity care that they want rather than the prescriptions of the increasing medicalization of pregnancy. This role occurs time and time again whereby the midwife champions the somatopsychological needs against the purely medical considerations. There are several examples of this in Appendix VI . It will be sufficient here to relate one part of the story.

14.11.7   'The Transformation of 'Normal' to 'Problem' and How to Overcome the Temptation'

The story is of a woman who wanted the birth to be as natural as possible

MW1A2:   I just booked our little group in went into a delivery room and shut the door on all the activity outside. She was a belting mum, you know well informed but sensible. She knew what she wanted but it wasn't a crusade for her. She wasn't one of those know-it-alls who come along with an arm full of books and a list of demands. They really get on my nerves, they want the birth to be a natural event but on the other hand they seem to think that it can all be planned out beforehand, the two don't seem to go hand in hand.

* N.B. MW1A2's definition of 'belting mum' = well informed but sensible.

After describing a 'nested story' the midwife went on to say,

MW1A2:   No, she was well informed but sensible with it. Her and her husband were really together. They were there for each other loads of rapport, loads of eye contact, he was rubbing her

before she could ask. They didn't need me really, well in such a situation I just back off and let them get on with it. He was doing much more for her than I could have done, so I let them get on with it.

* *N.B. what MW1A2 considers the best therapy*

Researcher: What! *you* just let them get on with it [laughter].

* *This is a small joke, the Researcher is friendly enough with MW1A2 to gently chide her characteristic (which she shares with many Midwifery Sisters) of liking to take charge.*

MW1A2:   Believe it or not, I know that I'm a pushy sod but I know when to let alone. She wanted to wander around so I didn't do any fetal monitoring. Instead of strapping her down I just let her do what her body told her.

Researcher: Is fetal monitoring necessary every time.

MW1A2:   Is it heck, not in my opinion. Its just that those doctors are so paranoid about litigation that they it is becoming a feature of a normal birth.

Researcher: What's wrong with that, isn't it safer?

* *The Researcher is using cultural dislocation (taking the doctors point of view) in order to make the midwife explain herself.*

MW1A2:   Look you know me, I am all for modern technology as long as it improves my practice, but I feel that in the majority of cases that it is inappropriate and actually increasing the abnormal birth rates in our area.

Researcher: What do you mean?

MW1A2:   Like it or not it is an intervention with the natural birthing process. We are strapping these women flat on their backs from early in their labour. This is not a natural position to handle the pain and quite frankly we are asking the mother to push uphill, who knows what effect 'strapping down' women so early in their confinement has?

Later the Researcher asks,

Researcher: Are you saying that in some cases the increased use of technology is transforming normal deliveries into abnormal deliveries.

MW1A2:   I think so, I mean look at the case that I was telling you about. She didn't want to be strapped into a fetal monitor. As I said I just left them to it, they were doing fine. She was restless and walked around the room a lot. If that's what she wants to do then that's fine with me. After about an hour or so the staff (CDU Midwife) asked me if I wanted to break the waters. But me, I like everything in place until it is ready to go, the mum was not in any distress and she was handling it well. Any way she said that she felt like pushing and I told her to try and hold on. She went to the end of the bed and crouched down and 'whoosh' the waters broke. I was pleased that we had been patient and waited, I bent down to clean her up a bit and the baby's head was there, I couldn't believe it, I could feel the top of its head. I thought great this will be a piece of cake.

* N.B. The previous paragraph indicates medical intervention could increase the number of abnormal births. In this paragraph she reinforces the need to resist interfering with a normal process.

MW1A2:   I said that she could push now and did she want to get into bed. She did and I felt her again the baby had gone back inside. She pushed for about 30 minutes and nothing, she said that she thought that she was getting nowhere and wanted to get out of bed. I said that it was OK. Blow me 30 minutes later the baby was born, no problem.

Here the midwife acts as an advocate by not 'strapping down' the mum and letting her 'wander about'. She allows the mum and her husband privacy in the early stages of the labour. She respects the woman's wishes about the birth plan. She stops the CDU midwife from breaking the woman's waters artificially (medical intervention) and basically acted as a *supporter of the woman's wishes in an alien environment.*

14.11.7.1   The Midwife as a Nurse

In a great deal of the midwife's work she performs the role of a nurse, making prescribed medical examinations of the mum (e.g. taking blood pressures etc). Although this is not specifically the work of a midwife (much of this could be performed by a trained nurse under direction) it is important source of data for the gate keeping role and is thus auxiliary work and allows rapport, essential to both the 'gate keeper' and the 'advocate' role to be built up.

14.11.8   Hindrances

The midwives regard anything that does not aid the core or auxiliary work as an hindrance. There are many petty tasks the midwives find hindrances. Many hindrances occur because doctors and midwives have different world views of pregnancy (see above) and the power relations are unequal. This is illustrated in the story above ('A Little Bit of What You Fancy) in which the midwife acts as a 'gate keeper' (see above). The mum had lost weight and this should not happen in a normal pregnancy. The doctor had acted on this objective measure and thus instructed the community midwife to visit the mother and take her blood pressure daily until the mums next appointment at the ante-natal clinic, where he could re-assess the situation. The midwife discovered the reason for the weight loss and told the doctor who instructed her to continue with the visits 'just in case'. This was a real hindrance to the midwife's daily work, in that it commits her time (to performing what is in her mind a useless task), time that she could be spending on auxiliary work.

Another major source of hindrance is where procedures are carried out purely to protect the Hospital Trust and or the staff from litigation often a at cost to the patient. For example, the following quote from Appendix VI.

Researcher:	Is fetal monitoring necessary every time.
MW1A2:	Is it heck, not in my opinion. Its just that those doctors are so paranoid about litigation that they it is becoming a feature of a normal birth.

The midwife is complaining that invasive medical procedure is being practiced on 'normal' mums not for medical reasons but for fear of litigation. This she sees as counter productive and a hindrance to her work.

14.11.9   Classification of the GIT System by the Midwives

As mentioned above the correct classification of a KIS in the work of the user is vital in order that various trade offs can be made in interface design. From the above it is clear that any computer system cannot help the midwives perform their core work and must be relegated to either auxiliary work or a hindrance. The GIT system *appears* to offer many advantages to the midwives assisting them in their auxiliary work.

The field work revealed that this was far from true. The GIT system was almost wholly regarded by the midwives as a 'hinderance'. This was graphically made clear every time the GIT system came up in conversations with the midwives.

An example of this is illustrated in Appendix V. The midwife is complaining that after asking 200 questions for the GIT system the midwives of Area 1 did not pick up the fact that the mum was a very high risk 'problem' mum.

MW1A5:   That's what gets me they keep telling us the computer is there
                     to cut down the risk of litigation. When the computer was
                     introduced it was brought in as a check, the difficult procedure
                     that we all had to go through in learning the damned thing was
                     all worth while because it improved the ante-natal history
                     taking process, in order that we would make fewer mistakes
                     and therefore, be less open to litigation.

* *The implementation of the GIT System was a steep learning curve for the midwives. The advantages of improving ante-natal history taking and a better defense against litigation seem to make the effort worth while.*

The system was to be an exhaustive set of questions by which
to assess the mum, if we were to ask all these questions then
we would ensure a good assessment, unlike the hit or miss
affair that of the manual system. But how can it do that if the
mums just lie and the midwives do not have the skills, time or
leeway to spot it.

> This is a prime example here we have an extremely high risk mother, a multiple drug addict, heavy smoker, heavy drinker, easily gave up the first child, with criminal past and judging by the inside of the flat a criminal present. But based on these notes she would be treated as a straight forward 'low risk' mother. Such a wrong assessment is likely to prescribe an inappropriate care plan for the mother and therefore, more chance of something going wrong. This could, therefore, open us up to more not less litigation. Why didn't they just leave us to get on with our job and build on our experience.

* A salutary warning to KIS designers, computerizing a system can have a dramatic and not always beneficial effect on client/expert interaction, in this case de-skilling the expert and impoverishing decision making.

At this point the researcher applies cultural dislocation by taking a different world view in order to make the respondent explain her tacit assumptions.

Researcher:	But don't you see that what you say only makes sense from the stand point of your assumptions. You say that the system makes no sense in respect to litigation. But it is a great defense. Can you imagine if for instance this woman has a handicapped child and later tries to sue you. The first thing that they would do is look at the records and say
	'This woman has told us a pack of lies, therefore, if things went wrong it is not our fault'.

MW1A5 sits there almost speechless at the logic of what the researcher has just said. She has a look of complete disbelief on her face.

MW1A5:	But what's the point, why are we doing it, that's just stupid.
Researcher:	No MW1A5 it's not, but from your point of view it is. You are talking about litigation and how to avoid it. Although it is an important consideration it is not central to your thinking.
MW1A5:	Go on you've lost me there.
Researcher:	Well when I said that for litigation it is a good defense, you know 'if she hadn't lied we would have got it right, therefore, it is her fault that something went wrong'.
MW1A5:	Yes but you can't do that.

Researcher:	Yes you can, but what's the point?
MW1A5:	Precisely, because more mistakes will happen.

Researcher: That's not the point, as far as litigation is concerned it's who to blame. For you the answer to reducing litigation is to reduce the amount of mistakes that are made. This fits in with your 'raison d'etre' the whole point of your being a midwife i.e. risk reduction during pregnancy.

MW1A5:   What's wrong with that?

Researcher: Nothing is wrong with it, in fact that is why I like working with midwives their whole ethos is caring for the person as a whole. You know that the woman is 'your mum' and you do the best you can for her and that is why what I just said surprised you so much.

MW1A5:   It was the fact that it was so stupid, but it sounded so plausible and I can just imagine somebody coming up with it.

Researcher: That's what I mean it turns your ethos on its head. Instead of being an advocate for your mum, the mum becomes a potential enemy. This transforms records to evidence against the mum, 'your mum'.

MW1A5:   That's it in one, what is the point, she wouldn't have been able to con me or those girls at Area 1, it wouldn't have been a defense to say she lied because the next question would have been.

'well how come you let her con you, you should have checked her out properly', you would have been seen to have conducted a faulty interview. But with the computer this doesn't happen, the interviewer is irrelevant. She just puts in the information and has no leeway to interpret the answers.

Researcher: Yes it is because the underlying assumptions of the system is that when you conduct an interview you ask a set of questions and receive a set of answers. The skill of the midwife is missed. Actually the individual midwives are seen as a liability in that she might miss some important question.

* The midwife is transformed from a skilled practitioner to a liability in that she may

miss some vital question and cause the hospital to be sued.

MW1A5:   That's what they kept hinting at and did it rub me up.

* N.B. the presentation of the GIT system alienated the users before its implementation, showing a lack of sensitivity for the work force.

Researcher: I can imagine, but if ability of the midwife to interpret the woman as a whole is not recognized then she is not responsible, if the facts she collects are wrong.

The GIT system hinders the auxiliary work in two ways.

1)   Reduction of the 'Gate keeping' Role

As mentioned in the Chapter 13 above the GIT system reduces the midwives to expert data collectors. They are simply required to ask a set of questions and input the mums' answers. Thus one of the key auxiliary functions of the midwife, that of a 'gate keeper' (classifying 'problem' and 'normal' mums) is transformed into a nursing role.

The case has also been made (especially by GIT and its champions in Area 1) that by systemizing the ante-natal history taking, the possibility of a mum receiving an unsatisfactory interview and the midwife missing some potentially dangerous condition is reduced. It is to be expected that the midwives should initially be adverse to the elimination of the 'gate keeping' function, but in the long run it will reduce auxiliary work (leaving more time for core work) and provide the mums with a better service.

However, the GIT system is regarded as a 'hindrance' because the inaccurate classification of mums will adversely effect the core work.

Midwife MW1A5 above sees the GIT system as an hinderance not that it replaces the 'gate keeping' function but that it is:

a)   A bad 'gate keeper': it allowed the extreme case of this 'high risk' mum to be classified as a 'normal' mum.

b)   It has a certain *cachet* that makes its pronouncements seem correct and therefore. 'not requiring further examination'. It seems to be making objective (therefore, correct) pronouncements, whereas the midwives' pronouncements appear to be subjective (therefore, suspect).

The GIT system is a formidable hinderance to the midwives work in that it is both ineffective as a 'gate keeper' and its pronouncements are difficult to question, and often remain unquestioned.

It seems harsh to judge that the KIS made an erroneous classification, when the cause of this erroneous classification was the fact that the respondent lied. The fact is that if the new system is to be judged it should be judged against the existing system. The case above indicates that 'lying' is more difficult under the existing (manual) system and the midwife is held responsible if she did not identify that the mum had lied. The new system seems to make it easier for the mum to lie and the midwife is not held responsible if she inputs lies.

The above is a case of deliberate lying (the mum had lied in order that a social worker would not get involved with her case), however, the researcher witnessed on at least one occasion where the midwife invited the mum to lie in order to prevent embarrassment. The interaction between the midwife and mum changes when the GIT system is used. Ante-natal histories are taken by a midwife with whom the mum has had no prior relationship or even contact. This is not regarded as a problem for all the midwife is required to do is ask over 200 questions and to input the answers.

She is in fact a stranger and some of the questions are of a personal nature and a source of potential embarrassment to both parties. An example, occurred during an interview observed by the researcher.

MW1A5:   Right Mrs. X I'm sorry but I've got to ask you this question, have you ever had a venereal disease, I can see from your file that you have had thrush, is that right.

Mrs. X   Yes.

The midwife quickly input the answer and moved on to the next question.

MW1A5:   Have you had any surgical operations?

The midwife quickly input the answer and then went on to the next question. It would have taken a very strong mum to make the midwife go back the pervious question and say that she had also had syphilis and herpes. The way the question was asked made it easy for the mum not to admit to a potentially embarrassing condition.

The computerized system, therefore, allows deliberate lies and almost encourages undeliberate lies by allowing the mums and midwives to 'gloss over' embarrassing questions.

In other cases the system invites 'lying'. The mums are often accompanied by their present partner at the ante-natal history taking.

MW1A4:   I was going fine then I asked,

          "have you ever had a venereal disease?
          "yes"
          The next question was
          "does your partner know"
          "No"
          Can you imagine he was sitting there next to her. It was so embarrassing.

The woman's candor revealed a badly designed sequence of questions. What it does not show, however, is how many women have lied at this point (and before the midwife was aware of the sequence problem) knowing their partner was present but unaware of her medical history.

2)   Transformation of the 'Advocate Role'

The GIT system also hinders the second key function of auxiliary work, the advocate function. The above indicates that the ante-natal history has been transformed from a record by which mums are classified to a record which will be used by the hospital as a defence against possible litigation.

Even if the GIT system could be redesigned and became a 'good gate keeper' the work by the midwives would still be regarded as an 'hindrance'. The reason for this is indicated above, once the gate keeping function is removed from the history taking the work becomes 'nursing', instead of an independent practitioner the midwife simply follows doctors' orders.

Therefore, the GIT system transforms 'auxiliary' work into 'hindrance'. The input interface should, therefore, be as simple and as easy to operate as possible.

As noted above this classification of the GIT system is not true for all groups operating in the maternity unit. Junior doctors in order to pass their course have to complete a piece of research. Passing the course is their core work and they view the GIT system as source of raw data for this research, an example of the effort that they will expend in order to complete this task is highlighted in Appendix VI)

Managers also see the GIT as a tool for their core work (measuring the efficiency of the unit) and will also invest a great deal of effort in order to master the system. These groups, however, use the system in a different way than the midwives. They

are interested in the statistics for the unit as a whole rather than the information about a particular mum. The interface these groups require is basically a statistical interface incorporating power and flexibility, even at the cost of a very steep learning curve (see Appendix VI).

A system that is designed to match the criticality of work for the maternity groups should, therefore, have two interfaces: an input interface where ease of operations should take precedence over power and flexibility; a statistical interface where power and flexibility should take precedence over ease of operation.

14.12 Heuristic for Analysis of 'War Stories' in Order to Ascertain Criticality

Once the importance of war stories was recognized as a resource of tacit knowledge, they were actively collected. When several were analyzed for tacitly held details (see 'social dislocation etc.) certain trends seemed to emerge. These formed an heuristic for ascertaining the criticality of various tasks for the subject of the story. It must be emphasized that this thesis is a probe to try to uncover methods for eliciting tacit knowledge. The following heuristic must be understood in this light. It was an indicator of criticality **in this instance** to be later verified. However, if caution is practiced the heuristic might be employed in future research in order to assess its generality for knowledge acquisition.

14.12.1   The Use of Humour to Explicate Tacit Held Definitions of Criticality

Many of the war stories contained elements of humour, however, this humour took different forms. In stories containing tacit knowledge about the core work a particular form of humour seemed prevalent, auxiliary work was characterized by a

different form and hinderance by yet another.

14.12.1.1   Core Work

It was noted that where core work was concerned very little humour was employed. The work is simply much too serious. Cultural dislocation does occur but stories are used to indicate how members of the other culture simply mis-read the situation (see Appendix I 'Termination Scan, Appendix III 'The Transformation of 'Normal' to 'Abnormal' and Appendix IV 'Ante-natal Testing for Downs'. Where humour does occur this takes the form of 'gallows' or 'black' humour.

14.12.1.2   Auxiliary Work

This area seems to abound with humour of the type similar to the story of the Ghanaian students. The humour takes the form of the archetype of the war story due to cultural dislocation. The vast majority of jokes and anecdotes concern auxiliary work. The humour is good natured and are genuinely funny, these concerned subjects such as mums having sex on the ward, fathers bringing the children to the ward for the mother to bath, unusual domestic arrangements (mum being visited by more than one partner) etc.

The work is not so crucial as core activities and therefore, the results of cultural clashes are likely to relatively less dangerous. Humour due to cultural dislocation seems appropriate.

14.12.1.3   Hindrance

Stories that reveal hindrances usually have a 'hard edge' to them. The stories are of exasperated situations and when humour occurs it is used to ridicule the source of the exasperation. Powerful members of other groups are depicted as acting like petulant

children.

Researcher: Well what did he (the consultant) do when he was confronted with the facts? Did he admit it?

MW1A2:   Did he heck he chucked his teddy in the corner and stormed out.

The most telling statement, for the purposes of this thesis however, concerned the computer system and placed the system firmly in the hinderance category. In the staff room someone had bought and pinned up a sign which seemed to elicit general agreement.

'To err is human, but if you really want to f**k up you need a computer'.

CHAPTER 15

Test: Redesign of a KIS Interface Using Tacit Knowledge

15 Test: Redesign of a KIS Interface Using Tacit Knowledge

15.1 Introduction

This chapter was originally envisioned to contain a brief description of a maternity interface re-designed to incorporate the tacit knowledge of the domain. During the testing of the new interface further methods of explicating tacit knowledge were discovered, but this time at a micro level (i.e. the level of interface design). This chapter, therefore, begins by describing how the interface was modified and goes on to explain how during the process tacit knowledge was unearthed. Finally the two further methods of eliciting tacit knowledge are discussed, these were,

a)   Action Research - whereby tacit knowledge is elicited by 'transference of knowledge'.

B)   Action Research - whereby tacit knowledge is elicited by 'organizational cultural dislocation'.

15.2 The Disadvantages of Conducting Tacit Knowledge Investigations for KIS Design

Conducting investigations into the tacit knowledge appears to further complicate knowledge acquisition. The findings in Chapter 13 indicate that although by objective criteria a degree of generality exists between Area 1 and Area 2 such assumptions become suspect when the subjectivity and inter-subjectivity of the two organizations is taken into account. A KIS designed for Area 1 (with minor modifications) would be inappropriate for Area 2 without a radical change in working practices (a major

reason for 'why systems fail' identified in Chapter 1). Such findings can expect an unfriendly reception by software designers in that it seems to indicate that generality (an aspect of considerable commercial advantage) is no longer possible. The findings seem to indicate, if generality between organizations as similar as Area 1 and Area 2 maternity units cannot be assumed, then the possibility of designing a KIS for independent organizations in the same domain (for example an accountancy KIS) is to say the least remote.

To further complicate the issue, Chapter 15 indicates that domains are tacitly delimited differently by different groups within the same organization. The complexity is further compounded by the fact that the criticality of a task by different groups within an organization also differs.

However, while considerably complicating the situation, investigating tacit knowledge offers several advantages.

15.3 Advantages of Conducting Tacit Knowledge Investigations for KIS Design

Investigations into the tacit knowledge of organizations while presenting many problems to KIS design also provide potential advantages. Investigations into tacit knowledge would be a problem if existing techniques based on the above were particularly successful. Experience, however, seems to indicate otherwise. Therefore, rather than regarding the elicitation of tacit knowledge as a complicating factor it should be regarded as a modifying tool to tailor a better 'fit' between an organization and the KIS. Such a tool has the potential to be of great commercial advantage. In order to illustrate this point the findings from the above fieldwork will be used to demonstrate how tacit knowledge research can improve a KIS.

15.4 Initial Considerations for the KIS Design

The fieldwork indicates that Area 1 and Area 2 maternity units are different in form. This does not mean that anarchy reigns, whereby, every organization is totally different. Chapter 15 indicated that although the organizations are different in 'form', the forms are not arbitrary but based upon recognized, but different bodies of knowledge. Therefore, organizations are limited to the number of different 'forms' that they can take, by the number of different bodies of knowledge present in the organization. The maternity units in the main study are characterized by three major groups i.e. doctors, midwives and managers. The importance of managers in the NHS is a new phenomenon, resulting from recent changes in Government policy. Although managers are a new group of growing importance, at the time the field work was conducted managers were just starting to make their presence felt. Area 1 and Area 2 maternity units were based on more traditional foundations. Management participation (at this time) concerned itself with the efficient running of the units once the medical criteria had been established. Therefore, the following sections will concentrate upon the doctors and the midwives.

Investigating the tacit knowledge of the maternity units revealed the different manner in which doctors and midwives view pregnancy. This has allowed an extra variable at an extremely high level (i.e. the level below the root) to be identified. From objective data alone the domain could be represented by figure 15.1.

Objective Domain Knowledge

Maternity Unit		

Ante-Natal   Intra-Natal   Post-Natal

Normal   Problem   Normal   Problem   Normal   Problem

A   A   A   A   A   A
B   B   B   B   B   B
C   C   C   C   C   C
D   D   D   D   D   D
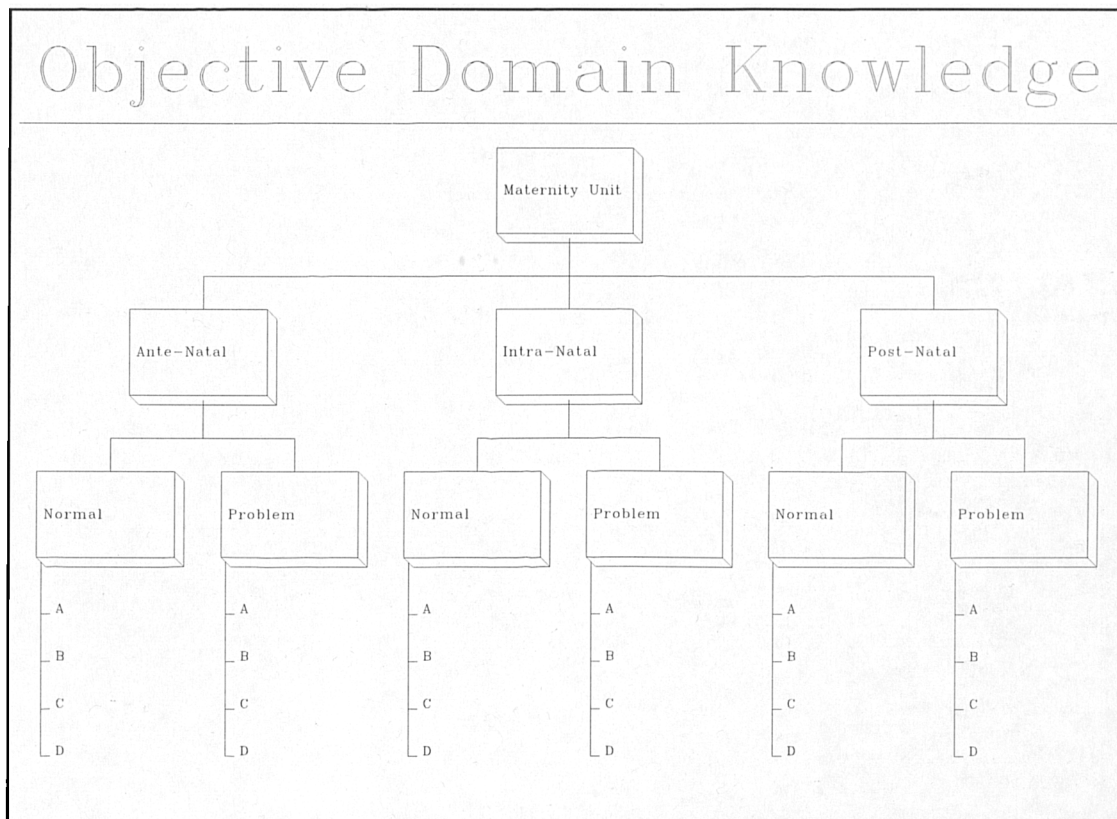
Figure 15.1   The Maternity Domain from Objective Knowledge

The objective knowledge acquisition of the domain of Maternity would reveal that the process of pregnancy is divided into three main sections i.e. Ante-Natal, Intra-Natal and Post-Natal. In each of these sections the mums are divided into 'normal' and 'problem' categories and receive care, A, B, C, etc. as appropriate.

However, tacit knowledge acquisition revealed that the domain is more complex (see figure 15.2).
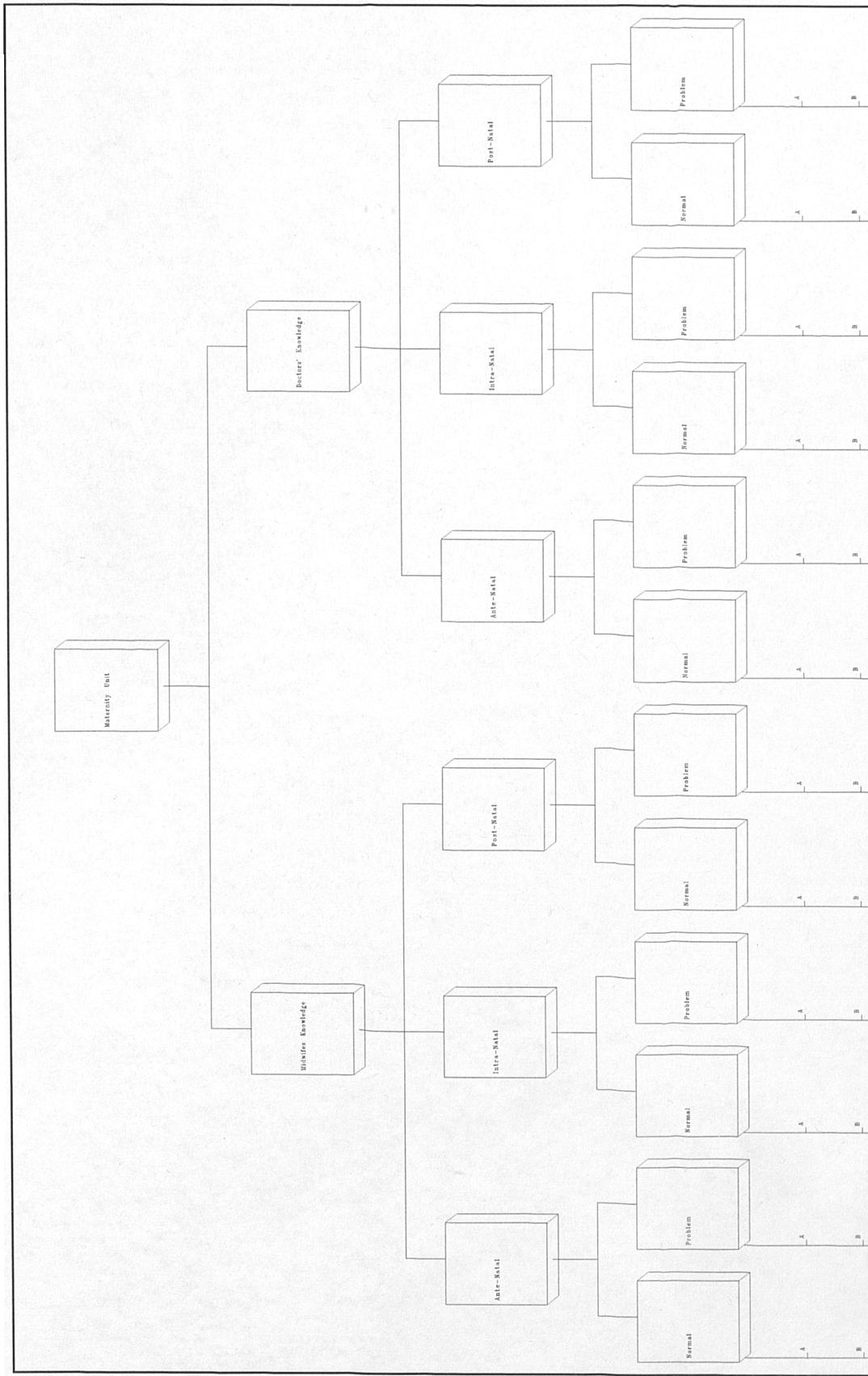
Figure 15.2 Objective + Tacit Knowledge

A division exists directly below the root of the domain and above the division of the process of pregnancy into ante, intra and post-natal sections. Two bodies of knowledge exist in Maternity care (i.e. doctors knowledge and midwives' knowledge), and each body of knowledge views the domain below this node point in very different ways. As noted above the doctors 'body of knowledge' is predominant in Area 1 and the midwifes 'body of knowledge' is predominant in Area 2. A KIS based on the doctors 'body of knowledge' is appropriate for Area 1 and a KIS based on the midwifes 'body of knowledge' would be appropriate for Area 2.

The situation is further complicated by the fact that both bodies of knowledge exist in each maternity unit. This is an important point to make in that although a particular body of knowledge is predominant in an organization other bodies of knowledge can exist in a unrecognized and often subversive fashion. Area 1 which concentrates on doctors body of knowledge requires information of concern to midwives and in Area 2 *vice versa*.

15.5 The Modification of the Interface Utilizing Elicited Tacit Knowledge

Whichever body of knowledge is predominant, it is the midwives that spend the vast majority of time with the KIS, inputting data. The KIS input interface should, therefore, be designed for the main users i.e. the midwives.

It was felt that to demonstrate the practical use of incorporating tacit knowledge into a KIS, a 'real' KIS should be modified and tested in a live situation. Only in this way can tacit knowledge be found and experienced. This presented many practical problems in the case of the hospital KIS.

*   The ante-natal package was in daily use and the hospital authorities quite

naturally would not allow this module to be modified.

* The data for this model was provided by the mums. This data constitutes part of their medical records and as such is confidential. Permission to use such material would have required gaining 'Research Ethics Committee' approval (a notoriously difficult and long-winded procedure).

It was therefore, proposed to use an existing GIT module which was being modified to come on line at Area 2. This module the *'Mother and Baby Discharge Module'*. This had several advantages:-

* The module was not yet in use. However, the midwives were training on the model ready for implementation. They were, therefore, experienced with the module and able to make comparisons with the modified interface.

* The source of data was the midwifes notes. In a real situation the midwife would make notes during the discharge of the mother and baby and later input these notes into the computer. Therefore, no second party was required and notes could be rendered anonymous, thus circumventing the need for 'Research Ethics Committee' Approval.

As noted above, the KIS is tacitly regarded as a hindrance to midwives, therefore, the main requirement of the KIS input interface was that it allows data to be input as easily as possible. All the midwives complained about the inadequacy and awkwardness of the light pen and bar code book. Therefore, the most obvious place to start to improve 'ease of use' was the input device. Even in the case of inputting the 'discharge' module, where the mum is not present, the book is felt to be a hinderance to the procedure. The book of discharge questions is short compared to the ante-natal history taking book, but still contains sixty-six pages and seventy-six questions. In many ways the replacement of the book with its bar codes by a screen

based set of prompts was obvious and could be described as simply the replacing of a bad design by a better design. However, the GIT system is a commercial product being successfully sold throughout the UK and as yet, it has not occurred to its designers to instigate such a replacement. More importantly, the redesign of the interface is described in order to show how two further methods of the explication of tacit knowledge emerged.

Apart from the technical difficulties, the input device, it also impeded communication between the midwife and the mum, which is felt (by the midwives) to be of vital importance. Therefore, an input device that facilitates, rather than hinders, communication is essential. This seemed an suitable opportunity to test a new input device, which if proved effective for this module could be incorporated into interfaces where midwife/mum communication is more important.

15.5.1   New Input Device

In order to design a new input device, initially the questions from the 'mother and baby discharge book' were incorporated into a 'mock interface'. The 'legal' answers from the book were also incorporated into the interface. This was quickly achieved using the software package EPI5. This package was used for many reasons.

* It is a package designed by the World Health Organization in order to help with epidemiological problems. As such, it is very powerful package and will allow data to be imported from a vast array of software.

* It is also extremely versatile and incorporates a word-processing package, a data base package, a check file and a statistical package, each with its own interface (of differing complexity, from 'command line' to a simple input interface.

*   It is extremely easy to use: an interface can be designed on the word processor and with the 'flick of a switch' is transformed into a data base. This was important because the first interface was a temporary 'mock up' which was to be modified in accordance with users recommendations.

*   EPI5 is Public Domain Software and thus extremely economical.

Initially the existing interface was re-designed, the book and bar code reader was replaced by a KIS within the PC. This was named 'Midwives Interface Version 1'. The use of the key board was kept to a minimum by the use of 'drop down menus.

15.5.2   Chunking

The midwives also felt that single question per screen made the process difficult to follow. The researcher attempted to put several questions together on the screen in a meaningful 'chunk'. This soon proved very difficult because the questions in the book were not in any meaningful (that the researcher could discern) order. For example, in the book, the first few questions were in the following order:

1)   What date and time was the mother transferred from hospital?
2)   Who transferred the mother?
3)   Method of Transfer?
4)   What was the mothers destination on transfer?
5)   Did the woman develop Puerperal Pyrexia?
6)   What is her systolic blood pressure?
7)   What is her diastolic blood pressure?
8)   What method of feeding has been chosen?
9)   Was the uterus involuting normally prior to discharge?
10)   Describe the lochia.

Questions 1-4 form a chunk 'around the transfer of the mum'

Question 5, is a medical question, about a condition that the mum may or may not have experienced.

Question 6-7 are a chunk of her medical status 'at this time'

Question 8 is concerned with the method, which the mum might feed the baby in the future.

Question 9 is a medical question, about a condition that the mum may or may not have experienced.

Question 10 is a medical question, about the delivery of the baby.

Again this seems like a question of poor original design. The point is, however, not just to demonstrate how the interface could be improved but to discuss lessons for the explication of tacit knowledge that emerged from the modification process. It was clear that for the interface to present meaningful chunks the whole of the interface would have to be re-designed. The original interface was divided into two sets of questions, the first pertaining to the mother and the second to the baby. This seemed to form a natural dichotomy because the mother and baby are two hospital patients and it makes sense to keep records separate but 'linked'.

It was decided to chunk the data for section based upon the tacit delimitation of their work by the midwives and the following layout was undertaken

15.5.2.1   Mum's Section

1)   Demographic data: every mum has such data, placing it at the beginning of the interface allows the midwife to check that she is inputting the correct mum's details.

2)   Details pertaining to all mums: this area contained questions that every mum
     must answer, for example, information of future appointments and emotional
     state etc.

3)   This section contained questions about medical problems that the mum might
     or might not have experienced.

15.5.2.2   Baby's Section

1)   Demographic data: every baby has such data, placing it at the beginning of the
     interface allows the midwife to check that she is inputting the correct baby's
     details.

2)   Details pertaining to all babies: this area contained questions pertinent to every
     baby, for example information of future appointments, weight on discharge
     etc.

3)   This section contained questions about medical problems that the baby might
     or might not have experienced.

This re-designed interface was constructed and tested. The midwives unanimously
found the new interface both easier and quicker to use. The main improvement was
the new input device. The Chunking of the data was seen as significant in that it
followed a logical sequence but secondary.

15.6 The Use of 'Chunking' as a Tool of Interface Design

The Chunking was, however, to lead to the most significant advancement of the
design. Observing the midwives using the interface revealed that several large
'chunks' were filled with negative inputs. In hindsight this was a self-evident, for

while every mum required her name to be input a small minority had developed puerperal pyrexia. While the medical questions were scattered throughout the input sequence (as in midwife interface Version 1), the fact that in the majority of cases the answer was negative remained overlooked. Once the medical questions were 'chunked' together there were whole screens where every question received a negative answer. This caused considerable frustration with the midwife users. For example the question 'Did the woman develop Puerperal Pyrexia?' required the midwife to press f9 to activate the 'drop down window' and choose from the following,

No
Chest Infection
Perineal Infection
Unknown Cause
Wound Infection
Vaginal Infection
Uterine Infection
Urinary Tract Infection
Other

She then had to make a selection by using the cursor keys to highlight the relevant input and press 'enter'. While this procedure was a considerable improvement upon the bar code book and light pen, for the vast majority of mums the answer was no. The same process was required by the next question and the next etc. When time and again, ten or more questions in a row, were negative (as is the case the majority of cases), the midwives complained that in putting redundant data was a waste of their time. The manual method of record taking was such that if the woman developed puerperal pyrexia a note would be made. If, however, the woman did **not** develop puerperal pyrexia no note of the condition was made. This was a form of default,

unless a reference to puerperal pyrexia is noted = the woman did not

develop puerperal pyrexia.

Therefore although the input device had been improved, it was still increasing the midwifes work in a non-productive manner and was thus, still a hindrance to them.

15.7 The 'Midwife Interface Version 2'

Many minor modifications to Version 1 interface were suggested by the midwives in order to improve the situation, however, the researcher proposed a more radical solution. Based on the research above, the interface was re-designed to incorporate only questions that the midwives tacitly consider are in their domain. The midwives deal with 'normal' mums and babies, which are those that did not develop a medical condition, therefore, in the Midwife Interface Version 2, medical questions were removed from the interface.

15.7.1   Advantages of the 'Midwife Interface Version 2'

Although this was a considerable reduction of the questions they were adequate for the vast majority of mums (to recap 80% of mums are 'normal' mums). This was a vast improvement for two reasons,

1)   The questions on the interface was reduced by over 50%.

2)   The questions were appropriate to the user (i.e. they are part of the auxiliary work of the midwife).

Thus the KIS had been improved, both quantitatively (less questions, therefore, quicker to use) and qualitatively (the work had been changed from a hinderance to auxiliary work).

15.7.2   Disadvantages of the 'Midwife Interface'

The main disadvantage was that (as in the case of the EMMY project) the knowledge base was simplified by quantitative methods and resulted in a reduction of the use of the KIS. For 20% of mums the 'midwife interface' would not be appropriate. While

it is true to say that the 'problem' mums are under the responsibility of the doctor, as noted above 'all deliveries are normal until proved abnormal' the midwife is initially in charge of all deliveries and acts a 'gate keeper', who decides when the delivery in abnormal. Therefore, although during a 'problem' delivery the doctor takes charge and the midwife remains to assist, she is required to write up her own report of the intra-natal period.

15.7.3   The 'Midwife Interface Version 3'

The 'gate keeper' function is considered auxiliary work. Where the mum is classified a 'problem' mum, the process of classification is considered as auxiliary work and the midwives are willing to expend more effort. The interface was re-designed, Midwife Interface Version 3 consisted of five sections (see figure 15.3).
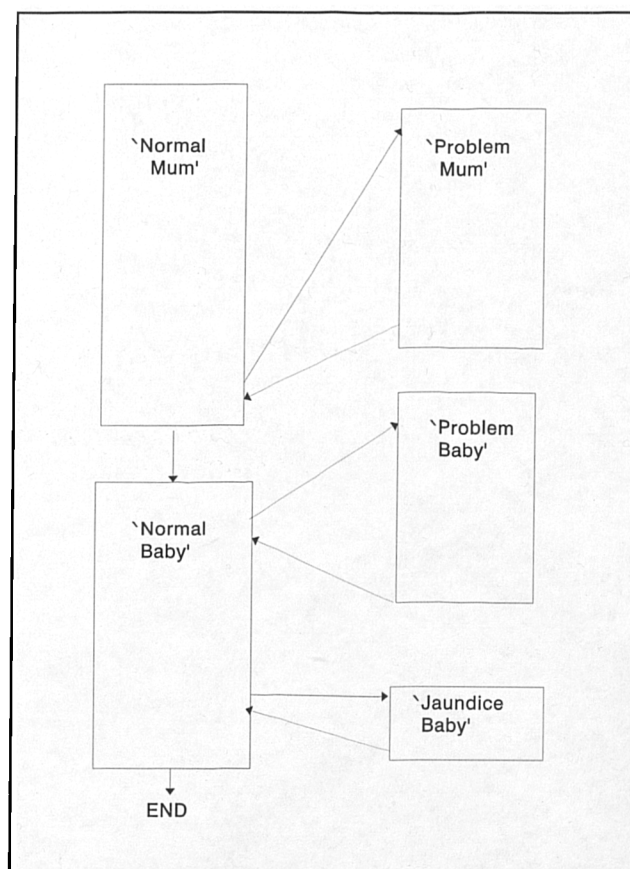
Figure 15.3   Sections of the Database

15.7.3.1   Section 1. The 'Normal Mum'

This contains data that must be entered for every mum and fills one screen. The 'KEY' (the 'key' is the question that links different sections of the data base) question 'Problems Before Discharge?' occurs towards the end of this section. The check file below allows a selection of legal entries that appear on the drop down menu. The KIS then 'chooses' the next question by referring to the check file, which for Problems Before Discharge (abbreviated by the check file to PROBLEMSBE) is as follows,

```
PROBLEMSBE
  MustEnter
  Legal
    NONE
    HYPERTENSION
    ECLAMPSIA
    "PPH ONLY"
    "PRIMARY PPH"
    "SECONDARY PPH"
    "WEAK/ALTERED LEGS"
    "RETAINED PRODUCTS"
    "SYMPHYSIS PUBIS"
    OTHER
  END
    IF  (PROBLEMSBE  =  "HYPERTENSION")  OR  (PROBLEMSBE  =
"ECLAMPSIA") OR (PROBLEMSBE = "PPH ONLY") OR (PROBLEMSBE =
"PRIMARY PPH") OR (PROBLEMSBE = "SECONDARY PPH")
  THEN
    ENTER M&BPROB MOTHERID 1
  ENDIF
  GOTO METHODFEED
END

METHODFEED
  MustEnter
  Legal
    BOTTLE
    BREAST
    BREAST/COMP
  END
```

```
END

MOTHERBA01
  MustEnter
  ENTER m&baby MotherId
END
```

Therefore, if the mother has hypertension, eclampsia, PPH only, primary PPH or secondary PPH she has a medical problem and therefore, the 'Problem Mum' section has to be completed. If any other answer is entered, the mum does not have a medical problem and the final question on the screen is entered prior to entering the 'Normal Baby' section.

15.7.3.2   Section 2. The 'Normal Baby'

This section contains data that must be entered for every baby and also fills one screen. The *'KEY'* question 'Any problems Prior to Discharge <Y>' (abbreviated by the check file to 'ANYPROBLEM') occurs at the beginning of the screen and is much less complex than the 'key' in the 'Normal Mum' section. The check file is as follows,

```
ANYPROBLEM
  IF anyproblem  = "Y"
  THEN
    ENTER M&BBABPR.REC BABYID 1
  ENDIF
  GOTO PAEDASSESS
END
```

Basically if there have been any problems prior to discharge, the baby is a 'problem baby' and the 'Problem Baby' section is required to be completed. If the answer is <N> then the 'Normal Baby' screen is completed.

15.7.3.3   The 'Jaundice Baby' Modification

A large number of babies (up to 20%) are born with jaundice. Originally the short section pertaining to jaundice was incorporated with the 'Problem Baby' section. However, this resulted in large numbers of records containing negative answers (in most cases jaundice was the baby's only problem). It was felt that the numbers of babies with the 'problem' of jaundice made it a special case and a separate section the 'jaundice baby' was developed. The sections were ordered so that if the baby had more 'problems' than jaundice, both the 'problem baby' section and the 'jaundice baby' section would be required to be filled in. If the baby has only one 'problem' i.e. jaundice it was not necessary to fill in the 'problem baby' screen.

Summary of Interface Re-design

The 'midwife's interface' had been radically re-designed in order to conform with the tacit knowledge of the midwives, namely that pregnancy and giving birth is a natural, rather than a medical issue in the majority of cases. The Version 3 interface made it possible to reduce what the midwives consider as hindrances and concentrate on the midwifes' auxiliary work. This was achieved by re-designing the interface around the midwifes domain (the normal mum and baby) rather than the doctors domain (the problem mum and baby). This produced a dramatic reduction in the work but more importantly the work that remained was felt by the midwives to be important (auxiliary work). When the mum or baby did have a medical problem the midwives did not resent filling in the extra section/s because they felt that this was also a worthwhile task. Filling in data about a problem mum/baby, when the mum/baby actually has a problem, and the data is in meaningful chunks, is regarded as part of the 'gate keeping' function and is therefore, auxiliary work. The investigations into the midwives' tacit knowledge as it relates to their paradigm of working produced a reduction of the knowledge base in a qualitative manner, producing a quantitative reduction in the work plus a qualitative enhancement of the work from 'hinderance'

to 'auxiliary work'. As in the case of EMMY, a qualitative simplification reduced work and extended scope.

15.8 Testing of Re-designed 'Midwife's Interface'

Midwife's Interface Version 3 was tested by 4 midwives (3 from Area 1 and 1 from Area 2). They all found that with minimal instructions the interface to be a vast improvement on the original interface. It was:

* Faster to use.

* Easier to use.

* Did not waste the midwives time Filling in redundant questions.

* The layout made sense following in a logical progression.

* The questions were in meaningful chunks that made input much easier.

The incorporation of tacit knowledge into the design produced a dramatic improvement in the interface.

Little time will be spent here discussing whether such a small number of users is adequate to draw the above results. The logistics of the research is limited, its findings must, therefore, be considered provisional. However, the results of the testing strongly indicated that this would be a fruitful method to aid interface design.

15.9 Summary of Chapter

The above chapter illustrates how the acquisition of tacit knowledge was relevant to system design and highlighted several important and interesting points.

a)   The modification of the GIT system revealed a difference between the 'ease of use' of the system at the knowledge level and at the symbolic level. The GIT system was extremely 'easy to use' at the bit-level. The promotional literature for the system repeatedly described the system as 'midwife proof'.[17] However, it was difficult to use at the knowledge level.

b)   Enhancing knowledge level 'ease of use' requires an awareness of the tacit (paradigm) knowledge.

c)   This chapter indicates enhancing knowledge level 'ease of use' is relevant to systems design, but this research is concerned with ways of eliciting tacit knowledge. This chapter indicates that if knowledge level 'ease of use' is enhanced then it may be that tacit knowledge has been made explicit in the design.

d)   The elements of the design process were:

*   Change the bit level input device.

*   Re-order the input.

*   'Chunk' with reference to common sense.

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[17] This patronizing tone speaks volummes for the esteem the user is held in, by the GIT designers.

*   Analyze the chunks.

*   Separate sections in accordance with tacit paradigms.

*   Test using different expert users.

The main purpose of the modification and testing of the GIT system was to illustrate that, tacit knowledge had been elicited and this elicited knowledge could result in an enhanced system. The modification of the GIT system also proved interesting for the purposes of this research, in that it uncovered two further methods (to be more accurate one method and a modification of this method) of explicating tacit knowledge at a micro level. The use of system development as a tool for explicating tacit knowledge will be discussed in more detail in the following two chapters.

CHAPTER 16

Method Three: The Explication of Tacit Knowledge at the Micro Level

16 Method Three: the Explication of Tacit Knowledge at the Micro Level

16.1 The Use of Action Research for Explicating Tacit Knowledge

Observing the midwives as they tested the 'midwifes interface' revealed that many improvements could be made. The interface was modified and re-tested in a series of loops in a process that could be equated to a type of action research. According to Blum (1955) action research has a diagnosis stage and a therapeutic stage. During the diagnostic stage an aspect of social life is investigated and hypotheses of the situation are developed. In the therapeutic stage, changes in line with the hypotheses are implemented and the effects studied. This will form a loop in which an hypothesis about the new situation is developed etc. in this way the situation is steadily modified.

The use of action research is problematic because it is open to the obvious claim that the researcher is actively contaminating the situation that s/he is attempting to understand, and is thus, to some extent creating rather than observing a situation. In response to such assertions attempts have been made to make the method more defendable and it has been refined by several authors in various ways, (see for example, Susman and Evered (1978)). For an informative discussion of the pros and cons of this method see Baskerville and Wood-Harper (1992).

It is the opinion of the researcher that the value of action research depends very much upon what the investigator is attempting to do. If, for example, the investigator is attempting to objectively define the reality of a social situation, then the method is hopelessly flawed, but the same could be said for the most non-interventionist form of participant observation, due to the 'Hawthorne Effect'. If, however, the object of the investigation is to understand and to improve a given situation, then it is probably

the method *par excellence*. Action research, therefore, seems to be poor for research but excellent for development. Thus, action research can be problematic when included in a Ph.D. thesis, which should be concerned with research rather than development. In this case, however, action research was not used as a method understanding a situation, rather as a tool by which tacit knowledge became explicated almost as a by-product of the process of re-designing the interface. Action research tended to explicate tacit knowledge in two ways: *transference of knowledge* from one of category to another due to radical shifts in context; *cultural dislocation* between the researcher and the respondent and between respondents from different maternity units.

Action research is usually used to understand and modify systems at the organizational level, however, the same procedure described by Blum (1955) can be applied at a micro-level in order to improve, for example, the interface design. Readers more acquainted with interface design will recognize strong similarities between action research (as used here) and rapid proto-typing.

In order for this 'micro form of action research' to be utilized as a method of explicating knowledge it was important that a particular relationship between the researcher and the respondent is developed. To conduct this type of research it is important that the respondent is both allocated a particular role and is aware of the power such a role affords. The respondents must take the role of expert testing a new or modified product.

16.1.1   Role of the Respondent

The role of the respondent is vital to the evaluation of a KIS. Lee (1995) illustrated the difference in the way 'dummy users' in the laboratory and the way that professional domain experts in the field test a new KIS. Dummies tend to use the manual much more often, ask for help more often and generally try harder to make

the KIS work than the professional domain experts. The difference is attributed to the phenomena first identified by Rotter (1966) i.e. 'locus of control'. The locus of control indicates where an individual perceives the power in a situation resides. People with an external locus of control feel relatively powerless to influence the situation in which they find themselves. Whereas, people with an internal locus of control feel that they have a great deal of power to influence their situation. In short,

> Things happen **to** people with an external locus of control, whereas, people with an internal locus of control **make** things happen.

The 'dummies' have an external locus of control, are presented a KIS and given various tasks to perform. When the 'dummy' fails to make the KIS perform these tasks s/he assumes that s/he rather than the KIS is at fault. S/he will try to learn from various means how to improve his/her performance and eventually make the KIS perform the tasks. The professional user on the other hand is presented with a KIS that s/he may or may not want to purchase. The professional user has an internal locus of control, s/he will use past knowledge and make a few attempts to make the KIS perform the set tasks. If the professional fails to perform the tasks, they will assume that it is the fault of the KIS, define it as a poor computer system and make no further attempts to learn or buy the system.

This point is worth noting in respect to Chapter One 'Why Systems Fail'. People in this position have the power to define the reality. The success or failure of a system has little to do with its inherent characteristics of a system and more to do with their perception of it.

For the purpose of Method Three it is important that the user has an internal locus of control and assumes any problems that s/he has performing tasks are the fault of the KIS. Things that the user finds frustrating, illogical or difficult to use will be perceived as a problem with the design. These problems can then be discussed with

the knowledge engineer, without embarrassment to the respondent.

16.1.2   Results of Action Research

The problems raised by the 'expert' respondents were helpful in two areas. They improved the knowledge elicitation of objective domain facts and subjective tacit knowledge.

16.1.2.1   Objective Domain 'Facts'

Many of the problems raised by the midwives were useful for improving the factual basis of the data base. For example the removal of ambiguities or errors on the part of the designer, adding or removing 'legal entries' etc.

MW1A4:	Oh that's interesting, they are asking about 'vitamin k', lets have a look at answers they have put in.
Researcher:	Why, what is the importance of vitamin k. I was wondering does it belong with the resuscitation or should it be in the part where the new born is examined.
MW1A4:	Well yes and no it can go either place. You know that when babies are distressed they have problems with their breathing. Well they found that these babies had a deficiency of vitamin k. Anyway any baby that was distressed was given a dose of vitamin k. Therefore, I suppose it should go in resuscitation.

16.1.2.2   Subjective Tacit Knowledge

Some of the problems raised by the midwives were also useful in improving the interface, by making tacit knowledge 'visible' to the researcher without of making the tacit knowledge explicit to the respondent. For example the criticality of a question and the appropriate method of data input.

The diagnostic stage consisted of working with the Area 2 midwives as they attempted to modify the GIT system for their clinic. This resulted in the formation of a hypothesis of what was required in order that the KIS more accurately met their requirements. In the therapeutic stage the hypothesis was implemented in the form of a modified KIS and the effects studied.

In any KIS it can be assumed that some questions are more important than others. Action research revealed how questions were tacitly ranked in order of importance by the users. Criticality has been discussed above at a macro level where the more critical a task is deemed by the user the more effort the individual is willing to invest in completing the task. Action research revealed that a similar phenomenon occurred at the micro level. At this level the more critical a question is deemed the more effort the individual is willing to invest in answering the question.

If the question is highly 'critical' the use of the keyboard is acceptable, less 'critical' questions might warrant the use of a 'drop down' menu. Some questions were regarded as so unimportant that even this form of input was regarded as taking up too much time and if they remained in the KIS at all warranted only a logical field, i.e. yes/no answer, or even a y/n answer. For example, once the midwives became accustomed to the new interface the improvements were soon forgotten and minor frustrations emerged.

MW1A4:   This is a pain 'how many vessels were present in the cord' then a you have to press f9 to make the drop down window appear and then make a selection. In 99% of the babies the answer is going to be three (vessels in the cord).

This is a nugget of tacitly held domain knowledge

Researcher: So should I do the same as before write 'were 3 vessels present in the cord' followed by a yes/no box which you have to type a letter 'y' or 'n' if you press 'n' then the cursor will jump to a field called 'other'.

MW1A4:   That's got to be easier, you know it doesn't take much thought
                to make these things so much easier, it's just common sense
                really, makes you wonder what these people are doing for their
                money.

The midwife's comment *'it's just common sense really.'* is particularly biting, for of
all the knowledge to elicit 'common sense' is probably the most problematic for two
reasons. Its ubiquitousness makes its elicitation extremely problematic, and once
discovered its value is immediately disparaged by the fact that it is self evident. This
is indicated by the fact that GIT are a successful commercial software company and
had been modifying the GIT Maternity Package for several years without discovering
the criticality of this entry.

Clearly inputting the number of vessels in the umbilical cord is classed as an
hindrance and warrants only a logical field answer. The following check file was
therefore, devised,

```
N3VESSELSP  ('were three vessels present in the cord?')
  Jumps
    Y HEARTRATE
  END
END

OTHER
  Legal
  2
  "CORD SENT TO PATHOL"
  OTHER
  END
END

HEARTRATE
  Legal
  0
  1
  2
  END
END
```

16.1.3   Transformation of a Question from an Hindrance to Auxiliary Work

It is interesting to note that the question about the number of vessels in the umbilical cord is considered a hindrance, because

'In 99% of the babies the answer is going to be three.'

However, its status is transformed if the number is other than three. In this case the criticality rises to auxiliary status and the midwife is willing to use the drop down window. The formal domain knowledge indicates that the number of vessels in the cord is an important fact to record, if the number is other than three. However, the fact that this is so rare is held tacitly.

Repeatedly information about the criticality of individual questions was elicited by simply chatting to the midwives as they 'acted as experts appraisers'. The following is a section from Appendix IX.

MW1A4:   Lets have a look at the options for 'liquor',

She was referring to the following as it appeared on the screen,

Liquor at SRM/ARM*_____
Liquor at delivery*_____

    Interval between SRM/ARM and delivery *##.##*

The check file was as follows:-

LIQUORATSR
  Legal
    CLEAR
    BLOODSTAINED
    "FRESH MEC.STAIN"
    "OLD MEC.STAINED"

```
   OFFENSIVE
   POLYHYDRAMNIOS
   OLIGOHYDRAMNIOU
 END
END

LIQUORATDE
  Legal
    CLEAR
    BLOODSTAINED
    OFFENSIVE
    "FRESH MEC.STAINED"
    "OLD MEC.STAINED"
  END
END
```

The midwife continued,

MW1A4:	hrrm, its only meconium stained ones that are of interest to us

Researcher:	Why is that significant?

MW1A4:   Well meconium is a black substance in the fetus' gut, if the fetus is 'distressed' it will sometimes expel the meconium and stain the liquor. This is significant but rare. The vast majority of women have a clear liquor. It seems such a bug to me to have to drop down the window when it would be much easier for me to type 'clear'.

This midwife is able to type and therefore, prefers this method of input. The interface will allow for this method, the integrity of the data is maintained by a check file.

Researcher: So usually the liquor is 'clear' how about having the question read 'was the liquor clear' followed by a yes/no box (logical field). That way it would be easy to type in the letter 'y' or 'n'. If the answer was 'n' then another field perhaps entitled 'unclear' would be entered. If the answer was 'y' this field could automatically be skipped.

MW1A4:   Yes that sounds all right there is nothing worse than Filling in an obvious answer over and over again, the least you can do is make Filling it in as easy as possible.

Many other modifications were suggested, these suggestions gave the researcher a deeper understanding of the domain knowledge, however, these suggestions were in a similar vein to the two examples above and will, therefore, not be discussed here. The importance of criticality to interface design should not be underestimated, rigorous attention to details such as these dramatically: reduce the effort of data input; speed up the operation and reduce frustration.

CHAPTER 17

Method Four

17 METHOD 4

17.1 Introduction

As noted above the use of action research to elicit tacit knowledge was attempted using four Senior Midwives three from Area 1 and one from Area 2. It was soon noted that the information elicited from the midwives at Area 1 was of a different quality than that elicited at Area 2. Midwives from both Areas could produce knowledge pertaining to for example criticality, action research, however, with the midwives from Area 1, also produced knowledge of a different quality. On reflection it was realized that while both Areas could explicate tacit knowledge via *transference of knowledge* by a radical shift in context. Area 1 could also explicate tacit knowledge via *cultural dislocation,* or more precisely organizational cultural dislocation (the difference occurred due to the way that the action research was conducted).

17.2 Action Research at Area 2

Area 2 Maternity Unit was at that time, preparing for the transition from keeping manual records to a computerized system of record keeping. The researcher worked closely with the senior midwife at Area 2 who had been given the task of modifying the GIT system for Area 2. The researcher had worked with her as she attempted to modify the specification for Area 2 maternity unit. Based upon: these interviews; the specifications that the midwife deemed necessary and the domain knowledge the researcher had already acquired an hypothesis of what was required was formulated and a KIS using EPI5 was constructed. The researcher then returned to Area 2 and the senior midwife evaluated the effect of the proposed changes. The radical change of context i.e. changing from a manual to a computerized record keeping system forced previously held tacit knowledge to be transferred into explicit knowledge. The

KIS was then modified and evaluated until the midwife was satisfied with the changes.

17.2.1   Action Research at Area 1

In and attempt to gain a more objective opinion of the modified KIS the researcher also allowed the modified KIS to be evaluated by the midwives from Area 1. These midwives differed from that midwife in Area 2 in that they had no direct input into the design of the KIS. They were less conversant with the interface and thus, be a better position to identify ambiguities and anomalies. The midwives of Area 1 were indeed able to provide several valuable suggestions. More importantly the Area 1 midwives explicated tacit knowledge via *cultural dislocation*.

Cultural dislocation was discussed above (Chapter 15) occurs where members of different cultures come into contact with each other (e.g. the Ghanaian students and the English teacher). It was also argued that cultural dislocation can occur between individuals belong to the same culture but belong to different mini-cultures (e.g. knowledge engineers and doctors). The action research seems to indicate that cultural dislocation can occur where individuals are members of the same mini-culture but belong to different organizations, i.e. *organizational cultural dislocation*.

17.2.2   Organizational Cultural Dislocation

Organizational cultural dislocation is a useful tool for the knowledge engineer for two reasons. Firstly: items of the interface that appear unusual to an expert (due to their domain knowledge) might not appear unusual to the engineer. Secondly: this is an expert opinion of the domain knowledge incorporated into the KIS and non-domain tacit knowledge that is important to expert decision making, extra mural tacit knowledge can be explicated.

17.2.3   Expert Opinion of the Domain Knowledge

A trivial example of this occurred when the midwife came across a section about the mum's position at birth.

MW1A4:	What's this? position of mother at delivery? We-ell I suppose they might be interested in that but I can't think of any possible use for information of that sort.
Researcher:	It's probably somebody's hobby horse, and they want to do some research on it.
MW1A4:	Suppose so that's why these things get out of hand and long winded.

It is important to identify fields that are specific to a particular unit, to avoid unnecessary lengthening of the interface. The importance of identifying fields that are of interest to particular individuals for research purposes can have far-reaching implications as the following dialogue from Appendix IX illustrates.

MW1A4:	It just shows you how careful you have to be when doctors want fields put in to help their individual research, the ramifications need really looking at.

The midwife goes on to talk about some research a doctor at Area 1 is interested in conducting

MW1A4:	Yes its all right for Dr. X, asking the midwives to test the cord blood to see if there is anything interesting in the results worth researching. But it's the midwives that get the extra work, more importantly it is the midwife that has to sign for the delivery. The problem is, for example, suppose future research reveals that a low ph. in the cord blood is an indication of a distressed fetus. We have signed and if anything that could be put down to lack of oxygen during the birth it is the midwife that they come back to sue personally, not the Dr. X. We have to keep these records for 21 years anything that happens in those years is down to us. I mean

> suppose in say 10 or 15 years somebody produces research that links dyslexia with low ph. blood cord, the writs would be flying thick and fast and it's us that have to take the flack, just because Dr. X thought that it would be interesting data to collect.

Therefore, if such fields exist, they should be clearly identified as separate from the core questions. If they remain embodied and the interface is used in another organization, there is a danger that such questions are seen as core questions of the interface. A second organization could fill in the fields without giving due consideration to the implications of collecting such data.

While discussing the modifications drawn up by the Area 2 midwife an interesting example occurred whereby as Collins maintained (see Chapter 10 tacit knowledge becomes explicated with dramatic changes in context.

Researcher:	I think I've made a mistake with the Apgar scores. I have allocated two spaces for each entry and it only needs one.
MW1A4:	That's right you get a score of 0, 1 or 2 for each category. Its interesting at Area 1 we have drawn up criteria for the categories. For example, if the heart rate is below 'x' then they are given a score of '1' if it is over 'x' then the score is '2'. Of course if it is as flat as a pancake then it gets a '0'. We used to leave it to the midwifes discretion but now we have drawn up a formula.

For reasons that will be discussed in the next section the midwives had taken the tacitly classified Apgar scores and allocated a specific measures to each. These can, (once their existence is discovered) be easily elicited, from the midwives at Area 1, for use on the system at Area 2.

17.3 'Extra Mural Tacit Knowledge'

Organizational social dislocation, that occurred when the midwives from Area 1 assessed the modification of the GIT system by the Area 2 midwives was also useful in the elicitation of extra mural tacit knowledge. For the purposes of this research 'extra mural tacit knowledge' is,

'Knowledge that is outside a particular domain, tacitly held and having an influence upon domain decision making.

Organizational social dislocation revealed that key variables outside the maternity domain were having major effects upon the management of pregnancy. In particular what came out time and time a gain, was that a key consideration to the management of pregnancy was the *'fear of litigation'*.

For example continuing the conversation mentioned above, about the colour of the liquor

Researcher: Well if it is rare is it significant enough to include in the questions.

MW1A4:   That's the problem. When we filled in the forms manually you could always write in if the liquor was meconium stained or not, the odd time that it happened. If the liquor was not mentioned, it would be presumed 'clear' But now it is important to put in, in case of litigation.

You know if the liquor was stained and you don't take action then you may be liable. This is stupid because if you saw meconium stained liquor then you would take immediate action. What this is saying is 'the liquor was clear, it has been noted down, therefore, if it later proves the baby suffers a condition that may be attributed to fetal distress then the midwife/doctor can point to the notes and say there was no signs of fetal distress at this point'. (N.B. see the instrumental aspect of

information in Chapter Six).

Researcher: So it's a way of 'covering your back' there is really no other reason for this question. I noticed that it doesn't appear on the manual form used at Area 2.

MW1A4:   Yes, but it's becoming more and more important that we 'cover our backs' there has been an avalanche of litigation in this area. Over 70% of gyaenie consultants being sued at any one time.

Another example occurred in reference to 'tagging' [18] the babies

MW1A4:   This is a laugh 'were identity labels applied?'.

Researcher: Yeah the answer is always yes. I thought it was like a check list to remind the midwife.

MW1A4:   Well yes, but what you need to know, however, after that cock up the other week is, 'by whom'.

The midwife is referring to an incident reported in the national press, where two babies were mixed up and given to the wrong parents. The key function of this question is not 'has the baby been tagged?' but 'who is responsible for tagging the baby should anything happen?'

17.3.1   The Defense Against 'Fear of Litigation'

As mentioned above an aspect of extra mural tacit knowledge is the 'fear of litigation', the following example illustrates how the interface can be designed to take this fear into account. The midwife is examining a section about 'fetal monitoring' (abbreviated to FETALMON01 on the check file). It appears on the screen as below.

---

[18] 'Tagging' refers to the fixing of identity bracelets to the babies

FETAL MONITORING

Fetal monitoring < Y >   Type* _____

             CTG < Y >   Type* _____

Result of last fetal scalp sample _____

The check file for this section is as follows,

```
FETALMON01
  Jumps
    N CTG
  END
END

TYPE
  Legal
    INTERMITTENT
    CONTINUOUS
    SONICAID
    PINNARDS
    OTHER
  END
END

CTG
  Jumps
    N RESULTLAST
  END
END
```

TYPE01 *(Type01 refers to the field named type that refers to CTG)*
```
  Legal
    REACTIVE
    "LOSS OF VARIABILITY"
    BRADYCARDIA
    TACHYCARDIA
    "EARLY DECELERATIONS"
    "LATE DECELERATIONS"
    "VARIABLE DECELERATIO"
    "SINUSOIDAL TRAC"
    OTHER
  END
```

END

MW1A4:	.... Lets have a look. What's this 'Last fetal scalp sample', does this mean time, because if it does, there must be a place to record the result.
Researcher:	When would the results come through, and who would enter the results at a later date.
MW1A4:	The PH results are essential and are done on the ward so the results are there on the spot.
Researcher:	So they don't have to go off to the path lab.
MW1A4:	No, a high acid content in the fetal blood is an indication of fetal distress. The ph. is tested on the ward so we can act immediately. It's like the stained liquor you need to show that it has been taken.

The point to make here is that a space is required to show that fetal monitoring had taken place, as a defensive measure for the health professional should anything go wrong.

Researcher:	More of a legal than a medical consideration.
MW1A4:	Yes and no, if you take a fetal sample then this is an invasive procedure and should be recorded. But its getting that way that we always carry out fetal monitoring whether the woman needs it or not.

There is a need to record invasive procedures but the fear of litigation is transforming a useful procedure *when* a baby becomes distressed to a procedure that is used *incase* a baby becomes distressed.

Researcher:	What's the problem in fetal monitoring? The women.
MW1A4:	Well in the old days we used to use our pinna stethoscope to listen to the fetal heart. This is not always so easy but with

practice it can be done. Every half hour you would pop in to see if she was progressing ok, then you would leave them to it. The mum could get up move around, and generally get comfortable. I think that you should leave couples alone especially in the early stages of pregnancy so they can feel at ease and talk intimately. It was only in the last stages that the heart was monitored if at all.

Now the woman is admitted and the first thing that happens is she is strapped onto a fetal monitoring machine. This in effect straps the woman flat on her back immobile for hours on end. The mums hate it they are uncomfortable for much longer and expecting something to happen hours before it does. I've talked to them and they feel that they have to lie still, it takes a lot of power away from them. You know what it's like to have a sore back, if it is aching while lying still you want to twist around, move about until you can find a comfortable position. It's the same with the mums, but the fetal monitor forces them to lie flat and bear the pain.

She goes on later to say,

The doctors are so afraid of litigation that they want everybody monitored. They are in a 'Catch 22' situation and dread something going wrong and at a later date being asked to account for the reason, given that something had gone wrong, why hadn't fetal monitoring taken place.

The fact that litigation is changing maternity practice often adversely affecting the delivery of the baby seems to be a concern beyond the scope of knowledge engineering. If the medics want a field for fetal monitoring they should be provided with such a field. However, once the aim of the knowledge engineer is to incorporate knowledge into a system then the identification of key variables is essential.

The following transcript illustrates how due to fear of litigation the type of data collected has changed. The researcher and a midwife were discussing a labour and delivery mock up. She pointed out that for legal reasons it was not sufficient to record *which* treatments were performed but also in areas prone to litigation record *why* such treatments were undertaken. By identifying the extra mural variable 'fear of litigation' areas that are prone to litigation can be identified and 'why' questions

inserted when appropriate.

It should be noted that this is not simply a defense for doctors. It will cause the doctor to question 'why' procedures are undertaken instead of simply performing them. In either case, knowing the reason for a field can be a great help to interface design.

The midwife was trying the interface when she came to the section pertaining to perineal trauma and said

MW1A4:   The information about whom, and why the epidural was given is very important in case of litigation.

PERINEAL TRAUMA

Any perineal trauma <Y>   Type* _____

Was episiotomy performed <Y> Reason* _____

Mother sutured <dd/mm/yy>   at *##.##*

Who sutured the episiotomy/tear* _____ name _____

Who supervised suturing* _____ name _____

What suture material* _____ method of suturing the skin* _____

Analgesia to repair episiotomy/tears* _____ quantity *###* mls

```
WASEPISIOT
  Jumps
    N RECTALVAGI
  END
END

REASON
  Legal
    "FETAL DISTRESS"
    "MATERNAL HYPERTENSI"
```

```
    "PREV PERINEAL DAMAGE"
    OTHER
  END
END

SUTUREDEPI
  Legal
    "MIDWIFE GRADE E"
    "MIDWIFE GRADE F"
    "MIDWIFE GRADE G"
    "MIDWIFE GRADE H"
    "MIDWIFE GRADE I"
    "MIDWIFERY TUTOR"
    "STUDENT MIDWIFE"
    "CONS. OBS."
    "SNR. REG."
    "SHO. OBST."
    GP
  END
END

SUPERVIS01
  Legal
    "MIDWIFE GRADE E"
    "MIDWIFE GRADE F"
    "MIDWIFE GRADE G"
    "MIDWIFE GRADE H"
    "MIDWIFE GRADE I"
    "MIDWIFERY TUTOR"
    CONSULTANT
    "SNR. REG"
    REG
    "SHO. OBST."
    GP
  END
END

SUTUREMATE
  Legal
    SOFTGUT
    DEXON
    OTHER
  END
END
```

```
METHODSUTU
  Legal
    SUBCUTICULAR
    INTERUPTED
    MATTRESS
    OTHER
  END
END

ANALGESIAR
  Legal
    "LIGNOCAINE 1%"
    "LIGNOCAINE 5%"
    +ENTONOX
    GA
    EPIDURAL
    SPINAL
    OTHER
  END
END
```

MW1A4:   Yes this is another important area for litigation 'perineal
                     trauma' [the perineum is the area between the thighs that lies
                     behind the genital organs and in front of the anus.] It's an
                     absolute mine field. You've got all this propaganda against
                     epidural, so if a woman has an epidural and has to have an
                     episiotomy or is badly lacerated they blame the trauma on the
                     epidural. Its natural they are no longer feeling the pain of
                     childbirth but have the pain of the trauma, they forget the relief
                     the epidural gave them and blame it for the pain that they are
                     feeling. You just can't win. The top and bottom, no pun
                     intended, is that you have to be very careful with your record
                     keeping in this area.

Here a defense is being built up and recorded, at one time the midwife would have

recorded the fact that an episiotomy had been performed or perineal trauma requiring

sutures had occurred. Now if an episiotomy is performed, the reason why has to be

given, if an episiotomy or perineal trauma has occurred records of the extent of the

cut/tear, the method of stitching, type of suture, who performed the stitching, who

supervised the stitching, when the mum was sutured and the type of pain-killer

prescribed, are required. The above indicate that extra mural tacit knowledge can be an important factor of KIS design.

17.4 Summary

The four methods show that:

*   Tacit knowledge is an important element in domain knowledge.

*   Tacit knowledge is present at the level of the culture, the organization and the individual.

*   At least some tacit knowledge can be explicated in a form useful to KIS development.

*   Tacit knowledge can produce a richer picture of the domain and its context than objective domain knowledge.

*   The presence of more than one body of knowledge can be present in a single domain.

*   Tacit knowledge often takes precedence over formal domain knowledge.

*   Tacit knowledge highlights the importance of criticality to KIS design.

*   Expert domains are often tacitly delimited. A knowledge of this is important to KIS design.

*   Extra mural tacit knowledge was explicated and found to be of importance to KIS design.

Tacit knowledge is therefore, an important element of domain knowledge. The above methods seem capable of eliciting at least some of the tacit knowledge of a domain. These points will be discussed in greater detail in the final chapter.

The above indicates that sociological methods can be of use for knowledge acquisition in the explication of tacit knowledge. The next chapter turns this notion on its head and briefly discusses how knowledge acquisition can be a useful method of sociological investigation.

CHAPTER 18

Knowledge Acquisition as a Tool for Sociological Investigation

18 Knowledge Acquisition as a Tool for Sociological Investigation

Chapter Eighteen is very short because it concerns a topic that is in many ways a by-product of the main research. In Chapter Seven it was envisioned that due to the fact that sociological methods have been employed the resulting data would be of sociological interest. For example, the main thrust of this research has been to uncover methods for the explication of tacit knowledge in a form useful to IT. However, in order to accomplish this task required the explication of the occupational cultures of the midwives and the doctors. Occupational culture is a topic of sociology, therefore, the findings of this thesis might be expected to contribute in a secondary fashion to the body of sociological knowledge. However, while contemplating the findings, it became apparent that the knowledge acquisition of tacit knowledge could be a useful aid to sociological research.

This research illustrates how sociological methods can explicate tacit knowledge in a form useful for KIS development. This next section seeks to turn this notion 'on its head' and discuss how KIS development using the above methods can be used by sociologists as a method of conducting research of their own.

KIS development can aid sociological research in three ways: provide access to the work-place; provide access during a time of complex shift of context and provide an alternative framework around which to assemble the data.

*   Access

The problem of negotiating access to respondent groups is common to most sociological investigations. However, gaining access to the work-place is particularly fraught in that it first requires formal permission from often suspicious management.

Crompton and Jones (1988) note,

> *'[D]ifficulties of gaining access may help explain why in-depth empirical studies of complex organizations are still something of a rarity.' (page 69).*

After negotiating the hurdle of access the respondent still has the problem of explaining to the respondents the reason for the research. There is often mistrust in that the researcher is seen by various groups a 'spy' for top management. Bulmer (1988) notes,

> *'Once admitted, the researcher must establish a workable and convincing role in which to gather data by various kinds of interview, observation and from documentary sources.' (page 151).*

The implementation of a KIS overcomes both of these problems for the researcher. If a KIS is being developed or modified for an organization, the development team are actually invited to investigate the organization. Therefore, a sociologist who is a member of the KIS development team to some extent overcomes the problem of negotiating access. In the same way, being a member of the development team gives the researcher a legitimate role for conducting interviews and other forms of data collection.

*   Complex Shifts of Context

Access to members of a KIS development team occurs at a particularly fortunate time for the conducting of sociological research. Collins contends that a transference of knowledge from cultural skills to heuristics or facts and rules can occur during times of complex shifts of context. In this knowledge engineers and sociologists share a topic, the explication of cultural skills. The computerization of a manual system is

such a shift in context and can, therefore, be exploited for purely sociological purposes, i.e. to gain knowledge of the occupational cultures concerned.

* **Alternative Framework**

Knowledge acquisition provides an alternative framework against which the occupational working practices of the midwives and doctors can be explicated. Instead of using the more usual sociological categories (culture, occupational culture, sub-culture, kinship, peer groups, class, role, norms, power etc.), the data has been collated around IT and IS categories (such as generality, delimitation of expert domain, prioritization of tasks, etc.). These categories have allowed some of the process whereby the 'actors' concerned construct their working world, to be explicated. A non-exhaustive list would include: how the midwives and doctors tacitly delimit their domains; how midwives tacitly prioritize the importance of tasks; how normal is transformed into abnormal; how abnormal is transformed into normal; the notion of extra-mural knowledge; the power of extra-mural knowledge to transform situations; the importance of tacit roles, (i.e. the gate keeper and advocate role of the midwife).

Sociologists finding the ideas in this thesis can unpack the data into sociological categories for their own purposes.

CHAPTER 19

Conclusion

19 Conclusion

In conclusion, the above graphically illustrates that gaining an understanding of the tacit knowledge of a domain can qualitatively improve a KIS. It is recommended for best results to use the methods in the order described in this research. Method One should be used first in order to ascertain the generality of the KIS. Method Two should then be employed to delimit the domain and ascertain the criticality of tasks performed by the various groups within the organization. Once this has been accomplished Method Three and Method Four should be employed in order to assist in the design of the interface.

The out line of the final chapter is as follows:

1) The main research findings of the thesis are recapitulated.

2) Each method for the explication of tacit knowledge is briefly described and then evaluated in relation to the lessons learned by the researcher during the research.

3) This is followed by more general lessons learned by the research for example, ethical issues.

4) Finally, suggestions for future research are made.

19.1 Pilot Study

The pilot study indicated that in a general way that it is possible to explicate tacit knowledge in a form useful to be embodied into the knowledge base and to enhance usage of the KIS. To be more specific, the pilot study: highlighted the importance

of tacit knowledge; showed that tacit knowledge pervades even apparently structured tasks such as building maintenance; experts classify their domain differently than laymen; tacit knowledge is often used in creating classifications; tacit knowledge does not respect formal disciplinary boundaries; tacit knowledge is often problem orientated; the common sense way that experts understand their domain considerably simplifies the knowledge base required for decision making. Therefore, eliciting tacit knowledge potentially allows the simplification of the knowledge base without reducing power of the KIS.

The pilot study confirmed several contentions formulated in the reading contemplative strand of the research: similar problems afflict knowledge acquisition for the knowledge base and the use/interpretation of the system; the definition of 'knowledge' (for the purposes of knowledge acquisition) should be 'widened' to include the tacit aspect; the explication of tacit knowledge was technically feasible in that the potential benefits out weighted the effort required for its explication.

The pilot revealed much about the nature of tacit knowledge, its explication and its effect on the KIS, which was of use in the main fieldwork

19.2 Main Fieldwork

The main fieldwork produced four methods for the explication of tacit knowledge in a form suitable for knowledge elicitation. It is interesting to note that as different methods were 'discovered', the tacit knowledge they explicated threw light upon different issues of KIS design.

19.2.1 Method One

Method One, contended that domain tacit knowledge is reified in the working systems and in the rationality internal to these systems. Sensitive analysis using Giddens' theory of structuration can allow the tacit knowledge responsible for the construction and maintenance of these systems to be explicated. An understanding of tacit knowledge at this level has implications for the generalisability of a KIS.

Situations where divergence occurs were found useful for the academic investigation of tacit knowledge in that it highlighted areas where such knowledge might be found.

On a more practical note, divergence is important for knowledge acquisition especially for evaluating the generality of a KIS. The notion of divergence is useful for knowledge engineers in that it forces them to explicitly examine the question of generality, rather than, as in the case of the maternity units, simply assume generality exists and differences must be differences of style. This explicit examination of generality helps the engineer to avoid the two methodological 'traps': comparing organizations at a lower level than appropriate on the hierarchy of comprehensive entities and importing logic from one domain to judge a second domain. Either of which would illegitimately allow the assumption of generality to be assumed and remain unexamined.

The notion of divergence is of practical importance to two main groups of practitioners. Firstly, identifying the reason for divergence is important for knowledge engineers, in that it indicates the most appropriate site and method of knowledge elicitation. Secondly, for purchasers of software applications, the notion of divergence offers a tool by which they can judge the initial suitability of an application. For example, the purchasers at Area 2 should not assume that a system which works in Area 1 should be suitable for Area 2 (as is the case at present). They could use the notion of divergence and Method One to decide if the difference

between Area 1 and Area 2 is one of style or form and make their purchasing decision accordingly.

A erroneous decision at this level could be extremely costly to the hospital in question. A system such as GIT would have an initial cost of over £60,000 plus ongoing annual maintenance of approximately £40,000. In addition, various 'hidden' costs must be added, for example, staff training etc.

19.2.2   Method Two

The second method exploited the fact that more than one set of tacit knowledge can be present in one domain. Points where different sets of tacit knowledge interact to expose contradictions were used as a tool to explicate the tacit knowledge of the groups. An understanding of the tacit knowledge of an organization at this level will reveal how each group tacitly, rather than formally, delimit their domain. It will also indicate how groups tacitly prioritize the importance of the various aspects of the work. The collection and analysis of war stories were of particular importance in the establishment of 'criticality' of tasks within a domain.

This method was of particular importance to the knowledge acquisition of both embodied knowledge and knowledge required for the usage of the KIS. It is interesting to note that the doctors and midwives both delimit their domains and the criticality of tasks, tacitly, in a manner which is not in accord with the formal knowledge of the domains. Given the tacit definitions were explicated directly from the praxis of the midwives and doctors, the elicitation of such knowledge will provide a better 'fit' between the KIS and the working practices of the users. As noted in Chapter One the KIS should 'fit' the way the users work and not vice versa. Systems that can only be made to work by radically changing working practices are less likely to succeed. An objective investigation would have systematically eliminated the tacit definitions and produced a KIS, at best, of dubious 'fit'.

An understanding of how key groups tacitly classify the criticality of tasks is important to the usage of a KIS. The effort expended must match the importance of the task, if the system is to be valued by the user. Matching the criticality of the task with the effort the user is required to expend, will reduce the learning curve, reduce frustration, and enhance the criticality that is tacitly assigned to the KIS by the users.

Skills Required:

It must be noted that research of this type where rapport becomes a resource rather than a tool of the investigation requires certain qualities in the researcher.

1)   The data that is being sought is an element of rapport. Therefore, the researcher will require the social skills necessary for striking up rapport with the respondents.

2)   Rapport is an unusual form of data and its analysis requires particular skills from the researcher. Data of this type has a particularly ethereal quality and requires a sensitive and flexible analysis, rather like the famous piece of evidence elicited by Sherlock Holmes of the 'dog that didn't bark'.

Although this seems to add to the list of skills required by the knowledge engineer, rapport can be collected along side the more usual knowledge elicitation with respondents. In practice a great deal of rapport emerges at these times which can be collected for later analysis. Many of the war stories here were collected in none official meetings. For example, after conducting research in the morning the researcher would invite the respondents for lunch or for coffee. During times such as this 'war stories' were readily exchanged between the researcher and the respondents. This requires the researcher to be confident and open enough to reveal some war stories of his/her their own (i.e. it also requires that the researcher actually has some 'war stories' of their own).

Eliciting rapport is well worth collecting in that it often adds 'flesh to the bones of the objective facts' as the above shows. It is one thing to coldly elicit facts about puerperal pyrexia etc. However, the story of the *'dead baby'* gives the researcher a deeper understanding of a midwives work than a thousand cold facts. Such an understanding can be an uncomfortable but rewarding experience for the knowledge engineer and well worth the effort.

19.2.3   Method Three

Action research, using a 'mock up' interface revealed tacitly held domain knowledge with implications for micro level criticality. This is of particular importance to interface design. Method Three revealed that users were willing to expend much more effort to input data that they consider important to their core work, less on auxiliary work and the minimum on hindrances. Such classifications are often tacitly held and if explicated can greatly improve the usability of the interface.

This method can be useful for knowledge elicitation in that it allows the respondent to clarify elicited objective facts using deep domain knowledge unavailable to the knowledge engineer. It also allows the elicitation of tacit knowledge of the criticality of individual questions. Knowledge of this kind can strongly influence interface design.

Method Three appears similar to rapid proto-typing or preliminary testing of the interface, and indeed can takes place during these procedures. However, Method Three requires that the respondents possess the following characteristics:

1)   High Conscious Respondents: these are respondents who have acquired great experience and domain knowledge accrued over a long period of time. This gives the respondent the deep domain knowledge required to question and clarify the objective fields and legal inputs of the interface.

2)   Internal Locus of Control: for respondents to be useful using this method, they must attribute problems they encounter, when using the interface, to be the result of in adequate design. In order to fulfill this role the respondent will need to have and be actively encouraged to maintain an 'internal locus of control'.

3)   Rapport: for the respondent to have the confidence to point out anomalies in the interface requires, along with a deep domain knowledge and an internal locus of control, a degree of rapport to be established between the respondent and researcher.

Given suitable respondents, Method Three is a useful tool which, if employed during rapid proto-typing or preliminary testing of the KIS, requires little extra effort from the knowledge engineer.

19.2.4   Method Four

Method Four makes use of organizational cultural dislocation. This is a useful tool for knowledge engineers for two reasons: Firstly, items of the interface that appear unusual to an expert (due to their domain knowledge) might not appear unusual to the engineer; secondly, this is an expert opinion of the domain knowledge incorporated into the KIS, which allows extra mural tacit knowledge (i.e. non-domain tacit knowledge that is important to expert decision making) to be explicated.

Method Four also requires the identifying of high consciousness respondents with an internal locus of control and with whom a considerable amount of rapport had been built.

This method is very important in that it gives the knowledge engineer access to non-domain knowledge which has particular relevance to the decision making process of

the expert. It is this extra mural knowledge that often makes the difference between decisions made by newly qualified practitioner and experienced experts. The importance of the 'fear of litigation' for the midwives and doctors graphically illustrates the importance of extra mural tacit knowledge. It is important to realize that records can have a multitude of uses, which can affect the design of the interface. For example, 'fear of litigation' makes the fact that the baby had been given a name-tag less, important than who had given the baby a name-tag.

19.3 Contribution of the Four Methods for the Explication of Tacit Knowledge

The methods for the explication of tacit knowledge which were identified in the main fieldwork contributed to knowledge in the following manner:

1) Four methods suitable for the explication of tacit knowledge were identified.

2) The use of sociological methods and their philosophical underpinnings proved fruitful for the explication of tacit knowledge for IT.

3) The use of sociological methods for knowledge acquisition has been shown able to improve and clarify the understanding of tacit knowledge

4) New insights into the particular expert occupational culture (maternity provision) enabled the building of KIS interface with a greater degree of *'fit'* with the way the doctors and the midwives actually work.

5) The identification of knowledge acquisition (especially where it seeks to elicit tacit knowledge) as a method of sociological investigation.

19.4 General Lessons Learned

19.4.1   Preparation of the Researcher

Whilst discussing the findings reservations were raised that the methods were somewhat problematic, in that they depended for their success on the distinctive and somewhat idiosyncratic personality of the researcher. In hindsight, however, this was found not to be the case, in order to explain requires the drawing of a distinction between the *'discovery'* and the *use* of the methods. A case could be made that the methods were only 'discovered' because the researcher was able to form extremely friendly relationships with the respondents. For example, the importance of war stories only became apparent after a critical mass had accumulated, in order for this to happen a great deal of time was spent with the midwives swopping stories over cups of tea etc. It is not every researcher who would, want to spend time in this way, or be invited to spend time in this way. Therefore, the 'discovery' of Method Two to a great extent depended on the personality of the researcher.

However, once the Method Two had been 'discovered', with a little training that most knowledge engineers who wish to do so can use the method to a greater or less extent. All knowledge engineers are required to instigate some kind of rapport with the respondents, Method Two requires that this is 'written into' rather than 'written out' of the engineers findings. Even if the respondent is very hostile a great deal of information can be garnered from what the respondent 'doesn't say' rather in the manner of the 'dog that didn't bark'. Therefore, the methods are not dependant on the researcher possessing a particular personality.

19.4.2   Suitable Site for the Collection of Tacit Knowledge

It was noted that many of the 'expert' classifications were only made explicit where contradictions between an informed-layman's and the expert's view of the world occurred. However, such contradictions can only occur after a considerable amount of knowledge acquisition has taken place (the engineer must have amassed a considerable amount of knowledge to recognize an expert classification being contrary to common sense classification).

In order to reduce the domain knowledge the engineer needs to acquire before contradiction can occur, it was proposed that the research should take place in a complicated environment where different types of experts with different occupational mini cultures interact. At such a juncture, the different world views of the different types of expert would throw up anomalies, which would reveal tacitly held knowledge.

This contention was found to be correct, however, extreme care must be made to assess the internal politics of the organization. With hindsight the political situation in the health service is such that if alternative research sites are available they should be used. For example, during the field work for this thesis, access had been negotiated to a local maternity unit and a considerable amount of fieldwork undertaken. During this time one consultant took particular exception to some of the provisional findings of the research and behaved in such a vindictive manner it was found that further research would place the respondents in an extremely vulnerable position. Research at this hospital was, therefore, abandoned and access to other sources negotiated. It must be emphasized, however, that this time was not a complete loss. A great deal had been learned about the organizational culture of the NHS had been gained which proved invaluable when researching in the site of the main field work.

If alternative research sites are not available or suitable it is recommended that the following steps are followed when conducting research in a politically charged organization.

*   Champion

The research must have a 'champion' within the organization and preferably a 'champion group' in case the original champion is transferred during the fieldwork. Without powerful sponsorship the fieldwork is vulnerable and access to data collection can be arbitrarily terminated.

*   Access

The amount of and quality of access must be negotiated at the outset, spelling out time limits and obligations on both sides.

*   Anonymity of Respondents

Agreement must be made with the management that the respondents is respected **AT ALL TIMES** (see below, ethical issues).

*   Presentation of Reports

Agreement must be made with the management about the 'ownership' of the data. Restrictions placed on the resulting research should be negotiated at the before the fieldwork begins. If possible the presentation of preliminary or interim reports should be avoided at all cost. In politically charged situations such reports have the potential to be used by one group against another. If this happens the researcher is perceived to be partisan and good will may be withdrawn or the research may even be sabotaged by the 'aggrieved party'.

*   Negotiation of Access

The above all concern the negotiation of 'access', once these have been agreed the researcher is strongly advised to **'GET IT IN WRITING'**.

If any of the above steps are not possible research should not be undertaken.

19.4.3   Ethical Issues

Research of this kind, however, throws up several ethical issues of considerable concern. Using the above methods to investigate tacit knowledge puts the respondent at a great disadvantage. The respondents are unconsciously revealing knowledge which although useful to the building of KIS might be professionally imprudent. The example cited in Chapter Five by Argyris and Schon (1978), indicated that for various reasons several managers and marketeers failed to convey their true assessment of Product X to top management, at great cost to the company. It is not inconceivable that once aware of these facts top management might dismiss these individuals for failure to comply with the formal policies of the organizations.

In a similar manner great care must be taken when investigating health service staff, such is the paranoia that pervades the NHS, that staff can be accused of gross professional misconduct for the most innocuous comment. For this reason respondents must be protected at all times. This can be achieved to a certain extent by encoding all names. However, certain individuals due to their professional position or particular mannerisms will be identifiable. Under such cases great care must be exercised in order to disguise their identity, even at the cost of eliminating valuable information from the research.

19.5 Future Research Recommendations

This research has highlighted four methods for the explication of tacit knowledge. More importantly it has demonstrated how the elicitation of tacit knowledge not only enhances the elicited domain knowledge but offers the potential to: qualitatively improve the KIS by reducing the knowledge base without reducing the power of the KIS; provide a better 'fit' between the KIS and the actual (rather than theoretical) working practices of the users. It is therefore, recommended that future research is conducted in the following areas:

1)   Testing the Methods for the Explication of Tacit Knowledge

It must be noted that this investigation was undertaken as a probe, methods that explicated tacit knowledge in this particular domain by this particular researcher were 'discovered'. Therefore, before more general claims can be made for their value as tools of knowledge acquisition, they must be rigorously and systematically tested in other domains, by other researchers.

2)   Further Methods

If the findings of this research is confirmed by subsequent investigations, the philosophical base and methodologies used in this thesis could be used as a platform from which a greater understanding of tacit knowledge and further methods for its explication could be initiated.

3)   Implications of These and Further Methods

It was noted above that Churchman (1971) contends, epistemologies differ not only in how they investigate the world, but also what is considered information. Research into how such redefinitions of information affect both the information system and the

KIS is therefore, necessary.

4)   Power of 'Elicited Tacit Knowledge'

The fieldwork for the thesis and the work by the EMMY team indicate that an understanding of how experts tacitly classify their domain can qualitatively improve the KIS by reducing the knowledge base without reducing the power of the KIS. Research in order to gain a greater understanding of the way experts tacitly classify their domain is, therefore, warranted.

5)   Provision of a Better 'Fit'

Research into how a knowledge of tacit domain knowledge provides a better 'fit' between the KIS and the actual (rather than theoretical) working practices of the users.

19.6 Concluding Remarks

This investigation into the possibility of using sociological research methodologies for the elicitation of tacit knowledge for building Knowledge Intensive Systems allows the research question to be answered in the following manner,

> *This research using sociological methodologies has provided four methods whereby at least some tacit knowledge can be explicated for:*

> a)   *building the knowledge base, and*
> b)   *more accurately predicting or planing for its usage and for setting expectations.*

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GLOSSARY

Apgar Score

> A system to assess the condition of the newborn baby. The test assesses respiratory effort, heart rate, colour, muscle tone and reaction to nasal stimulation, at one minutes and five minutes after the birth.

Artificial Intelligence (AI)

> The attempt to re-create intelligence within a computer. AI is the attempt to design computers able to perform tasks which would require intelligence if performed by a human.

Criticality

> Refers the value the user puts upon a task. The more important the task the greater the criticality.

Decision Support Systems (DSS)

> A programme which uses complex inferential reasoning upon knowledge from a domain in such a way that it helps the user to make decisions.

Decision Tree

> A decision tree is used to describe concepts or the decision making process. Nodes are sometimes used to represent attributes and branches the values the attributes can take.

Declarative Language

> A computer language which expresses facts and relationships rather than procedures. Examples of declarative languages are PROLOG and LISP.

Due-date

> This refers to the estimated date of delivery. The day that the baby is expected to be born. This is usually taken to be 40 weeks, although birth 2

weeks before or 2 weeks after are considered 'normal'.

Estimated Date of Delivery (EDD)

see Due-date.

Expert Systems (ES)

A programme which uses complex inferential reasoning upon knowledge from a domain to carry out the tasks of a human expert.

Expert

A person with deep experiential knowledge of a domain.

Hawthorne Effect

The 'Hawthorne Effect' was first recognized by Elton Mayo during a series of experiments conducted at the Hawthorne Works of Western Electric Company in Chicago. This was a series of experiments in which elements of the environment were changed in order to ascertain the most productive environment for the workers. It was found that the most important element for increased productivity was the fact the workers were being observed. Hence the 'Hawthorne Effect' when a researcher observes a social situation the situation changes, therefore such research can never capture the 'true' situation.

Heuristic

A 'rule of thumb' used by experts to simplify the decision making process.

Knowledge Intensive Systems (KIS)

A computerized system which has encapsulated within it representations of knowledge of a domain.

Knowledge base

A collection of facts, relationships and rules that constitute the knowledge of a particular domain.

Knowledge Engineer

A researcher who elicits knowledge, and suggests a suitable model of the knowledge and its representation in the knowledge base.

Locus of Control

Individuals have an internal locus of control when they tend to believe that they make events happen; they have an external locus of control when they see events 'happening to them'.

New builds

A newly built property.

Referb

An existing property which has been completely refurbished. This usually entails removing everything from the inside of the house including floors and plaster (gutting) and replacing. The external surfaces of the house are also renovated.

Training Set

A set of examples produced by an expert and used in order to induce rules.

APPENDICES

0.1 APPENDIX I

TERMINATION SCAN

MW1A4:   I was 'acting up' the other day.

Researcher: What you are always 'acting up' with me.

MW1A4:   I'll act up in a minute, you know what I mean, my boss was off and
              I was standing in for her, for the week. Anyway I was working away
              and I walked out of the office. You know the one near to Mrs. S's
              just up the corridor. I walked out of the office and there was a woman
              breaking her heart on the stairs. I got hold of her but I couldn't get
              any sense out of her so I took her into the office and made her a cup
              of coffee. After a while she regained her composure a little and was
              able to talk.

              Eventually it all came out. It seems that she has had a hard life but
              got on with it and made the best of things. Anyway what had
              happened was that she had 3 kids and the youngest was 14. She had
              as soon as possible worked part time and in the last year she had been
              able to get a full time job and put a few quid bye. They had been able
              to go on holiday for the first time and things were just coming together
              for her. Any way you've guessed it she is pregnant and after much
              soul searching she had decided to have an abortion.

Researcher: Isn't that just the way as soon as you take one step forward life slaps
              you back again.

MW1A4:   Yes, you know that this woman was in a terrible position, she had
              done her best and now was faced with an unwanted pregnancy. By the
              time that this child was off her hands she would have been close to 60.
              No chance of a respite or an easy period to her life before the poverty
              of old age.

*   The Sister is giving the background to the woman's story, it is noticeable that
             the factors she has chosen as relevant are non-medical.*

Researcher: How did she feel about having an abortion?

*   Another non-medical question.*

MW1A4:   That's just it she loved kids and would if circumstances would allow
              would have loved another but it simply wasn't on.

* Another none-medical observation.

Researcher: Why was she so upset if she had made up her mind.

MW1A4:   That's just it she had to make the worst decision in her life and her doctor had agreed with her and referred her to Mr. P the consultant. That's the procedure. Anyway she had been given an appointment and when she arrived the appointment was in the middle of the ante-natal clinic.

Researcher: I don't believe it not the ante natal clinic.

MW1A4:   Can you imagine having made the worst decision of your life to terminate a pregnancy and then be told to wait in a room full of pregnant women, all full of themselves looking forward to their happy events and there's you sat there not wanting to talk to any one in case they ask you about your pregnancy.

* The Sister and the Researcher can not believe the insensitivity of this action. Presumably it was not a consideration of the doctors.

Researcher: God how insensitive can you get.

MW1A4:   That's nothing they used to make the women coming in for infertility treatment wait in the ante-natal waiting room with all the mums to be. Just think how they felt, they must have felt like real failures with all those fecund wombs pushed in their faces.

*   *This indicates that it is not simply the actions of a particularly insensitive consultant but 'standard practice'.*

        But this gets worse.

Researcher: How could it.

MW1A4:   Well she had held herself together and waited and waited in the ante natal waiting room. Finally she got in to see Mr P. and he had been brusque with her and agreed to do the termination then at the end of the session casually said,

        'Oh please go for a scan on your way out'.

        She walked out of the room shell shocked. On the way down the stairs she just collapsed in tears. She just couldn't take the scan, how could she abort a baby once she had seen it move inside her womb.

It was just too much to ask a woman to do. But she couldn't see how she could go on and have the child she was in a total quandary she just didn't know what to do. This woman was at her wits ends I gave her as much counselling as I could, I tried to convince her that she was not a wicked woman and in my opinion she should go ahead with the termination. I don't know these doctors are so totally insensitive.

*   *The doctor simply sent the woman for a test, like any other test. He was totally insensitive of the importance that the ultra scan has for any pregnant woman. They love to see their baby by ultra scan. They see the fetus and from then on it is a baby. The heart breaking decision to abort a fetus is one thing but killing a your baby is quite another.*

Researcher: Perhaps that was just the point, perhaps he deliberately made it so difficult to make the woman reassess the situation before taking such a final step.

*   *The Researcher is trying to find a good reason for such crass behavior.*

MW1A4:   Rubbish if that was his reason then OK I might not agree with him but I could understand it. But he's not anti abortion he's must have done thousands over the years. Any way if he was, the G.P.s in the area would know and they wouldn't refer terminations to him.

Researcher: Then why did he send her for a scan is it for some medical reason.

MW1A4:   Not really, well not one that I consider to be a medically valid reason. He did it just to confirm how many weeks pregnant the woman was.

*   *Not a reason that 'she' considered medical.*

Researcher: Why.

MW1A4:   Well he wanted to organize his theater rota. The longer the pregnancy has been going on the longer it takes in theatre.

Researcher: What do you mean that a few weeks either way can make a big difference to the time it takes.

MW1A4:   Well sort of, after about 20 weeks the operation is more tricky.

Researcher: Yes but I remember you telling me about a woman that you was examining felt a bit small for the number of weeks pregnant.

*   *The Researcher is discounting the Sisters explanation. If the Consultant can tell the age of the fetus from an external examination why didn't he conduct one?*

MW1A4:   You can tell give or take, you can tell by experience and they have come up with a new idea you measure the distance from the pubis bone to the belly button and the distance in centimeters is the number of weeks pregnant. You know me I hate stuff like that but I have been surprised at how accurate it is.

* This is an interesting point and one that would fit well into a KIS. It is a case of transferring knowledge from what Collins refers to as cultural skills to a r..e

Researcher: What for all women size doesn't count.

MW1A4:   Of course not if the woman is small you deduct a bit and if she is large you add a bit.

*   *Unfortunately it is more complex and further information is required.*

Researcher: How do you know.

Both together: Well you just know that's all [Laughter].

Researcher: So it helps but in the end it's down to experience.

MW1A4:   Yes I suppose so, it acts as a good check and so it is useful.

*   *The Sister obviously sees it as a good heuristic if not a hard and fast rule.*

Researcher: To get back to sizing the fetus though. Can't you tell by feeling if the baby is either side of the 20 week barrier.

MW1A4:   Course I can and he can to, the point is for some reason he wants to know the exact number of weeks the woman is pregnant and then he organizes the theatre accordingly.

Researcher: But surly he must realize what he is putting those women through for nothing, doesn't anybody tell him.

MW1A4:   Are you joking he would only pull rank and claim that it was up to him to decide what tests to do on his patients and he would throw a paddy and make your life hell for ages. This seems cowardly, but we are just not confident in our professional practice to stand up in the

face of a Consultant.

* *The Sister admits even in non-medical areas, where midwives have superior knowledge, the Consultant is in such a position that they dare not even offer suggestions in private that could have dramatic effects on the lives of the pregnant women.*

Researcher: I'm not suggesting that you second guess the Consultants every move or that you confront his clinical judgement, but more on the lines of a quiet word in his ear.

MW1A4: They would take even that as an affront.

* *Suggestions are taken by doctors as personal attacks upon their professional practice.*

To be honest even if I told him he would not understand the pain he put that woman through. He would probably say it is for her own safety and surly being a bit upset is a small price to pay in such a case.

* *The medical considerations are seen by doctors to outweigh every other consideration. Even in this extreme case where in order to ensure against a minute risk to the woman's physical body he is certain to cause tremendous psychological damage.*

* *Doctors are interested in human bodies not human beings. Psychological considerations are not addressed.*

The point is there is no such thing as a good abortion, every one is taken not as the best option but as the least worst. Many women would in other circumstances love another child but they are not in a position to and are forced to have an abortion. Some of these women never get over the guilt especially when, in later life they become better off. The guilt stays with them for life. Any thing that increases the guilt should be avoided at all costs. The doctors seem to see the abortion as a solution to a problem and the solution of the problem marks the end of the doctors involvement. As far as they are concerned it is a job well done.

* *From the doctors point of view the woman has an 'unwanted pregnancy' therefore they will solve her problems and give her an abortion in as safe a way as possible. The Sister is pointing out that after the abortion has taken place the doctor never sees the woman again and what happens to her later*

is not his/her concern.

Researcher: What happened to the woman.

MW1A4: I don't know I got her together and tried to support her in a difficult decision and eventually she composed herself and went away.

Researcher: Do you think that she went ahead with the abortion.

MW1A4: Not a chance.

Researcher: How do you know.

MW1A4: I don't but she was a really nice woman and under the same circumstances I couldn't have gone ahead. She probably went home and told her husband, condemned the family to poverty and got on with it. What a life, the poor woman done her best and a lifetime of living hand to mouth to look forward to. It made me sick.

0.2   APPENDIX II

The tacit definition of the core work of the midwife is shared by both midwives and the mums

It is interesting to note that the midwifes' definition coincides with the public's opinion of core areas, for example when a community midwife was taking a domino (mother) into hospital to deliver her baby, the midwife was asked who would actually be delivering the child when the midwife reassuringly replied that she was the mum said that she didn't mean to be cheeky but was she (the midwife) up to it.

0.3 APPENDIX III

ANTE NATAL TESTING FOR DOWNS SYNDROME

I was talking to MW2A2 today 4/3/93, and she was telling me that she was interested in conducting research into the psychological effect that testing for Down's Syndrome was having on mothers to be. At Area 1 testing is given to all mothers to be. The Sister was particularly concerned in the high number of **false positive** results that were occurring.

MW2A2:   For a start they don't get proper counselling, you know they are just asked if they want the test and they all say 'well yes' and then they are tested.

* The Sister sees counselling as an important process which is being neglected.

They are never sat down and told the ramifications of the test. For example they are never asked if the test proves positive are you willing to abort the baby etc. Any way what happens is a large number of the tests are inconclusive and the women are simply called up on the phone at work and asked to come in for re-testing because there is something not right with their test. Can you imagine getting a phone call out of the blue like that.

* The use of the telephone as a way of recalling women for a re-test is seen as acceptable by the powers at be at the hospital. It is seen as totally inappropriate by the Sister.

Researcher: What just like that out of the blue, I'll bet they are asked if they can come in for testing next week or longer.

MW2A2:   Yes and they have all that time to worry about it. It would be better if they were made an appointment and when the attended told and were retested there and then.

* The Sister considers the anxiety level of the mother to be extremely important.

Any way what follows is 2 very detailed scans on separate occasions followed by a amnio centesis test if necessary. But this is the worst part every one of them, they all say no matter what the test says they never believe that the child will be OK until after it is born. Can you imagine the whole pregnancy would be taken up by that worry. I am interested on the psychological effect that this worry has on the women. I mean given the large number of false positive tests I am

really doubtful whether they are necessary at all. Its all politics, Area 1 was over the moon about developing the test that they could sell to other authorities but I just don't know. I mean they don't do it at Area 2, Area 3 or Area 4 (local maternity units) for all cases.

* The Sister is concerned that the anxiety that false positives cause might outweigh any benefits that the test might offer.

Researcher: Just Area 1

MW2A2:   Yes, but nobodies done any work on it. I mean the cut off point for example at Area 1 we use 200 at Central they use 250 I mean depending on where you live whether you or called back or not differs.

Researcher: What do you mean 200.

MW2A2:   Well suppose your Stella [the researcher's 18 year old daughter] got pregnant then you could expect the chance of her having a Downs baby is 1 in 2300 but for a woman like myself in my early 40s the odds are about 1 in 30. The point is that it is only women regardless of their age that show a 1 in 200 ratio that are recalled. So if your Stella had a count of say 201 she would not be recalled in Area 1, but she would at Central.

* Some really useful 'hard' data.

Researcher: Yes but that's crazy, if a young woman's count showed such a dramatic fall surly she is worthy of a recall.

MW2A2:   That's just my point, if a woman with an expected count of say 500 dropped to say 230 I would not be too concerned, but for a young girl to show 230 I would be very concerned. I mean its so arbitrary.

* This is uncovering more subtle ideas that could improve the way that the test data is analyzed.

There's another thing, in our journal I was just reading that the cost to an area of testing is about £40,000 per year. However, the article went on to say that it was cost effective because if it prevented one Downs baby being born the through costs to the authority of the child over time would be greater than the £40,000. Never mind the morality of it all,

* The Sister considers that it is outrageous not to consider such moral questions.

> whether you think that Downs children might have the right to live etc, leaving all that to one side the article went on to say that if, however, one Downs child is slips through the whole purpose of the test is useless in Financial terms.

* A test (according to this paper) is deemed successful if the amount of money saved by using the test is greater than the cost of administering the test.

Researcher: Well.

MW2A2:   Look at the number that slipped through this year.

Researcher: How many.

MW2A2:   Four.

Researcher: What slipped through, were they by younger women with above a 200 count.

* The researcher has made an educated guess at the population of mothers with undetected 'Downs' babies, based upon his less crude analysis of the counts. NB. This guess is based upon his common-sense understanding of statistics alone without medical knowledge.

MW2A2:   Precisely, everyone was a young mother, they were all complete surprises, its a tragedy.

Researcher: What despite the test four young low risk mothers had Down's Syndrome babies. I can't believe that the stats could be used so crudely. I mean surly if Stella had a predicted odds of 2300 and achieved a score of say 1000 doesn't that indicate that something might be amiss.

MW2A2:   I just don't know, I mean common sense would tell you that she deserved another look but to tell you the truth I don't think that anybody knows. That's my point they seem to use the 200 score as a bench mark. Anything above this is deemed safe and any score below it warrants a retest. Although the test expects that the odds will differ in direct relationship with the mothers age, this criteria is not taken into account when the test is evaluated.

* Some thinking a loud, which would be useful for any software that attempted to

analyze data from the 'triple test'. What is revealing is the fact that the test is being used extensively without its results being analyzed. This is only surprising if you think that the way the woman might feel is an important consideration. For example the test is unobtrusive and causes no risk to the mother or fetus. Therefore test all mothers and if some have a week of anxiety while the test is confirmed it is a small price to pay for the early diagnosis of a 'Downs' fetus.

Researcher: Surly, they could write some type of protocol that is flexible enough to take the woman's estimated and actual score into account as well as the cut off score of 200.

MW2A2: It is not that it couldn't be done the fact is it hasn't.

* The doctors consider that the test is very successful and therefore it doesn't require any research to be performed. The Sister has picked on the article in order to attack the test. She knows that any arguments about the way the women feel will be held as trivial by the doctors compared to the goal of early detection of Down's Syndrome. This article allows her to claim the test a failing by its own criteria. She is in fact joining with a third group the managers in order to confront the power of the doctors clinical practice.

Researcher: But surly the criteria could read something like if the actual score is less than 50% of the estimated score or less than 200 then a re-test is required.

MW2A2: Why 50% why not 40% we just don't have the figures.

Researcher: I know I just used that as an example, I wasn't suggesting using 50% arbitrarily, it would be easy to correlate the figures from around the area to give some indication.

MW2A2: But it hasn't as far as they are concerned they have a test that is cheap and can predict Downs more accurately, so they are happy. They have developed a test which they can sell to other hospitals. I have already told you at Central they retest at 250 that is a 25% increase on the Area 1 retest score. If they can't even agree on that, what chance is there of them agreeing on the more sophisticated analysis that you are advocating.

* The Sister indicates that the doctors have considerable autonomy in each Hospital, often with a degree of competition.

Researcher: Don't you think that it would be a worthwhile project.

MW2A2:   Yes, of course it is, but what I don't like is all this testing without
            enough thought going into the implications of the test. Its awful to be
            so cynical but you know that we can be sued for up to 18 years after
            the birth of a baby for negligence. Where will we stand in the case of
            these 4 young mums, we have really let them down badly. We ask
            them if they want to be tested to make sure that their baby hasn't got
            Downs and low and behold their baby comes out a Downs baby. I
            can't help wondering where we would stand if they took us to court
            for compensation. For that matter what would happen if one of our
            mums with a score of 220 had a Downs baby, if she had been under
            Central criteria she would have been retested, what is our defense of
            the 200 score as an acceptable risk, by what criteria did we chose 200
            and why was the same criteria not acceptable to the staff at Central
            which is a centre of excellence for obstetrics. It's just a mine field.

* The Sister brings up the specter of litigation for malpractice.

Researcher: Its awful really though, you (at Area 1) come up with a cheap test and
            straight away you are up to your necks in trouble.

MW2A2:   That's just the point, it's not just a test, it is a procedure that is carried
            out on individual women, which could have dramatic consequences for
            the rest of their lives. It is not just a case of estimating the worth of
            the test by statistically calculating the results. It has negative costs that
            are not brought into the equation.

** The Sister's interest in the women as individuals rather than medical cases to be
solved, results in her regions of interest being much wider than the doctors.*

            Look at the protocol that you mentioned before, this will tend to cause
            more women to be retested. But it would be hard to find a mum who
            would not rather be safe than sorry, so if in doubt retest.

Researcher: Yes, what's wrong with that, it must be better to pick up on the
            Downs that are slipping through.

MW2A2:   See you are falling into that way of thinking. What you say is true
            and hard to argue with. The test will help pick up on Downs babies
            that might slip through. It must be worth a few false positives if our
            practice can be improved. What's the problem, we can point out the
            numbers of Downs that this test has picked out, now you tell us why
            we shouldn't use the test.

* The Sister outlines the doctors argument which she feels is inherently wrong but it

is difficult to argue against using their criteria.

Researcher: Well what's the problem?

MW2A2:   The problem is that what we are talking about is mothers to be, not numbers or statistics. Women like Mrs Chew, and her husband have that Chinese chippie on North Street. She is in her late 30's and has got two kids already and her test showed positive. She is one of my mums (one of the mothers-to-be that MW2A2 is giving ante natal care), I knew that she didn't speak English very well, so I went round to explain to her what would happen. When I went I was immediately offered a meal, you know how polite they are. I sat her down and explained that the test showed that she was under 200 and that she would have to be retested, you should have seen the look on her face.

* This is the real reason that the Sister is against the way that the tests are carried out, she sees the effect that the test has on individual women that she has to deal with.

Researcher: But don't they usually just phone?

MW2A2:   Yes, and they don't know the woman and don't see their faces. They just assure the women that the positive result does not mean she will have a Downs baby and that's why the mum needs to come in to have further tests.

Researcher: Why did you go round then?

MW2A2:   Well I had delivered her other two children, I knew her, her English is quite poor but more importantly she is very isolated. Just her and her husband, I don't know where the rest of her family is, but like many Chinese they open their business in areas where there are no other Chinese chippies which means no Chinese.

* The Sister knew the woman as an individual and therefore had knowledge of her particular circumstances.

Researcher: Is that why you wanted to see her, to be another woman for her to talk it over with.

MW2A2:   Yes I thought she would need an other woman to discuss it with. That's the point you should have seen her face, she was so hurt by the news. She had to go through a series of scans and have amniotic fluid tested. Can you imagine what that woman would have gone through

during the two weeks before her tests came through. You know the anguish that she felt just never gets considered when the test is evaluated. Can you imagine all that pain for nothing in the case of a false positive.

* Here the Sister is noting that because the pain is psychological and not physical it is not considered by doctor. To be more accurate it is considered but allocated a low priority.

Researcher: Yes but if it is a 'true positive' then the fetus can be aborted early but if the test proves a false positive the woman would be so thankful that everything is alright that she forgets all about the worrying two weeks. It is a painful necessary period.

MW2A2:   But I've asked many of these women and they all say that they never have confidence in the false positive result. None of them believe it until after the baby is born and they can see for themselves.

Researcher: That's understandable, I mean would you, you would always have that nagging doubt at the back of your mind.

Its easy to understand how the doctors can get a narrow view of the test. If it is a 'true positive' then it is justified if it is a 'false positive' then the woman is a low risk mother again and the doctor will hand their care over to the midwife. The doctor will not be aware of the woman's feelings in the rest of the pregnancy.

MW2A2:   Yes, but is it [the test] justifiable. Basically the false positive is ruining the whole pregnancy for all these women. Instead of a beautiful experience we are needlessly transforming it into a nightmare of worry for hundreds of women. That's what I want to research, just what lasting effect these false positives are having on the mothers and how they bond with the child later.

Researcher: Lets just get this right, I'll play Devil's Advocate, just to be contentious.

MW2A2:   Your favorite stance

Researcher: Well you know me, anyway I think that the test is a good idea, every woman should be given it, it can give a more accurate early indication of Down's Syndrome. Therefore, these babies can be aborted much earlier in the pregnancy causing the mother less stress. The test is non invasive (blood has to be taken whether the test is performed or not)

and cost effective to the community in that it prevents the long term cost of looking after a Downs baby. Yes some women have a stressful fortnight due to the incidence of false positives but this is a small price to pay for the early detection of Down's Syndrome.

MW2A2:   You are a hard faced Devil, right number 1) It is not cost effective, four slipped through in Area 1 alone.

2) Why do the test if the woman is not going to have an abortion for one reason or another. You are simply assuming that a Downs child is a tragedy and therefore best aborted as soon as possible. Many people think that all life is special and they wouldn't have an abortion no matter what. It is therefore completely redundant to test these women.

3) The test is too widely administered, if it is unsuccessful in picking up low risk mothers, like the four that slipped through then why do it on this group.

4) Amnio centesis increases the risk of spontaneous abortion (miscarriage) by performing it on false positive mums we are increasing the chances of them miscarrying normal babies

5) It opens us up to future litigation.

6) Give me a minute and I'll think of a few more. What really gets to me is the gut feeling that we have to oppose the test using their [those for the test] type of arguments. Even by its own terms I think that the test is a waste of time but my real reason is the fact that we are interfering with a normal process and making it a problem.

* For the Sister pregnancy is not a medical problem looking for a solution but a natural, normal if altered state.

How do we know that the Downs babies we detect early would not have naturally aborted thus falsely inflating the number of Downs babies the test has prevented. How do we square putting perfectly normal false positives at increased risk etc. But my main argument is not even taken into consideration, the pain that we needlessly put the false positive mothers through is simply not seen as important. The mothers feelings are simply not considered. As if the right to enjoy the experience a peaceful pregnancy is somehow a dispensable luxury.

* Arguments like this have no place in medical books, but clearly as a woman and a

midwife they are very important to the Sister.

Researcher: It's funny you mention enjoying pregnancy, I talk to many women and its surprising to me how many describe just how much they enjoyed being pregnant, as if it is a surprising fact. You know as if they were expecting a grueling experience and in fact really enjoyed it.

MW2A2:   Well its lovely, you are the centre of things and for the first time in your life you feel that you are doing something really important. But it's not only that but you really feel great inside it's a real high some how. Nature takes over and you feel great.

Researcher: That's true they seem to get a bloom, like the cat that got the cream, you know smiling to themselves like they have a secret.

MW2A2:   Yes, but it's natural, being pregnant is a natural life event for women, and tests like this is making this special time, a nightmare and for no good reason.

* *Reiteration of the pregnancy is natural not pathological.*

ANALYSIS

1)   This is a graphic illustration of the two models of childbirth in action the 'medical model' and the 'holistic model'. The two are in fact idea systems held by different health care workers. This means that each has a different rationality that makes it problematic for the two idea systems to confront each other. Criteria deemed vital in one system (e.g. the enjoyment of pregnancy) is deemed irrelevant in another.

What counts as a worthwhile test can not be properly addressed.

1)   The war between the doctors and midwives for professional control of the normal birth process is highlighted.

2)   The problem of litigation once again crops up.

3)   The importance of knowing the individual mum (Mrs. Chew) is highlighted as opposed to 'blanket care'.

5)   The importance to Sister of social backup is shown.

6)   The thought that anybody would sooner have a Downs baby than an abortion

is held to be irrational and therefore not consciously addressed.

Post Scrip

I was just listening with half an ear to Woman's Hour and a piece came on about ante natal testing Thursday 26 September 1993. Unfortunately I missed the names of the interviewees. They were talking about the above test. The woman went on to say that it is a 'screening' and not a 'diagnostic' test. [I wonder just how many pregnant women understand the distinction] Therefore when a woman is pronounced positive she has been screened positive and not diagnosed positive, she has less than a 1 in 200 chance of carrying a Downs child. Further tests are required to diagnose a handicapped fetus. The interviewer says that these tests are invasive and therefore carry a risk of miscarriage. Yes the doctor said only 1 in 20 women who are screened positive actually are diagnosed as carrying a Downs Baby. She like MW2A2 was anxious about the pain that the other 19 women are put through, but unlike MW2A2 she didn't address the post diagnosis period as a problem. She was very sensitive (but that's what you would expect on Woman's Hour) but as a doctor after the invasive test is proved negative the woman is classified as a non problem mum and therefore handed over to the midwives. MW2A2, however, has to deal with these women and therefore is more sensitive to their concerns.

The man interjected and said that in the *best* hospitals the chance of miscarriage after amnio centesis there is a 1 in 100 chance of miscarriage (his tone seemed to indicate that the chances of miscarriage could be considerably higher in less than the best hospitals). He said that we should be very wary about testing a woman using a test that has a 1 in 100 chance of miscarriage in order to confirm a screen that has 1 in 250 chance of being positive. N.B. He uses the screen 1 in 250 and the woman doctor uses 1 in 200.

0.4 APPENDIX IV

THE DEAD BABY

* N.B. The criteria that the midwife assess the woman i.e. Asian, fat and old (in relation to giving birth). Anyone of these factors could indicate a 'high risk' mum, the combination confirms the fact. The explanation for these risk factors is given below.

The baby had not moved.

* A key experiential heuristic.

Researcher: How bad ?

MW1A2:   The worst, you know alarm bells time.

* An emergency indicator.

* Another risk factor i.e. the baby was too large for the woman to deliver.

Researcher: Surly she would have had children by that age.

* The Researcher is indicating that this shouldn't be a factor. Prima Gravida is seen as a risk factor. If she has given birth in the past she should be physically capable (her pelvis should be large enough) now.

MW1A2:   That's the way it should be small frames and small babies match no
              problem.

* A good diet here is seen as problematic to Bangla Deshie women giving birth.

              The baby was dead.

* In the case of Asians the mothers weight might not be as significant as their pelvis size.

              After about two hours I said that we should phone for the consultant.
              The other midwife said that there was no way that she was going to
              wake up the consultant for a dead baby.

* This seems strange to the layman, if the delivery is 'normal' the midwives assist. If the delivery is in any way abnormal a doctor is called for advice and if necessary

to deliver the baby. The midwives carried on assisting the woman in labour, the fact that the baby was dead didn't seem to make the birth 'abnormal' to them. After two hours and the woman was still not progressing the delivery had become 'abnormal' to them. One suggested getting a doctor, the other refused because the baby was dead. The fact that the baby was dead made calling the doctor seem redundant in that he could no longer save the child.

0.5   APPENDIX V

IT DOESN'T MATTER IF THEY LIE.

This conversation took place on with a community midwife MW1A3, it was interesting in itself but with towards the end underlying assumptions may be drawn out concerning the world view of the midwife and the problem of litigation.

MW1A3:   How are you getting on making the world safe for mankind with those computers.

Researcher: Don't wind me up you know what I think about them.

MW1A3:   But you must like them to work with them.

Researcher: That doesn't mean that I think that they are all *powerful, you know* that I am very aware about their limitations, but the right system put to an appropriate task can be very useful.

MW1A3:   Let me know when you see one because that thing at Area 1 is a complete waste of time.

Researcher: You know that I think that it is crap but what's happened this time.

MW1A3:   Well, this girl came into the surgery the other day and I don't know something about her wasn't right, you know I couldn't put my finger on it but you know the feeling. Any way I asked the G.P. about her and he said that she is from a bad lot you know the mothers a prostitute the whole thing.

* Experiential knowledge, the Sister has interviewed the girl but is not satisfied with her story. She checks out the girl with the G.P. and he points out she is from a bad lot. Although this has nothing to do with the medical condition of the woman it is seem as significant to the midwife.

He said that she already had a child but she never brings him to surgery he didn't know why. That was it I thought I'll find out a little more about her.

Researcher: What the alarm bells were ringing.

MW1A3:   Yes, anyway I went around to her house and it was one of those tiny maisonette type things in an awful place. You know those types they don't even have a window on to the walk way just a front door. The

glass had been broken and a rough piece of wood had been nailed up, you know the type and it was full of graffiti. I was worried because these flats are very poor you know, just two rooms a kitchen and a living room which acts as a bedroom as well. Hardly a fit place to bring up a child let alone bring a new baby back to. God knows what it would be like on the inside if that was the outside.

* The Sister uses her background knowledge of the area and indicates that she doesn't think that the place would be fit to bring up a baby. This is another risk factor to add to the multiple risk factors that the midwife had already attributed to the woman.

I was determined to see inside and I kept going back and hammering on the door and leaving notes with times that I would be coming back and to wait in. Any way I went back eight times can you imagine eight times, no luck.

* The number of repeat visits indicates the importance that the midwife attributes to seeing the woman's home. Every time she didn't get in to see the woman made her more and more suspicious.

Then I was driving through town on Saturday on duty and I spotted her strolling along with her boyfriend so I 'bibbed' and she put her hands up and said 'shit' I said never mind that get back home I want to see you. She said OK, but she had to go to the shop for fags first.

* This is an interesting exchange, it is difficult to imagine the Sister ordering a middle class person around like this. What is more interesting is the fact that the mum obeys the order. Plus she makes no attempt to hide the fact that she is smoking, it is considered by her 'natural' that she smokes.

Any way she opened the door and it was like a little palace inside absolutely spotless and beautifully done out. She said that she didn't like the idea of a bed in the living room and so he had rigged a partition up in the kitchen and the both of them slept on a single bed behind it.

* The Sister has had a stereo type pleasantly exploded.

Researcher: So they had made the best of it.

MW1A3:   Oh yes I was really impressed it was lovely. Anyway I tried to get her story out of her, they always open up when they are in their own homes, they are on their own turf and feel more confident.

* Key experiential knowledge, people tell you more in their own homes.

Researcher: Yes I suppose if you can see how they live there's no point in lying.

* The Researcher is presuming that people might lie in the surgery about their lifestyle but in their home their is no point in lying.

MW1A3:   Precisely, anyway they always talk to me better at home rather than in the surgery that's why I wanted to see her at home.

* While the above is correct the Sister indicates that the relationship is different in the woman's home and therefore enhances the interaction.

> Then it all came out she was a heroine addict but on the methadone treatment which was gradually being reduced. She was on tamazapan, she smoked heavily, and she drank eight cans of strong larger every night. Oh aye she was up on shoplifting charges, to pay for the habits I suppose. She said that was all over now because of him. She was coming off heroine and having the baby because of this new relationship.

* These are extremely high risk factors that might damage the fetus, however, the Sister sees all these surmountable because the mums relationship with her partner is supportive.

> The other child was not with her, she had not seen him since he was 6 weeks old, he was with the boy's family and would be about 8.

Researcher: So the lads family took responsibility.

MW1A3:   Yeah I asked her if she wanted some help in order to see the child and she said that she was very young when she had him 15, and she didn't know him and he didn't know her so it would be better to leave things how they were.

* Here the midwife is offering to help the woman that has nothing what so ever to do with her pregnancy.

Researcher: I suppose you couldn't argue with that really.

MW1A3:   No, anyway she said we don't have to have a social worker involved do we and I said that if she didn't mess me around missing appointment and things then no. But if she didn't keep up her side of it yes.

* The girl indicates that a social worker is a threat and the midwife uses the threat to get the girl to do what she (the midwife) wants.

Researcher: Seems fair enough she seemed to be making a go of what life had dealt her.

MW1A3:   Yes but you have got to keep your eye on them. But the point that I'm trying to make to you is I went to the hospital and got out the notes that they had taken on the computer, and I couldn't have believed it, you would have thought it was Princess Anne's notes:-

         Have you ever had a venereal disease...No.......She has.
         Do you take drugs..............Yes, aspirin.
         Do you drink alcohol..........Yes
         How much......................2 units per week
         It didn't even ask about the shoplifting, it simply is not seen as a relevant question.

* The fact that the girl is a shoplifter is not relevant to her pregnancy but clearly it is to the midwife. It is a key indicator of the type of mother that the girl would make.

         The whole thing was a tissue of lies from beginning to end. I read on and there it was 'previous pregnancies' yes a boy weighing 5lb odd it was simply assumed that the baby was with the mother.

* The midwife is pointing out that if a woman has already given birth then she is an experienced mother and low risk. It is assumed that because she has successfully raised her first child she will have no problems with the second. Clearly in this case the assumption was faulty.

Researcher: And that she would therefore be and experienced mother.

MW1A3:   Yes we would assume that she would be reading the notes.

Researcher: A perfect candidate for a 'domino' in fact.

* The Researcher is making an ironic point, the domino scheme is now being implemented in various parts of the country. This option is at present only available to pregnant women who are considered at 'very low risk' and has been criticized as being to selective. Many women who would like a 'domino' birth are denied one because they are considered at too high a risk.

MW1A3:   Yes just the job on her second child a low risk mother with no problems yes from these notes she would get a domino, why not. This

is what I mean, they had asked her 200 questions and received a worthless pile of paper, I had spent a few minutes with her and I knew there was something more to this girl.

* *This indicates that the interview can not be reduced to a check list of questions. The input from the questioner is of vital importance.*

It's that damned computer it's stealing our skills I picked it up and what's more those girls from Area 1 (the midwives who have to take ante- natal histories using an computerized system) would have too.

They are too busy asking questions that they are not watching and listening to what they are told. You know here's a girl unemployed with £50 trainers on makes you want to try to find out where she gets the money.

* *The clothes that the women are wearing are an indicator to this midwife. Not are they expensive or cheap, clean or dirty but are they appropriate for a girl of her means. If not what is she doing to afford them?*

That's what gets me they keep telling us the computer is there to cut down the risk of litigation. When the computer was introduced it was brought in as a check, the difficult procedure that we all had to go through in learning the damned thing was all worth while because it improved the ante-natal history taking process, in order that we would make fewer mistakes and therefore be less open to litigation. The system was to be an exhaustive set of questions by which to assess the mum, if we were to ask all these questions then we would ensure a good assessment, unlike the hit or miss affair that of the manual system. But how can it do that if the mums just lie and the midwives do not have the skills, time or leeway to spot it.

This is a prime example here we have an extremely high risk mother, a multiple drug addict, heavy smoker, heavy drinker, easily gave up the first child, with criminal past and judging by the inside of the flat a criminal present. But based on these notes she would be treated as a straight forward low risk mother. Such a wrong assessment is likely to prescribe an inappropriate care plan for the mother and therefore more chance of something going wrong. This could therefore open us up to more not less litigation. Why didn't they just leave us to get on with our job and build on our experience.

Researcher: But don't you see that what you say only makes sense from the stand

point of your assumptions. You say that the system makes no sense in respect to litigation. But it is a great defense. Can you imagine if for instance this woman has a handicapped child and later tries to sue you. The first thing that they would do is look at the records and say

'This woman has told us a pack of lies therefore if things went wrong it is not our fault'.

MW1A3 sits there almost speechless at the logic of what I have just said. She has a look of complete disbelief on her face.

MW1A3:   But what's the point, why are we doing it, that's just stupid.

Researcher: No MW1A3 it's not, but from you point of view it is. You are talking about litigation and how to avoid it. Although it is an important consideration it is not central to your thinking.

MW1A3:   Go on you've lost me there.

Researcher: Well when I said that for litigation it is a good defense, you know 'if she hadn't lied we would have got it right therefore it is her fault that something went wrong'.

MW1A3:   Yes but you can't do that.

Researcher: Yes you can but what's the point.

MW1A3:   Precisely, because more mistakes will happen.

Researcher: That's not the point, as far as litigation is concerned it's who to blame. For you the answer to reducing litigation is to reduce the amount of mistakes that are made. This fits in with your 'raison d'etre' the whole point of your being a midwife i.e. risk reduction during pregnancy.

MW1A3:   What's wrong with that?

Researcher: Nothing is wrong with it, in fact that is why I like working with midwives their whole ethos is caring for the person as a whole. You know that the woman is 'your mum' and you do the best you can for her and that is why what I just said surprised you so much.

MW1A3:   It was the fact that it was so stupid, but it sounded so plausible and I can just imagine somebody coming up with it.

Researcher: That's what I mean it turns your ethos on its head. Instead of being an advocate for your mum, the mum becomes a potential enemy. This transforms records to evidence against the mum, 'your mum'.

MW1A3:   That's it in one, what is the point, she wouldn't have been able to con me or those girls at Area 1, it wouldn't have been a defense to say she lied because the next question would have been, 'well how come you let her con you, you should have checked her out properly', you would have been seen to have conducted a faulty interview. But with the computer this doesn't happen, the interviewer is irrelevant. She just puts in the information and has no leeway to interpret the answers.

Researcher: Yes it is because the underlying assumptions of the system is that when you conduct an interview you ask a set of questions and receive a set of answers. The skill of the midwife is missed. Actually the individual midwives are seen as a liability in that she might miss some important question.

* The midwife is transformed from a skilled practitioner to a liability in that she may miss some vital question and cause the hospital to be sued.

MW1A3:   That's what they kept hinting at and did it rub me up.

* N.B. the presentation of the GIT system alienated the users before its implementation, showing a lack of sensitivity for the work force.

Researcher: I can imagine, but ability of the midwife to interpret the woman as a whole is not recognized then she is not responsible if the facts she collects are wrong.

Analysis of the Story.

The above indicates many basic assumptions of the midwives which are very different than the doctors.

1)   She is interested in the woman's lifestyle the house she lives in and how she is coping with the upkeep of it. These are important to how she will cope once the new baby is brought home.

2)   Both MW1A3 and the doctors are interested in the drugs, alcohol and nicotine that the mum might be taking. They are both interest because these can adversely affect the growth of the fetus. The doctors have little interest in these mums and babies after the birth although the babies of such women often have problems i.e. underweight or born addicted to the mothers drug

habit. Such babies are treated by a different group of doctors i.e. pediatricians. MW1A3 is interested in the above but her interest extends beyond the intra-natal period birth and she has to consider the post natal problems of the baby and also how the mothers habit will affect how she will cope with bringing up the child.

A good example of the different areas of interest arises with the question 'Have you any children' the medical (doctor and midwife) interest is based on the assumption, based on experience that if the woman has had one straight forward pregnancy she is likely to have another. However, MW1A3 extends this to if the woman has successfully raised one child then she is an experienced mother and will be able to bring up a second. Therefore the fact that the mother had not seen the child since it was 6 weeks old is of no interest to the doctors but is of vital importance to the midwives.

These seem to indicate that the boundaries around what is 'seen of interest'. The domain of the doctors is narrower than the domain of the midwives.

0.6   APPENDIX VI

The Transformation of 'Normal' to 'Problem' and How to Overcome the Temptation.

This is a short story by MW1A5 a Community Midwife of considerable experience. She is concerned that the medicalization of child birth might be increasing the number of 'abnormal' births

MW1A5:   When we arrived the CDU (Central Delivery Unit) was frantic they had, had a terrible night. There were four women waiting for sections (Caesarian Section) and two more were having difficult births and requiring forceps. The midwives after the stress of helping these women through a torturous labours right through the night were running around trying to arrange theatre [for the Caesarian sections] and get doctors for the forceps [deliveries].

I just booked our little group in went into a delivery room and shut the door on all the activity outside. She was a belting mum, you know well informed but sensible. She knew what she wanted but it wasn't a crusade for her. She wasn't one of those know-it-alls who come along with an arm full of books and a list of demands. They really get on my nerves, they want the birth to be a natural event but on the other hand they seem to think that it can all be planned out beforehand, the two don't seem to go hand in hand.

* N.B. MW1A5's definition of 'belting mum' = well informed but sensible.

Researcher: Yes that is an irony they want a natural birth as long as it progresses to a specific and artificial plan.

* This ironic joke provokes MW1A5 into recounting a war story within a war story.

MW1A5:   Precisely, you just can't tell beforehand how it will go, I mean I have delivered thousands of babies and I must admit I get a 'feeling' when things are going to be a problem. Nothing that I can put my finger on but as I get older I pay more attention to my intuition. Its like one of my mums the other month (a mother receiving ante natal care from MW1A5's, but delivered in the Central Delivery Unit). She was a poor little thing, a bit heavy for her size, but nothing that you would worry about. They didn't have much but you know the type did their best and had made a nice little home up on Hillside (a poor area of town). Well she had, had three babies before hand, no problems they just 'popped out'. Anyway she came in (to the CDU) and what a

carry on. She went through agony there was just no way the baby would come, it finally ended in a section. The baby was almost 9lbs a good 2lbs heavier than the rest. We thought she had just put on more weight but it was a different father, a fine big feller, what can you expect.

* Obviously a question that the GIT system had not thought to ask. This knowledge could have saved the woman considerable pain and distress.

Researcher: Did you know that there was a different father.

MW1A5:   I did, but they didn't and they couldn't have known from the file even if they thought to ask. She was a definite low risk mother but something went wrong. That's what I mean, you never can tell how it will go, if we can be surprised what can a somebody who has probably read all the books know?

* The file MW1A5 refers to has the GIT ante-natal history which failed to ask this question.

This is not something that is easy to admit but you know I had my lad quite late, I was about 30. I had been a midwife for years and I was sure that the fact that I had not had a baby would have no detrimental effect upon my practice, which at one level of course it didn't. After I had, had James I revised my opinion [laughter] to say the least.

* Another 'nested' war story

Researcher: What about this mum (the mum that MW1A5 had taken into the CDU), did she have it all planned.

MW1A5:   No, she was well informed but sensible with it. Her and her husband were really together. They were there for each other loads of rapport, loads of eye contact, he was rubbing her before she could ask. They didn't need me really, well in such a situation I just back off and let them get on with it. He was doing much more for her than I could have done, so I let them get on with it.

* N.B. what MW1A5 considers the best therapy

Researcher: What! *you* just let them get on with it [laughter].

* This is a small joke, the Researcher is friendly enough with MW1A5 to gently chide her characteristic (which she shares with many Midwifery Sisters) of liking to take

charge.

MW1A5: Believe it or not, I know that I'm a pushy sod but I know when to let alone. She wanted to wander around so I didn't do any fetal monitoring. Instead of strapping her down I just let her do what her body told her.

Researcher: Is fetal monitoring necessary every time.

MW1A5: Is it heck, not in my opinion. Its just that those doctors are so paranoid about litigation that they it is becoming a feature of a normal birth.

Researcher: What's wrong with that, isn't it safer?

* The Researcher is using cultural dislocation (taking the doctors point of view) in order to make the midwife explain herself.

MW1A5: Look you know me, I am all for modern technology as long as it improves my practice, but I feel that in the majority of cases that it is inappropriate and actually increasing the abnormal birth rates in our area.

Researcher: What do you mean?

MW1A5: Like it or not it is an intervention with the natural birthing process. We are strapping these women flat on their backs from early in their labour. This is not a natural position to handle the pain and quite frankly we are asking the mother to push uphill, who knows what effect 'strapping down' women so early in their confinement has?

* MW1A5 is against this practice in that it seems counter productive to the mums. It is also a case of doctors interfering inside the midwifes domain i.e. normal deliveries, thus delimiting the domain.

This is all subjective, but what I know is that if I listen to the babies heart straight after a long contraction I am going to hear a slow bump bump bump. Its bound to happen all that effort the mother is putting into the contraction plus the fact that the baby is being squeezed tighter in the birth canal the babies heart rate is bound to drop dramatically. What anybody with any sense does is wait until the mother has recovered and then listen to the babies heart. Then if it is slow something is up. This applies to a normal birth you understand. The problem with fetal monitoring is we have a continuous read out of the heart rate and that is a legal document. If anything goes wrong they will refer back to the read out and find us negligent for not

taking action.

Researcher: But surly there is someway of telling whether this is a natural event an
                expected 'blip' or not, you know for example someone must have done
                research to show that for say 30 seconds after a contraction the babies
                heart rate is an unreliable indicator.

MW1A5:   Have they heck, but if anything goes wrong there is hell to pay and
                remember we can be sued for up to 21 years after the birth.

** Fetal monitoring therefore places the midwife in a vulnerable position. She is likely
to call the doctor because of the fetal blip which might be a normal physiological
response, because if anything goes wrong it 'will be used in evidence against them'.*

Researcher: So in effect you are collecting data, the significance of which you are
                not sure off but might be used in evidence in litigation against you at
                a future date. That's madness.

MW1A5:   Tell me about it, but it's even worst if anything goes wrong and the
                mother has not been monitored there will be hell to pay. So more and
                more women are being monitored routinely, any drops in heart rates
                are refereed to doctors and once they are involved the chances of
                intervention increase. This is not some conspiracy by the doctors or
                that they like to intervene, but simply they are trained to look for
                problems in the birth process and tend to act when these arise. But
                every birth sometime in the process will indicate potential problems
                and the more closely the process is monitored the more of these
                potential problems will emerge, but we have very little evidence at
                present to distinguish the 'blips' from the problems. The technology
                is in advance of our ability to interpret the data, so we don't take
                chances.

** The different view point of the doctors is highlighted but simply they are trained to
look for problems in the birth process and tend to act when these arise.*

                The thing is, I think used correctly the fetal heart monitor is a
                tremendous advance, it can really help us in our work. If there is a
                problem with the birth then the monitor is brilliant, I wouldn't be
                without it. But it should be retained for abnormal births and not a
                routine procedure.

* She notes the difference between normal and abnormal births

                The funny thing is that a lot of the women love it and expect to be

monitored as part and parcel of the hospital experience. They even ask for it, 'Sister when can I have the monitor on, aren't I far along enough for it yet'. It gives many of them confidence, once the monitor is attached they know that the delivery is well on the way and while they can hear the machine quietly bleeping away they know every thing is alright. But as health professionals is that a good enough reason, I mean look at that work done on scanning.

* Lay expectations of what it is to delivery a child has changed, they are expecting the monitor and see it as a sign they are actually in labour.

* New story emerging about ultra sound scans

Researcher: What's that, I thought that scanning was totally side effect free.

MW1A5:   Didn't we all, and every body loved it, I was one of the worst I mean I must have had 3 or 4 scans and there was nothing the matter with me, it was great to go and see the baby inside you and see how it was growing. But the medical value of those scans must have been nil. Maybe one had some value in estimating my delivery date, if the exact date is so important. Don't get me wrong the scan is a fantastic diagnosis aid and the staff at Area 1 have a brilliant reputation, but is it right to repeatedly scan 'well mums' just because they like it and we can.

Researcher: What's the story with scans.

MW1A5:   Well there's a study been carried out and it seems that for the population as a whole 15% are left handed. But of the population that has been scanned this has risen to 20%.

Researcher: Yes you know that left handed people have a lower life expectancy don't you.

* The Researcher identifies the wrong reason for this being a problem.

MW1A5:   Do they, well put that on one side because if they are dead they can't sue us [laughter]. It is a bit more important than that. They (research indicates) think that left handedness is the result of brain patterns. If the ultra scan is altering brain patterns in this way who knows what other ways it is effecting the developing fetus.

Researcher: Bloody Hell that does make you think.

MW1A5:   Mind you altering the brain patterns of one fetus would be unforgivable, but the left handedness might be due to some other reason. They say that the increase is significant, is 5% significant?

Researcher: Well I'm not a statistician but a 5% increase in population could be analyzed as, what would it be a 25% or 33% increase in left handedness, either of which is extremely significant.

Researcher: Are you saying that in some cases the increased use of technology is transforming normal deliveries into abnormal deliveries.

MW1A5:   I think so, I mean look at the case that I was telling you about. She didn't want to be strapped into a fetal monitor. As I said I just left them to it, they were doing fine. She was restless and walked around the room a lot. If that's what she wants to do then that's fine with me. After about an hour or so the staff (CDU Midwife) asked me if I wanted to break the waters. But me, I like everything in place until it is ready to go, the mum was not in any distress and she was handling it well. Any way she said that she felt like pushing and I told her to try and hold on. She went to the end of the bed and crouched down and 'whoosh' the waters broke. I was pleased that we had been patient and waited, I bent down to clean her up a bit and the baby's head was there, I couldn't believe it, I could feel the top of its head. I thought great this will be a piece of cake.

* N.B. The previous paragraph indicates medical intervention could increase the number of abnormal births. In this paragraph she reinforces the need to resist interfering with a normal process.

I said that she could push now and did she want to get into bed. She did and I felt her again the baby had gone back inside. She pushed for about 30 minutes and nothing, she said that she thought that she was getting nowhere and wanted to get out of bed. I said that it was OK. Blow me 30 minutes later the baby was born, no problem.

Researcher: So by not interfering she was able to give birth normally.

MW1A5:   No, that's just the point, if a mum is pushing for 30 minutes without progressing I should have called a doctor to assess why, she would have been an abnormal delivery. But I had felt the baby so I knew that it could come down, but just wouldn't. By making her get into bed I had interfered with both nature and gravity and knocked back the delivery. We must learn to leave well alone.

* Problems of even minimal interference.

Researcher: So what you are saying is that just by suggesting the woman get into bed you in effect transformed a normal into what if you had not already felt the baby and had the confidence to proceed could have been an abnormal delivery.

MW1A5: Well it's common sense look what happens when a cat is having kittens, you leave her alone every one knows that if you disturb her it will knock back her delivery several hours.

Researcher: I didn't but I suppose that it's a defense mechanism, the delivery must be a very vulnerable time in the wild, so if the mother is disturbed, the delay of the birth will enable the mother to escape danger.

MW1A5: Precisely, who knows what effect we are having on these women, that mum getting into bed knocked back her delivery for sure and I am convinced that she would have been hours pushing on her back, who knows what would have happened. As it was she up and wanted to have a bath 15 minutes later.

Researcher: Not like you eh! [referring to a previous story]

MW1A5: [laughter] No not like me, that was what convinced me that 'blanket cover' was a waste of time. Then we thought that the nicest thing that a mother could want after the messy business of childbirth was to be cleaned down so she would feel better. After I gave birth the last thing I wanted was to be messed around with being woken up to be washed, all I wanted was to relax and sleep. You see we are all different, each birth is a separate one off occasion and we should treat them as such. All this pre-event planning is pointless and in my opinion can be dangerous.

Any way she stepped into the bath 15 minutes later, I gave her a hand to get dry and she said that she was ready to go home. I said are you sure, she was, I left her blowing her hair in the mirror and went to book her out. The CDU staff said has she delivered, I said yes. 'But' they remarked 'you didn't ring' (for help), I said that we didn't need to. It was great we were a complete little unit nice and private without the intervention of strangers. But if anything had gone wrong they (the CDU backup team) could have been there in a few minutes.

* Assumption by the CDU midwives that their help would be required.

It was a lovely experience, I knew the couple, we went to the CDU together, she gave birth with our help and we had a nice chat and cup of tea to round off the experience. It was a nice complete event one that I felt privileged to be at it made me feel great to be a midwife. I went back to give her, her post natal the next day, it was lovely.

* *This emphasizes the wholeness of the experience for the job satisfaction of the midwife. She was obviously moved by the experience.*

Researcher: Were they (the CDU staff) miffed that you didn't need them.

MW1A5:   No, not really, more surprised. I'll tell you what though I felt really sorry for them.

Researcher: Why were they busy?

MW1A5:   No just the opposite, they were relaxing (after the traumatic events of the night) and the new shift was coming on.

Researcher: Why did you feel sorry for them?

MW1A5:   Well as I told you they had had an horrendous night every thing that could go wrong went wrong, they had had an harrowing night helping these women through agonizing deliveries. It really tells on you, it doesn't matter how you try to detach yourself, when you are with someone going through all that it effects you.

Researcher: If it didn't you would be in the wrong job.

MW1A5:   Precisely, any way they had gone through all that, eventually got the doctors and theaters organized, all that activity. But when I came out all the mums had gone and the delivery suites were cleaned out. It was as if nothing had happened, the ward was deserted. They had nothing to show for all their effort. When the new shift came on duty they had nothing to tell them.

Researcher: Surly they told them that they had had a terrible night.

MW1A5:   Yes, they did but its not the same you know,

                  'We had a terrible night 4 sections and 2 forceps'

                  'Oh did you'.

They had nothing to show to personalize the experience you know.

'We had a terrible night 4 sections and 2 forceps. Mrs Jones over there had a very bad time, she hung on until the end but is badly torn, she did well but she came in on her own poor thing she's a good one though give her a bit of TLC (Tender Loving Care).

Or

'I had a right row with Dr X about Mrs Smith over there' etc. Its hard to explain but they just didn't have any stories to share with the next shift. I mean when I was the Night Sister on a busy Mat. Ward, I've had loads of nights like that, but the thought of just sort of clocking off at the end of the shift is unbelievable, we always had to talk away our experiences, it was a way of winding down, sort of getting rid of the stress in a nice way with knowledgeable colleagues before you went home to bed. I just don't know how they could sleep after such a night without 'coming down' first.

Researcher: But *you* had something to talk about I'll bet.

MW1A5:   Oh yes I had something to talk about, I said 'you'll never believe this but my mum gave birth 20 minutes ago, she has just had a bath and wants to go home. I've just left her in front of the mirror blowing her hair'. I told them of the way they were a lovely couple together and how she had wanted to walk around. How I felt the babies head when the waters broke, how together she was. But most of all I told them what a lovely night the three of us had had. A little unit quietly getting on with our business, I knew the mum well, I had delivered her first baby and this was somehow a continuous life process that I felt privileged to be a part of. Later when we left some of them came across to look at the baby. Remember they had had a terrible night and none of them had seen a baby for all their work.

Researcher: What did they say.

MW1A5:   They said the baby was lovely, and it was, I felt so proud.

* *N.B. The midwife 'felt so proud'. Note the difference between the experiences of the midwife and the CDU midwifes.*

Researcher: Not about the baby, don't go all broody on me now. I mean about how nice your experience was as opposed to theirs.

MW1A5:   They said 'yes it's alright for you but' you know the old stuff about dominos being hand picked and low risk mums where as they have to take on all comers so to speak. I know that but if we are picking low risk mothers so what. Why not let us handle all the low risk mothers in this way, the mothers love it and it is so much nicer for the midwives. The more we handle the low risk, normal mothers, the less normal births have to be delivered by the CDU team, the more time that they will have to spend on the problem deliveries.

* The CDU midwives make excuses because clearly they can see the difference, and the domino experience is clearly superior. MW1A5 agrees that the criteria selects easier births, however, she advocates changing the criteria to admit 'all normal births'.

Researcher: But don't they do normal deliveries now.

MW1A5:   Yes but when the women come on to the CDU the chances that the midwife will have seen her previously is remote to say the least. The mums arrive are wheeled into the delivery suite and if all's well give birth and are sent down to the wards that's the last they see of them. Its the same for the midwives on the wards. The mums come down with their babies and they give them post natal care. They don't know what the woman has gone through its just another mum.

* Emphasizes atomizing tasks is unsatisfactory for the midwives job satisfaction.

Look at those women that had gone for section the previous night, they come back from theatre and all you can do is treat them as a post op patient. They don't know what she has gone through or who has been ringing in about her and how worried they had been about her or if any body gives a damn. At one level the midwife doesn't need to know, but if we are trying to provide a quality service personalized knowledge such as this will improve both the whole experience for the mum and the practice of the midwife.

ANALYSIS

This is a remarkable piece of conversation in the richness of description and real feel for the task that these women (they are mostly women) perform.

As far as traditional knowledge acquisition techniques are concerned it could be described as interesting but not fruitful in terms of facts that could be transformed into code. If the engineer had such a conversation at all it would probably take place during a break and serve as a way of building up rapport with MW1A5. As such

most if not all of the conversation would have been written out of the report.

However, as a sociological source it is extremely rich in data.

MW1A5 and the midwives on the CDU are almost from different tribes. There experience of work and viewpoints are radically different.

She reminds them of the past when they were intimately involved with the process of giving birth rather than just the delivery. She reminds them of how nice the job was and the relationship of midwife/mum was a key part in the facilitation of the birth. The CDU midwives look on her as a sort of dinosaur of a previous 'golden age' when times were slower and a higher neo-natal death rate was acceptable. Yes it is possible to return in specially selected cases and get good results. But only in specially selected cases, as MW1A5 remarks you just can't tell beforehand how the delivery will go. Therefore they have to be ready in case of emergencies. Individual personal care for everybody would be ideal in an ideal world but we live in the real world and have to operate within limitations. They monitor the birth looking for indications of problems such as 'water hasn't broken' they are willing to intervene to increase 'progress'

The CDU System takes on the tacit assumptions of the 'dominant class' the physical layout of the building is a reified symbol of this tacit knowledge. i.e. basically a 'modernist' concept of medicine reflecting the 'Atomism' that has been so successful for natural science.

They by being constrained by the physical symbol of the doctors tacit knowledge have taken on board their tacit knowledge and are loosing their own. This is shown by the fact that they have taken the biomedical model and applied it to pregnancy.

MW1A5 has the traditional and ironically 'post modern' somatopsychic model

0.7 APPENDIX VII

POOR DR. B

At 7 pm. one night I received a phone call from the Snr Reg at the Area 1. She said that she was sorry to interrupt me but there was something wrong with the colposcopy package that I had written for her. She thought that there must be a bug in it. Dr. B. had entered some data and when they had tried to use the stats package large amounts of the data had not been recorded it just didn't appear. I asked what whole records and she told me that just parts of the records had not been recorded. She sounded very anxious and so I said that I would come around and have a look. I thought because it was Thursday night by the time that I had sought some expert advise and put the thing right that it would be at least next Monday before I could get back to her. I asked her which data was recorded and which wasn't, she said that there seemed no logic to it. What she did tell me, however, gave me a clue to the problem and at about 7:30 I arrived at the Area 1 and was greeted by Snr. Reg and Dr. B. I asked her to show me how she had discovered the omissions, she went to browse and sure enough each of the 40 or 50 records were present but a large number of fields were empty. There was indeed no logic to the omissions, however, I noticed that all the logical fields were recorded and only some of the texts. My knowledge of the way the data base was designed led me to suspect user error.

I asked her who has entered the data and she said mostly Dr. B, who was sat looking really anxious. I said when did you manage to get the time, he said that he had done it in his spare time (that's a joke they work all the hours God sends) as he said this his bleep went off and he excused his self. I said that Dr. B had entered all these records (40 to 50 and each very long) it must have taken him forever. Snr. Reg told me that as a part of his training he must complete a research project and he had chosen to research a part of colposcopy, (an technique of cervical cancer treatment). Snr. Reg had told Dr. B that if he entered the records she would help him do the stats when they got a quiet moment (another joke) any way Dr. B had spent the whole week entering the data and when she finally had time to help him the records were missing. She said that she was sorry to bother me but when he saw that his work was for nothing he was at his wits end. I said that I could understand that and I would do my best. With that her bleep went off, she took the phone call and gave some orders. She said that, that was Dr. B he had sorted out the problem and was on his way down. I said good because I wanted to see him input a record.

Dr. B came down and I said that I had heard he had had a rough time, then I asked him to input a record he said OK and set about it. It must be emphasized that the man had no computer experience and to see him set about the task was painfully slow. Eventually Snr. Reg could stand it no longer (worrying about my time) and took over after the first section was completed I asked Dr. B to continue and sure enough after painstakingly typing in one letter at a time the data he hit the down

cursor key instead of the enter key. The cursor jumped to the next field without entering the data. On the other records sometimes he hit the enter button but more often he hit the cursor. The logical fields etc automatically entered themselves. I pointed this out and I thought for a minute that Dr. B was going to kiss me the relief that shot across his face. The time that he had wasted was forgotten (it cannot be emphasized enough how precious free time is to these junior doctors) now he could get on with the research he needed to complete his studies.

[I had set the data base up so that this would not occur, however, they had modified the progamme from COLP4 to COLP5 without properly updating the check file and this had allowed the errors to occur. I altered the check file and showed Snr. Reg how to do it in future.]

The whole atmosphere lifted as if the room had been lit up and we were all in a happy mood and we start chatting. I explain Dr. B what the enter key does, Snr. Reg is a bit embarrassed at getting me out at night for a trivial mistake but I have made worse mistakes and I told them.

She starts telling me that Dr. B has been very discouraged by the research. He has been working hard for very little results. Snr. Reg has been telling him that is what research is all about, you spend vast amounts of time and produce nothing and then at the end of the research the results sort of 'snowball' together. The practice of research is necessary in order that one appreciates just how difficult it is. Snr. Reg says that she likes EPI5 because it is so easy to use. But for her the main thing is that the thing works and she can get what she wants out of the thing. The new system pretends to be user friendly but as far as she is concerned it is only so at the cost of inflexibility and this is too great a cost for her purposes. But the worst thing is that even though it is inflexible it still doesn't give her the data that she needs. There is always a problem, huge numbers are 'not included' and you can not interrogate data base to find out why. For her own use she uses RBase and tells me that when she was at Area 4 she used a data base that was very difficult for the user to manipulate. It was a command line and if a comma was out of place it would not work. The system was very frustrating BUT if you got the command correct then it produced what you wanted was. She told me of how she would spend hours struggling over the command line and then somebody would notice that she had missed a speech mark or made a spelling error. She said that it was frustrating but at least the results were rewarding. I sympathized with her and told her of the problems that I had trying to understand data base when I first went to the ITI. The experience with Dr. B shows how basic instruction needs to be. I asked him how he felt and he was just so relieved to be able to get back to his research, he thought that it had all evaporated in front of his eyes and was at his wits end.
When I went home I began thinking over how these busy doctors had spent so much of their precious time wrestling with the computer in an attempt to make it work. I could not help but contrast this effort to the way that other members of staff viewed

the computer. The amount of effort the individuals were willing to invest in learning the system was directly related to the amount of perceive use the system would be to the individual. This phenomena known as 'criticality' is well known but the research at Area 1 provides a dramatic example of its importance

0.8   APPENDIX VIII

'I Never Worry About Roughies'

EXAMPLES OF HOW DIRECT QUESTIONING IS INEFFECTIVE IN GAINING EXPERT KNOWLEDGE.

This is a nice example that came out of a conversation I had with a community midwife. Although it is not a verbatim account I will transcribe the conversation as if it was to try and to retain some of the character of the conversation.

MW2A2:   Oh what a day I've had, I've been running around all day making calls on my ladies. Do you know what I had to visit seven of them six on Hillside [A large 'problem' estate notorious for crime and drug abuse] and guess where the other one was Parkside Road [this is a prestigious area a 'millionaires row'].

Researcher: God that's a bit of a difference.

MW2A2:   I know, but do you know what, I spent longer at Parkside Road than I did at the other six put together, it was awful.

Researcher: I told you the middle class always get more out of the Health Service

MW2A2:   Oh shut up this was different

Researcher: Why? you would think that the mob on Hillside would need your care much more than her on Parkside Road, I'm sure that she is eating enough green leaf vegetables [this is a reference to a joke about dietary advice to pregnant women]. Why was it awful?

MW2A2:   Well there I was perched on the end of this huge sofa balancing a cup and saucer making polite conversation. I noticed the way I was talking changed it was very hard.

Researcher: Well what was the difference on Hillside?

MW2A2:   Oh well you just go in and say hiya how are you getting on and you feel at home right away, you just sit down and start chatting. For instance they never ask you if you want a cup of tea, they know me and if I want one I just get up and put the kettle on. Well you don't do that in every house, you pick the ones that you know are quite clean, some houses you would never have a drink in.

Researcher: Yet you felt they were OK in spite of their problems and the woman at Parkside needed help.

MW2A2:   I never worry about a 'roughy' I always know that they will be alright no matter what. You ask them as you leave hospital with their baby have they any backup at home is there any one to help them with the baby or have they been able to get everything the baby needs. No matter what they say you just know that they will be alright, when I go to visit them they are always OK. Its that they are such social people. You know, if you get a couple of middle class women in [in hospital] they sit in their on their own and mind their own business. After a couple of days they might nod to each other but in general they just look after their babies until they can get out. You get two Roughies on the ward after about ten minutes they are walking down the ward arm in arm like life long friends. Probably going to the day room for a fag but never mind [there are tremendous moral pressures placed on pregnant women in hospitals not to smoke].

When you go and see the girl who is isolated on her own up on Hillside you will find that the house is full, not the best environment for a baby lay in a room with four or five adults smoking like chimneys and the gas fire on full belt but the girl gets lots of support from her neighbors. That girl on Parkside Road had all the physical advantages that money could buy but she was totally isolated. Her husband has a high powered job which takes up most of her time, her mother lives somewhere down south and her mother in law is a headmistress and can give her little time. I can see I'm going to have a lot of problems with her. But what can you do.

KEY POINT TO NOTE

This account points to the poverty of trying to gain expert knowledge through interviewing 'experts'. Such questioning would have revealed that there are certain requirements that a new mother needs if she is to cope properly with a new baby. MW2A2 would have quite cheerfully rattled off the standard needs. I contend that according to these needs the woman from Parkside Road would have been deemed well provided for whereas the single girl from Hillside would have seemed a high risk mother. It is MW2A2's expert knowledge and classification of 'ROUGHIES', her first hand experience gained by her backup calls to these mothers that allows her to KNOW that they will be alright and that if they are not someone a neighbor with experience of children will see that she gets help. Knowledge of this kind only emerges after considerable interaction with the expert which enables them to explain their categories. Alternatively simply observing MW2A2's movements over a period of time would have shown the inconsistent way she treated her visits, this would have

been a spur to ask questions which may have resulted in the above explanation.

analysis

Clearly MW2A2 sees support of the mother to be of vital importance to the baby and mother. Clearly the poverty stricken smoke filled room on Hillside is preferable to the luxurious mansion on Parkside Road as far as she is concerned.

Post Script

I asked MW2A2 to read the above analysis and asked her if she agreed with my analysis, she replied,

MW2A2:   Well do you know I've never actually thought about it like that but now you point the fact out to me I must do. I don't actually think about it like that but unconsciously, yes, I think social support is vital. It can make all the difference to whether the mum copes or not.

Researcher: Do you think before I showed you this [document] if I would have asked you what do you think the key post natal factor that you would have answered, social support.

MW2A2:   No I would have given you the standard list that we have to check for. I didn't actually know that I held social support as so important. How come you know more about the way I think than I do.

Researcher: You'd be surprised at what I know.

MW2A2:   Well keep it to yourself you smug bugger.

0.9 APPENDIX IX

Researcher: How are you liking your 'updating' at the CDU (central delivery unit).

[MW1A4 is a community midwife, as such she is required to spend 2 weeks per year on the CDU to update her midwifery practice.]

MW1A4:   Great I feel like a real midwife again. I suppose I should never have left, it's where I belong at the centre of things.

Researcher: You look like you have been having a good time, how many have you delivered so far.

MW1A4:   Eight so far.

Researcher: Did you pull out any tricky ones.

MW1A4:   Not to bad.

Researcher: How are you getting on with the computer?

MW1A4:   Don't ask.

Researcher: Any way this is my version of MW2A3's reorganization of the GIT system. I found the system (the GIT system) full of disjointed questions you know like this one.

> 2.3 'Was the onset of labour spontaneous, induced or no labour?' followed by 8 options. This is followed by a list of questions about induction and caesarian section. MW2A3 has simplified the question to 'was labour:' followed by the options 'spontaneous go to 2.10 ' 'induced' followed by 3 questions on induction. I've tried to chunk the information up in meaningful sections for example I've put all the apgar scores on one screen instead of a question per screen so that you can make sense of what you are looking at. You know you can see all the apgar scores at one glance and make a judgement about them.

MW1A4:   Lets have a look at it then,

[MW1A4 knows how to use the data base she was therefore interested in the questions and checks that had been installed].

> Lets have a look at the options for 'liquor', hrrm its only meconium stained ones that are of interest to us

Researcher: Why is that significant?

MW1A4:   Well meconium is a black substance in the fetus' gut, if the fetus is 'distressed' it will sometimes expel the meconium and stain the liquor. This is significant but rare, the vast majority of women have a clear liquor. It seems such a bug to me to have to drop down the window when it would be much easier for me to type 'clear'.

Researcher: So usually the liquor is 'clear' how about having the question read 'was the liquor clear' followed by a yes/no box (logical field). That way it would be easy to type in the letter 'y' or 'n' . If the answer was 'n' then another field perhaps entitled 'unclear' would be entered. If the answer was 'y' this field could automatically be skipped.

MW1A4:   Yes that sounds alright there is nothing worse than filling in an obvious answer time and time again, the least you can do is make filling it in as easy as possible.

Researcher: Well if it is rare is it significant enough to include in the questions.

MW1A4:   That's the problem. When we filled in the forms manually you could always write in if the liquor was meconium stained or not, the odd time that it happened. If the liquor was not mentioned it would be presumed 'clear' But now it is important to put in, in case of litigation. You know if the liquor was stained and you don't take action then you may be liable. This is stupid because if you saw meconium stained liquor then you would immediate action. What this is saying is 'the liquor was clear, it has been noted down therefore if it later proves the baby suffers a condition that may be attributed to fetal distress then the midwife/doctor can point to the notes and say there was no signs of fetal distress at this point'.

Researcher: So its a way of 'covering your back' there is really no other reason for this question. I noticed that it doesn't appear on the manual form used at Area 2.

MW1A4:   Yes, but it's becoming more and more important that we 'cover our backs' there has been an avalanche of litigation in this area. Over 70% of gynae consultants being sued at any one time. They can't be that bad'

Researcher: Yes I was talking to MW2A3 and she was saying that you couldn't blame the parents from suing. They have a brain damaged child and so they try to get some money to care for that child for the rest of its

life. They have no other recourse. MW2A3 says and I agree with her that what is needed is a 'no-fault' compensation scheme like they have abroad, then there would be a drop in litigation.

So if I change the input field it should stay in.

MW1A4: Yes I suppose so if it is easy to fill in. Lets have a look. What's this 'Last fetal scalp sample' does this mean time because if it does there must be a place to record the result.

Researcher: When would the results come through, and who would enter the results at a later date.

MW1A4: The ph results are essential and are done on the ward so the results are there on the spot.

Researcher: So they don't have to go off to the path lab.

MW1A4: No, a high acid content in the fetal blood is an indication of fetal distress. The ph is tested on the ward so we can act immediately. Its like the stained liquor you need to show that it has been taken.

Researcher: More of a legal than a medical consideration.

MW1A4: Yes and no, if you take a fetal sample then this is an invasive procedure and should be recorded. But its getting that way that we always carry out fetal monitoring whether the woman needs it or not.

Researcher: What's the problem in fetal monitoring the women.

Don't get me wrong I think that the fetal monitor is a very useful tool, but only when and where appropriate like most things in medicine 'blanket cover' (this means that everybody gets the same treatment) due to individual differences is inappropriate. The doctors are so afraid of litigation that they want everybody monitored. They dread something going wrong and at a later date being asked to account for the reason, given something had gone wrong why hadn't fetal monitoring taken place.

Researcher: This part here about the various stages of labour I have had to change MW2A3's programme about a bit here. I have tried to chunk up the information in meaningful lumps

MW1A4: Yes this is a bind having to fill in the date over again, won't it fill in

automatically from the admission date.

Researcher: Yes but its a bit tricky, if she starts 1st stage say 23.23 Thursday and the second stage 03.30 Friday morning, I am sure that there is a way of doing this but I have not put it in at this stage. Any way carry on I will see what I can do.

MW1A4:   What's this? position of mother at delivery? We-ell I suppose they might be interested in that but I cant think of any possible use for information of that sort.

Researcher: It's probably somebodies hobby horse, and they want to do some research on it.

MW1A4:   Suppose so that's why these things get out of hand and long winded.

Researcher: Yeah, but you've got to remember that this is their first attempt at computerization. They have still to draw the dichotomy between record keeping and data for statistical analysis. Using the paper method the difference is unimportant but with computers it is vital for all sorts of reasons.

MW1A4:   Bloody computers, why couldn't they leave us alone with a perfectly good system, instead of going through all this heartache, and for what, so some consultant can seem go ahead by introducing so called hi-tech.

Researcher: You know what I think, replacing a cheap working system with an expensive unproven system that even if it performs to spec will be an impoverishment of the original system is the height of madness. On the other hand you and I know that computers are here to stay like it or not, so if you've got to have a system lets try to make it a good one.

MW1A4:   This is no good, where it says 'who delivered the baby' etc. It's not good enough to say 'midwife grade e' they want names in case of litigation. There needs to be a field for free text along side each of these entries, and the same all through the data base.

Researcher: Speaking of that, I just put in the grades in order. It's easier for the user if the most used answer is the first or last in the window. Would a 'midwife grade e' be the one who is usually delivering babies.

MW1A4:   Most cases yes.

Researcher: Good I got something right them [ha ha].

MW1A4: This is a laugh 'were identity labels applied?'.

Researcher: Yeah the answer is always yes. I thought it was like a check list to remind the midwife.

MW1A4: Well yes but what you need to know, however, after that cock up the other week is 'by whom'.

Researcher: No problem.

MW1A4: This is a pain 'how many vessels were present in the cord' then a you have to press f9 to make the drop down window appear and then make a selection. In 99% of the babies the answer is going to be 3.

Researcher: So should I do the same as before write 'were 3 vessels present in the cord' followed by a yes/no box which you have to type a letter 'y' or 'n' if you press 'n' then the cursor will jump to a field called 'other'.

MW1A4: That's got to be easier, you know it doesn't take much thought to make these things so much easier, its just common sense really, makes you wonder what these people are doing for their money.

Researcher: The trouble is that common sense isn't very common. But to be serious at the bottom the rational seems to be that what is needed can be reduced to a list of questions to be answered. The person who is answering them seems of little importance. There has been a lot of work done on making the interface much more friendly (HCI), but the user is seen as either a novice, expert or something in between. It doesn't seem to be a consideration, what I mean is the feelings of the user don't seem to be considered. For example like the question about the number of vessels in the cord, the difficulty of inputting the data should be in someway related to the use of the information it yields. You know if the information was vital you wouldn't mind if it was difficult to input. Somehow the effort would have been worth it. But if the information was largely irrelevant it irks you to expend the same amount of effort.

***Importance for knowledge acquisition**

The more relevant/important the question the more time/effort that the user will be willing to expend inputting.

MW1A4:   Yes, if for example there was an abnormality with the cord vessels I wouldn't mind pressing f9 etc, it would seem worth it somehow.

Researcher: That's the problem, for the designer to know just how much effort you are willing to expend on a given piece of information means that the designer will need to know a great deal about your working practices. That takes time effort and most importantly enthusiasm.

MW1A4:   But its worth it in the long run.

Researcher: Not if questions is a question is a question. Any way I'll put that in for you. [MW1A4 carries on with the data base] I think I've made a mistake with the apgar scores, I have allocated two spaces for each entry and it only needs one.

MW1A4:   That's right you get a score of 0, 1 or 2 for each category. Its interesting at Area 1 we have drawn up criteria for the categories. For example if the heart rate is below 'x' then they are give a score of '1' if it is over 'x' then the score is '2'. Of course if it is as flat as a pancake then it gets a '0'. We used to leave it to the midwifes discretion but now we have drawn up a formula.

*Importance for knowledge acquisition.

Changes in context move knowledge from one box to another. In this case from tacit to laws/rules

MW1A4:   They will have to sort that out at Area 2 before they go on-line. [MW1A4 carries on with the data base] Oh that's interesting, they are asking about 'vitamin k', lets have a look at answers they have put in.

Researcher: Why, what is the importance of vitamin k. I was wondering does it belong with the resuscitation or should it be in the part where the new born is examined.

MW1A4:   Well yes and no it can go either place. You know that when babies are distressed they have problems with their breathing. Well they found that these babies had a deficiency of vitamin k. Anyway any baby that was distressed was given a dose of vitamin k. But recently they have been giving all babies a dose. I was reading last week that a doctor had run a test, only small but he has come up with a significant correlation between babies given vitamin k and childhood leukemia.

Researcher: Shit.

MW1A4:   Precisely, the strange thing is it seems to be the oral vitamin k that is causing the problem, that's why I looked at the answers that they were interested in.

Researcher: This is another example about what we were talking about remember taking cord ph levels and the rows you had about it. MW1A5 is wrong in thinking the more questions that you ask the less you open yourself up to litigation. Just imagine noting down that vitamin k had been given thinking that you are covering yourself by showing that you have done every thing possible to help the baby to breathe. Then at a later date a side effect is discovered unknown at the time for the procedure you are giving. You are providing evidence against yourself. It's a legal nightmare. It just shows you how careful you have to be when doctors want fields put in to help their individual research, the ramifications need really looking at.

Importance for knowledge acquisition

Establish the ramifications for all questions. Don't ask questions that just seem to be interesting.

MW1A4:   Yes its all right for Dr X asking the midwives to test the cord blood to see if there is anything interesting in the results worth researching. But its the midwives that get the extra work, more importantly it is the midwife that has to sign for the delivery. The problem is, for example suppose future research reveals that a low ph in the cord blood is an indication of a distressed fetus. We have signed and if anything that could be put down to lack of oxygen during the birth it is the midwife that they come back to sue personally not the Dr X. We have to keep these records for 21 years anything that happens in those years is down to us. I mean suppose in say 10 or 15 years somebody produces research that links dyslexia with low ph blood cord the writs would be flying thick and fast and it's us that have to take the flack, just because Dr X thought that it would be interesting data to collect.

Researcher: But someone has to do the research.

MW1A4:   Of course but there is a time and place. Research should be conducted in Research Hospitals where they are aware of the potential problems and have the resources to conduct proper research. At Area 1 and Area 2 we are stretched enough just looking after the mums and babies.

Researcher: This part I have chunked the babies vital signs on a single screen in a different way than MW2A3, what do you think?

MW1A4: It looks ok to me, you can see them all at a glance

Researcher: This next bit should be in the labour section, I'll move them later.

MW1A4: There is a problem here, can you enter more than one type of analgesia.

Researcher: Not at the present, but I can change that. How many do we need.

MW1A4: Well all of them really but at least four, I mean if a woman comes in early she might start off on TENS that is very mild and just helps her along. Later she might have some pethidine to relax her and later still perhaps an epidural. If she has bad tears or an episiotomy you would probably use lignocaine to freeze her bottom while you stitch her up. You just can't tell but you need to be able to input more than one.

Researcher: How about a list of them with yes/no [logical] fields for speed. We could have a field say for amounts to be filled in if 'y' is entered.

MW1A4: I like the yes/no fields they are easy to fill in, but I am not sure whether we need fields for the amount.

Researcher: What' syntocinon? they seem very interested in it by the way it is separated from the rest of the drugs.

MW1A4: That's because it is not an analgesic drug. It is the brand name, a synthetic form of the hormone oxytocin. This has a variety of uses but can be used to induce childbirth. It causes contractions. Sometimes these can be stronger and more painful than usual. I suppose that they are comparing the incidence of syntocinon and an increase in analgesic drugs. Can't be sure you will have to check up with MW2A3.

MW1A4: The information about who and why the epidural was given is very important in case of litigation.

Yes this is another important are for litigation 'perineal trauma' [the perineum is the area between the thighs that lies behind the genital organs and in front of the anus.] Its an absolute mine field. You've got all this propaganda against epidural, so if a woman has an epidural and has to have an episiotomy or is badly lacerated they blame the

trauma on the epidural. Its natural they are no longer feeling the pain of childbirth but have the pain of the trauma, they forget the relief the epidural gave them and blame it for the pain that they are feeling. You just can't win. The top and bottom no pun intended is that you have to be very careful with your record keeping in this area.

These 'maternal investigations' are very important as well, if just to get a record that they have been taken.

Researcher: I remember you saying so before that is why I lumped them together on one screen. What do you think of it so far.

MW1A4:   Rubbish (ha ha ha) no seriously, it seems a lot better than the 'thing' that they have at Area 1.

Researcher: What do you think about the way that I have made the various sections. Labour, Delivery, Examination of the new born then examination of the mother after child birth.

MW1A4:   Seems alright to me.

Researcher: Does it follow in a sequence that seems logical to you, what I mean is, is this the way that you would naturally or should I say does this sequence follow how you would go about your work.

MW1A4:   Yes seems natural to me.

Researcher: Thanks a lot MW1A4, I think you've earned that lunch I promised you.

0.10 APPENDIX X

MW1A5:   Yes but what I mean is that we are giving this fantastic service to a small number of women and I am not sure whether it will be possible to offer such a service to the majority of mothers.

                    She knew what she wanted but it wasn't a crusade for her. She wasn't one of those know-it-alls who come along with an arm full of books and a list of demands. They really get on my nerves, they want the birth to be a natural event but on the other hand they seem to think that it can all be planned out beforehand, the two don't seem to go hand in hand.

Researcher: Is fetal monitoring necessary every time.

MW1A5:   Is it heck, not in my opinion. Its just that those doctors are so paranoid about litigation that they it is becoming a feature of a normal birth.

Researcher: What's wrong with that, isn't it safer?

MW1A5:   Look, you know me, I am all for modern technology as long as it improves my practice but I feel that in the majority of cases that it is inappropriate and actually increasing the abnormal birth rates in our area.

MW1A5:   Like it or not it is an intervention with the natural birthing procedure. We are strapping these women flat on their backs from early in their labour. This is not a natural position to handle the pain and quite frankly we are asking the mother to push uphill, who knows what effect 'strapping down' women so early in their confinement has? This is all subjective, but what I know is that if I listen to the babies heart straight after a long contraction I am going to hear a slow bump bump bump. Its bound to happen all that effort the mother is putting into the contraction plus the fact that the baby is being squeezed tighter in the birth canal the babies heart rate is bound to drop dramatically. What anybody with any sense does is wait until the mother has recovered and then listen to the babies heart. Then if it is slow something is up. This applies to a normal birth you understand. The problem with fetal monitoring is we have a continuous read out of the heart rate and that is a legal document. If anything goes wrong they will refer back to the read out and find us negligent for not taking action.

Researcher: But surly there is someway of telling whether this is a natural event an expected 'blip' or not, you know for example someone must have done research to show that for say 30 seconds after a contraction the babies heart rate is an unreliable indicator.

MW1A5:   Have they heck, but if anything goes wrong there is hell to pay and remember we can be sued for up to 21 years after the

0.11 APPENDIX XI

'Donna's Mock Interview'

Ante Natal History at Area 2

Interviewer: Sister MW2A2. (Midwife).

Interviewee: Donna (Mum to be).

MW2A2:	Now then Donna, it is Donna isn't it?
Donna:	Yea.
MW2A2:	Donna I'm MW2A2, I'm the one who is going to look after you and I'd just like to book your bed. (the traditional reason for a 'booking clinic' was to book the mum to be a bed for her confinement).

Now my first question, is that what you want? Do you want to have your baby in a hospital? and do you want to have it at Area 2?

[N.B. The mid-wife asks Donna's opinion to where she wishes to have her baby. This attempts to place power with the mother, the sub text being, because this is a normal life event the mother's choice is most important. At least at this point, i.e. unless the mother later proves to be at 'high risk' it is her personal choice.

Donna:	Erm, yes.
MW2A2:	You want your baby in hospital, you have discussed that with your Doctor.

[MW2A2 checks that Donna's choice is an 'informed choice' i.e. it is not just a whim, the pro's and con's of where to have the baby has been taken with medical advice.]

Donna:	Yes.
MW2A2:	Your doctor has written to us and your G.P. has asked to put you under Mr. B, that is our consultant. Is that alright with you?

[This is the traditional procedure the G.P. writes to the consultant inviting him/her

to take responsibility for the mother to be.]

Donna: Yea, yes.

[This is a strange question because the mother is unlikely to have sufficient knowledge to make an informed choice. However, in a town like Area 2 the reputation of gynecological consultants becomes well known.]

MW2A2:   You would normally see Mr. B today but unfortunately he is off sick, so the next time you come you'll see Mr. B then after that it's the midwives who will see to you. Ok.

[This is a political statement, first of all she tells Donna that she would normally see the consultant and she will the next time that she comes to clinic, but she is really under the supervision of midwives. This state of affairs is true unless Donna is re-classified 'high risk' later in the interview.]

Donna: Yea.

MW2A2:   Now I'm your midwife here, so I'm the 'named midwife' so anything that you need you should see me, Ok.

[MW2A2 specifically tells Donna that she (MW2A2) is her (Donna's) 'named midwife' this means that she is Donna's personal midwife with whom she can liaise. However, most of the Donna's antenatal care will take place in the 'community' therefore Donna will also have a 'named midwife' in the community. Any problems that Donna might encounter will be dealt with by MW2A2 personally, who will if necessary will become an 'advocate' for Donna as she passes through the stages of her pregnancy.]

Donna: Right.

[Up to this point MW2A2 has been giving Donna lots of 'eye contact', when she asks Donna questions she holds her gaze and reinforces her words by 'head nodding' in order to get Donna to 'mirror' her. She is talking to Donna in a woman-to-woman manner in order to establish a personal relationship that she considers essential for a satisfactory (for both parties) pregnancy]

[in a loud voice, this points an ending of the woman to woman conversation and the beginning of the formal interview]

MW2A2:   Who's your G.P. Donna?

Donna: Doctor W.

MW2A2:   Now I tell you what I want to do first. I want to fill this sheet in [she outlines the sheet with her hands]. Just for statistics, then I want to sit and talk to you about this pregnancy.

[MW2A2 outlines the form that the interview will take. It will have two elements, the first part filling in the official form is less important but has to be completed for statistical reasons. The second element which is more important is to,

'[S]it and talk to you about this pregnancy

NB. MW2A2 wants to 'sit and talk' to Donna not give Donna advice or information. Although MW2A2 is the expert in this situation she relinquishes her position in the interaction and later empowers Donna by giving her input importance. MW2A2 knows that 'blanket care' is not appropriate in maternity, every mother is different with different needs and requirements. These can take an objective form such as individual medical requirements or a subjective form such as home birth, delivery positions, etc. Therefore in order to design a 'birth plan' appropriate to Donna's needs requires input from Donna. MW2A2 knows that this will only be forth coming from extremely confident mothers or by transforming the interview into a discussion between the two women.]

Donna: Right.

MW2A2:   Now any of these questions that I'm going to ask, you might think 'well what the heck is she asking me that for?' I want you to come back on me.

[Again MW2A2 empowers Donna inviting her opinion of the questions. This is also another way for Donna to indicate questions that she doesn't understand in order to elucidate and inform Donna on areas that she finds difficult to understand.]

Donna: Right I will.

MW2A2:   Ok, was you born in England Donna?

Donna: Yes,

MW2A2:   How old are you love?

Donna: 36.

MW2A2:   Do you work Donna?

Donna:	No.
MW2A2:	You don't work, you're a housewife or a student?
Donna:	I'm unemployed.
MW2A2:	Are you married Donna?
Donna:	Yes.
MW2A2:	Yes, does your husband work?
Donna:	Yes, he's a joiner.
MW2A2:	Right, you and your husband are not relations, you're not cousins?
Donna:	No.
MW2A2:	Now before you had this baby was you on any form of contraception?
Donna:	No.
MW2A2:	Was your periods regular?
Donna:	Yes.
MW2A2:	How many days do you lose blood?
Donna:	Erm, about 5.
MW2A2:	And when was the first day of your last menstrual cycle?
Donna:	Erm, about the 10th of November.
MW2A2:	So have they given you a date?
Donna:	No.
MW2A2:	Well, from that about the 17th of August, ok. Now that last period was it a normal period?
Donna:	Yes.
MW2A2:	Normal period of blood loss?

Donna: Yes.

[This seems to be a repeat question checking Donna's last menstrual period. This an important point to check whether Donna had had a true last period or just a 'show'. When a woman becomes pregnant it is not unusual for her to loose a small amount of blood when her period in due, this is known as a 'show'. If the woman mistakes a 'show' for a period, she will be have been pregnant for 4 weeks more than she realizes. Often (when the pregnancy has not been planned) a woman will be so worried that she might have 'got caught' i.e. might have got pregnant she will imagine the 'show' is a real menstrual period. However, once the woman is confirmed pregnant she will hesitate when asked about her last menstrual period.]

MW2A2:   From your doctors letter I can see it's not your first pregnancy.

Donna: No.

MW2A2:   How many pregnancies have you had?

Donna: Two previous ones.

MW2A2:   That's actual pregnancies you've had no miscarriages?

[This is a check, many woman might not consider a miscarriage a pregnancy. A history of miscarriages or terminations can have a considerable effect on the outcome of future pregnancies.]

Donna: No.

MW2A2:   Now, can I just take some details of these previous pregnancies please?

Donna: Yes.

MW2A2:   First pregnancy was when?

Donna: Erm, what when was she born?

[Donna became mixed up here, the talk about LMP made her wonder did MW2A2 want to know when the pregnancy started? i.e. the LMP of that pregnancy, or when the baby was born?]

MW2A2:   Yes.

Donna: Erm, sixth of the eighth eight one.

MW2A2:   That makes her eleven?

[MW2A2 checks the date, it is easy to mistake a child's date of birth but every mother knows her child's age.]

Donna: Yes.

MW2A2:   Where was she born?

Donna: Then sixth of the eighth.

MW2A2:   Yes where was she born?

Donna: Oh, Where was she born?

MW2A2:   Yes, where was she born?

Donna: Oh, where, Central.

MW2A2:   Town 1.

Donna: Right. And the second one was 23rd of the 3rd 83.

MW2A2:   Did you have that one in Town 1 as well?

Donna: Yes.

MW2A2:   Did you go full term with both children?

[A history of pre-term birth can indicate a risk factor.]

Donna: Yes.

MW2A2:   Anything wrong with both children that you were bothered about?

[MW2A2 asks Donna if there was anything about either of her children that Donna is worried about. She doesn't ask Donna a checklist of illnesses that the children may or may not have had. She knows that if anything is wrong with either of the children then the mother will bring it up. These may not occur on even an extensive checklist.]

Donna: No.

MW2A2:   That the medical staff or anybody was bothered about?

[A similar check but this time about the medical staff. This is a clever question, it is an open question about a 'yes or no fact' and thus allows the elicitation of more knowledge. The medical staff might have been worried about one of the children but these worries eventually prove foundless. This information might be important if for example the child has been a borderline case, responded well and been classified 'normal'.]

Donna: No.

MW2A2:   So it was all straight forward.

Donna: Yes.

MW2A2:   Now you were never at hospital for either of these children?

Donna: No.

MW2A2:   Right were you alright? Were they normal deliveries?

Donna: Erm, the first one I had forceps.

[This is a problem delivery usually performed by a doctor.]

MW2A2:   Yea, do you know why you had forceps?

Donna: Yea, epidural (this is a form of anaesthesia, inserted directly into the spinal column, deadening the area below the waist).

MW2A2:   Cos you had an epidural, we don't necessarily have to do that now, they've improved it a lot.

Donna: I'd never have one. Oh the second one was just normal.

[This is a important statement by Donna, and one that shows the appropriateness of individual care. Donna's experience of epidural (see below) was so traumatic that she would never have another one. This is a subjective preference which will over ride objective medical considerations.

MW2A2:   Now after you had the children was everything alright?

Donna: Erm, not after the first one.

MW2A2:   Why what went wrong?

Donna: I had to have the wound cauterized, the stitches went septic.

MW2A2:   Oh, I infer from that you were a right mess.

[MW2A2 backs up the information elicited from the open question and tries to pin down the specific details by asking a series of closed questions. MW2A2 then asks a series of questions to try to define the extent of the problems that Donna experienced]

Donna: [Nods].

MW2A2:   You had to have a lot of baths and things like that?

[This is the standard method of getting stitches to heal and prescribed to all women who have been extensively sutured.]

Donna: Yes.

MW2A2:   Re-sutured, did you have to be re-sutured?

[When sutures fail and need to be re-sutured, indicates the post natal period has been abnormal possibly due to a problem delivery or an infection after delivery.]

Donna: Erm, I went, erm.

MW2A2:   To hospital, you had to go back to hospital.

Donna: Erm, [yes].

MW2A2:   You had to go back down to theatre?

[This is another indication of the seriousness of the situation.]

Donna: D and C.

MW2A2:   D and C. (MW2A2 mutters something indistinct).

Donna: (Donna replies in an indistinct undertone).

[Indicates that Donna's post natal experience was indeed problematic. MW2A2's voice changes and becomes louder and more cheerful, indicating that the type of questions have changed from serious to easier to answer questions.]

MW2A2:   Little boys? Little girls (up note in the voice)?

Donna: Both girls.

MW2A2:   What did they both weight?

Donna: Erm, seven twelve and eight two.

MW2A2:   Thank you, and they are both ok, no medical record.

[MW2A2 indicates that a new area of questioning is to start.]

Right Medical and Surgical History. Is there anything, any operations you've had or any illness you've had that could cause concern?

Donna: No, none at all.

MW2A2:   None at all, did you have the normal childhood diseases, you know measles, german measles. Do you know if you've been vaccinated against (indistinct) at all.

[If a woman is infected with German measles or Rubella can give birth to a severely handicapped child. However, if she has had rubella previously or has been inoculated against rubella both she and her unborn child is protected. There is, however, a problem with measles in that measles is difficult to distinguish from other childhood diseases in general and rubella in particular. Therefore all women are routinely tested for Rubella.]

Donna: Erm, no.

MW2A2:   Your not sure?

Donna: No.

MW2A2:   Hmm, have you ever had a blood transfusion?

Donna: No.

MW2A2:   Are you sensitive to any drugs that you know of?

Donna: No.

MW2A2:   Now this applies to your husbands side as well, any history of twins?

Donna: No.

MW2A2:   Sugar diabetes?

Donna: No.

MW2A2:   Epilepsy?

Donna: No.

MW2A2:   Spina bifida?

Donna: No.

MW2A2:   T.B?

Donna: No.

MW2A2:   Anything that you were a bit bothered about?

(indistinct sentence) Have you got any questions? (smile).

[After a set of closed questions MW2A2 re-establishes dialogue with Donna inviting input.]

Donna: Not yet (returns smiles).

MW2A2:   Number 13 High Drive.   There's you, your husband and the two children.

Donna: Yea.

MW2A2:   Nobody else lives there?

[Checking for social problems such as overcrowding.]

Donna: No.

MW2A2:   Any pets?

Donna: Yea.

MW2A2:   What have you got?

Donna: Two cats,

MW2A2:   Do you know.

Donna: Two cats having kittens.

MW2A2:   Do you know the precautions you should take with the
              cats litter and things?

[leans back and looks at Donna and scratches her head. She leaves the form at one
side and engages in a conversation with Donna in which she informs Donna about
potential risks while pregnant. She invites Donna's participation. The importance
of this information is indicated by the fact that the form is put on one side while the
information is impressed upon Donna.]

Donna: No.

MW2A2:   Do you know the danger from cats?

MW2A2:   Only about the litter.

MW2A2:   That's it really, the litter tray. Taxi plasticize it is. It's a virus that
              can be passed on to your children from the litter tray. You've just got
              to be careful that's all.

Donna: Yes.

MW2A2:   Get your husband to change the litter tray, if you can't have a spare
              pair of gloves. Erm, and these gloves please, please, please make sure
              that they are just used for the cat's litter. Don't do like some of our
              mums, we tell them to have a spare pair of gloves and they end up
              doing the washing up in them. A spare pair of gloves for that alone.

              Ok so I don't actually know Alkridge is it

Donna: Middlebridge

MW2A2:   Is it near fields or anything like that?

Donna: No.

MW2A2:   Because do you know that it can be dangerous if erm, in the lambing
              season.

Donna: No.

MW2A2:   Oh, (something indistinct) another virus.

[They both laugh together.]

MW2A2:   It could, it could affect your pregnancy, so all we do is advise our mums to avoid, really about wandering about, in the Spring with the lambs. But if Alkridge is not near the fields it's not as bad as you know on the moors up there (she points to the hills).

               Right

[MW2A2 straightens up the paper, slaps the pen down leans back in her chair away from the table and says]

MW2A2:   Right you tell me about your pregnancy now. You tell me how you've been this pregnancy?

[This is a dramatic change of tack, she asks Donna an open question about how she feels her pregnancy is progressing. This is an empowering statement, Donna's subjective feelings are given importance.]

Donna: Erm, just tired.

MW2A2:   Anything else?

Donna: No.

MW2A2:   You, we need to know why?

Donna: Erm (nods).

MW2A2:   Well it's all theory this, there is no proof it's just theory. There is a big change, a big hormone change, going on in your body there's a big change, the biggest one is during the first 12 weeks of pregnancy. It's just natures way of saying 'Put everything down'. So don't be frightened about being tired. And don't jump to the conclusion automatically that you are anaemic. Lots of people are tired and not anaemic. We test your blood, I'll speak to you about that in a minute. Very (indistinct).

[In the holistic model of pregnancy, pregnancy is not a pathological or medical state

but an altered physical state. Bodily states regarded as abnormal in an non-pregnant woman are thus regarded as normal in a pregnant woman and vice versa. e.g. rapid weight gain is normal for a pregnant woman and abnormal for an non-pregnant woman. The maintenance of a stable weight or weight loss may be normal for an unpregnant woman but abnormal for a pregnant woman.]

MW2A2:   But are you eating well?

Donna: Yea.

[This is MW2A2's way of checking just what the mother is actually eating. When asked in this fashion it does not allow the mother to make up what she thinks the midwife wants to hear and indicates what she is actually eating. The use of this trick might indicate the importance that midwives attach to a good diet.]

MW2A2:   What did you have yesterday?

Donna: Erm, branflakes, and err cheese on toast, two satsumas and an apple, pork chop, roast potatoes (laughs)

MW2A2:   It's a good diet this (laughs) its good for you

Donna: Carrots and my supper.

MW2A2:   That's a good diet that is. It's a good diet. I'm sure that you don't need me to tell you that's a good diet. But urm, I ask some people that question and they'll come out and say 'alright', [when MW2A2 goes on to say] well tell me what you are eating and err its not what it should be. What we do like to say [pause]. Do you eat brown bread, you say you had cheese on toast, is it wholemeal you eat?

Donna: Sometimes.

MW2A2:   If you can, if you can go on to wholemeal bread well it's just more beneficial really, with vitamin B's you know for your pregnancy. And err, cereals, your taking cereals, ok and I thought you said two fruits.

Donna: Three fruits.

MW2A2:   Three.

Donna: Three.

[It is obvious that Donna knows what is a good diet and therefore MW2A2 spends

no more time on this topic.]

MW2A2:   Oh yes we like you to have three so that's alright, your doing ok there. Do you know what foods you should avoid?

[MW2A2 tries an alternative investigation of Donna's eating habits.]

Donna: No.

MW2A2:   Right liver, have you heard of liver?

Donna: No.

MW2A2:   You have heard of liver, but have you heard that you should avoid liver?

Donna: No.

MW2A2:   Well you should. That is the new directive that's coming up from the Department of Health, it's just a precautionary measure, to ask pregnant women not to eat liver. Err, the reason being it is the food that is fed to the cattle that's making a high Vitamin A content in the liver. Now this research was done in America but it's (indistinct) is to make a precautionary measure. ok.

Donna: (nods).

MW2A2:   Soft cheeses, have you heard what it is in cheese (indistinct). Well there's a sign that increased, that cheese. Have you heard about listeria.

Donna: Erm, (nods).

MW2A2:   Well listeria, it wouldn't matter a jot if you and me got listeria if we wasn't pregnant, it's just food poisoning. And you feel of color for a bit, get a rash er and don't feel very well, but you get over it. But you babies, baby can not stand it what so ever, it's very rare but what we are trying to do is minimize the risk. To minimize the risk you should avoid eating (counts on her fingers) soft cheeses, that haven't been processed. French cheeses, anything that hasn't got a (indistinct). Your alright about cottage cheese.

[Indicates the 'altered state' that pregnancy constitutes in that what is 'normally' considered constituents of a healthy diet are considered to put a pregnant woman and

or her unborn child at risk.]

Donna: Cottage cheese.

MW2A2:   Your alright about cottage cheese but the other watch out.

With fresh veg, they should be scrubbed up, they should be really clean. Because again listeria is in the soil. You know sometimes people bake potatoes and they just wash them under the tap, instead of scrubbing them. There's no cutting corners when your pregnant.

Do you have a micro wave?

Donna: (Shakes her head)

MW2A2:   Well if you re-heat pies? Do you buy pre-cooked pies, you've got to be really careful. I mean make sure they are thoroughly re-heated. Really what I'm trying to say, don't cut any corners and do every thing that your mother used to do. Make sure that your veg is washed thoroughly. Don't eat soft cheese and pate. Do you like pate?

Donna: Emm (yes).

MW2A2:   Please don't have any pate, the rest of the family can have it but not you when your pregnant. Alright is there anything you want to ask me or that

[At this point Donna speaks up and even interrupts MW2A2, pointing out a contradiction with the ante natal information she has received in the past and this advice.]

Donna: It's just that it's all changed, (ha ha) they used to tell you to eat liver didn't they?

MW2A2:   Well they did but you see it's new research that's been done and we just like try. Next time you have the next baby it might change back. There might be a new directive and that'd be it. Ok. Erm, do you smoke?

Donna: No.

MW2A2:   Does your husband smoke?

Donna: No.

MW2A2:   You know the dangers of a smokey atmosphere (indistinct), does anybody smoke at work?

Donna: Yes.

MW2A2:   Oh, you don't work (laughs).

[MW2A2 has unwittingly uncovered an anomaly in Donna's answers. She either doesn't considers that she is employed, because the work is part time or menial (in comparison with the employment of which Donna a graduate is capable.) or she might be working in the 'black economy' and for reasons of her own not wish MW2A2 (an official figure) to know.]

Donna: Well I'm unemployed but I work part time in a pub.

MW2A2:   Oh dear, that's a bit difficult in a pub isn't it, because they smoke in the pub.

Donna: Your telling me.

MW2A2:   Well try to stand back away from the bar and avoid it as much as you can, cos passive smoking can be dangerous. Do you drink?

Donna: No not when I'm pregnant.

MW2A2:   Good cos that's a risk too. We don't, we want to minimize risks, alright. Right have you any complaints while you've been pregnant.

[Here once again she uses an open question to ask Donna to comment on the progress of her pregnancy.]

Donna: No.

MW2A2:   None at all, are you on any tablets?

[MW2A2 is prompting here.]

Donna: No.

MW2A2:   You've had no bleeding?

Donna: No.

[Although Donna says that she has experienced no bleeding MW2A2 goes on to

explain that it is a significant symptom that while normal for none pregnant women is abnormal for pregnant women.]

MW2A2:   Bleeding is abnormal in pregnancy, if there's any bleeding at all I want you to get in touch with your doctor right away. I'm not telling you that it's panic stations but it should be looked into.

Donna: Ok.

[MW2A2 explains that although discharge can be normal it under certain circumstances can indicate problems. As such MW2A2 is educating Donna to be alert to medical indicators.]

MW2A2:   Now you might have noticed Donna that you have a discharge. That's only because you have a (indistinct) and some women don't like to talk about it. And I'm telling you about it, now it's important that if it becomes offensive or itchy at all that you go to the G.P. and sort it out.

Donna: Yes.

MW2A2:   It's as easy as that. Now have you thought about how you are going to feed, I know it is a long way off, but

Donna: Breast feeding.

MW2A2:   Did you breast feed the other children?

Donna: Yes.

MW2A2:   Any problems?

Donna: No.

MW2A2:   Good. If you have any problems, obviously the midwife's there to help you get breast feeding established. But if there's anything your not happy about, you come to me, but with breast feeding two already you probably know more about it than any body. When did you last have a chest X-ray?

Donna: Erm, can't remember.

[This is an indirect trick question, perhaps MW2A2 has had problems eliciting answers to this question innocuous though it seems. But then she goes on to tell

Donna that it was a trick. Perhaps it is alerting Donna that the questions are not all as direct as they seem and act as a warning to give truthful answers.]

MW2A2: That's alright, bit of a catch question, in case you've had one while you've been pregnant. When did you last have a smear Donna?

Donna: Erm, three years ago

MW2A2: Three years since, now you've a choice Donna, you can have your smear done if you want it today or you can leave it till you've had your baby.

[This is a strange question MW2A2 gives Donna the choice of having the smear test now or after the birth, not of having the test or not. I later asked MW2A2 was this a deliberate ploy to get the mums to have a smear test. She laughed not being aware of the persuasive way the question was poised. She didn't, however, seem repentant, anything that encouraged women to have their smear test was justified in MW2A2s eyes. I think that rather than being coercive MW2A2 never considered that a woman would not wish to have a smear therefore the choice was as far as she was concerned when rather that whether the woman had the test.]

Donna: Can I have it done today?

MW2A2: There you are (making a note to do the smear today), we'll do that today. So, so far is there anything else you want to ask me about?

Donna: No not at all really.

MW2A2: Right so how many weeks are you Donna (looking at the notes) 10th of November.....9 weeks right that's enough information today. For 9 weeks we don't do anything, take blood for investigations. The doctor will come in at the finish to listen to you heart and chest to check that you are medically alright and (indistinct). Ok.

[Blood tests are usually performed on women at least 16 weeks pregnant and therefore inappropriate to Donna at this time.]

Donna: Right.

MW2A2: Now I'll just tell you about the tests, because I don't know (looks at the notes) 1983 some of these tests might have changed since. What we offer you today, and if there is any...(-thing you want to ask). Blood tests that you want to know more about, just you know. We test the blood for German Measles and I asked you about German

Measles and you said you were not quite sure about that. We do one W.R.(indistinct) for venereal disease. We do the group (indistinct) test are five routine tests. Now I'm sure you have heard of H.I.V.

Donna: Yes.

MW2A2:   That test is not offered, it is offered but not, it is offered but it is not open to everybody that. We offer it to anybody who falls into a 'high risk' category and from the history you've given me I can't see you falling in a 'high risk' category.

Donna: No.

MW2A2:   Do you know what the 'high risk' category is?

Donna: Erm.

MW2A2:   And anybody you know, well do you live with anybody in a 'high risk'.

Donna: No.

MW2A2:   I mean you could have the H.I.V. [test] Donna but it is a separate test and I need have to sit and talk to a bit about it.

Donna: Yes.

MW2A2:   Now there is a possibility Donna under the National Screening Test going on at the moment that some of your blood may be used in a H.I.V. screen which is anonymous. You don't need to be one of the sample but if there's any objection I'll put a sticker on it and it wont act as a sample.

Donna: No.

MW2A2:   Right, Hepatitis B is another test that we offer to people that fall in a 'high risk' group, but you don't. There are.... Have you heard of any other tests you want to know about?

Donna: No none.

MW2A2:   Because at 36 years old you don't really fall into the category of any other screening test, another 12 months, you would do, they would be offering you further tests but at 36 you are all done at this stage. You

quite happy about that?

Donna: Yes.

MW2A2:   You haven't thought about any further tests.

[MW2A2 asks Donna twice are there any other tests that she wants to know about. The obvious test for a woman her age is for Downs Syndrome. Donna doesn't raise this subject and so MW2A2 rounds up this part of the interview.]

Donna: No.

MW2A2:   That's the history taking, I usually introduce the source material as I do the rest (*physical examinations*).