CRANFIELD UNIVERSITY

Paul Trott

INWARD TECHNOLOGY TRANSFER AS AN INTERACTIVE PROCESS: A CASE STUDY OF ICI

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Paul Trott

Inward technology transfer as an interactive process: A case study of ICI

Supervisors: Professor M Cordey-Hayes
RAF Seaton

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Abstract

This thesis sets out to explore the area of inward technology transfer and in particular the notion of "receptivity". A conceptual framework is developed which identifies four major components of the inward technology transfer process. These are: "Awareness"-"Association"-"Assimilation"-"Application".

Using this conceptual device a series of investigations are undertaken into three of these components. These studies are conducted within a number of businesses within ICI Chemicals and Polymers Ltd. A combination of structured and semi-structured interviews are used along with cognitive mapping to uncover the factors involved.

A process theory approach is used in this thesis to uncover not only the key variables that affect inward technology transfer but also how they affect it. Hence, a number of models are developed showing the sequencing of the variables uncovered.

The results of the analysis reveal the importance of technology scanning and prior knowledge in enabling organisations to recognise the value of external information, to assimilate this with internal capabilities and to apply it for commercial ends.

The implications of these findings with respect to technology policy in the UK are also discussed.

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List of contents

Section and title | **Page**

Appendices

List of figures

Chapter 1

1.1 Research Overview

1.1.1 Background

The last few years have seen an unprecedented level of debate on the UK's record of innovation. As a consequence of this we have seen the publication of an annual "R&D Score-board" which shows, along with many other facts and figures, the level of Research and Development (R&D) expenditure by UK industry and provides international comparisons. In addition the Government have recently published a White Paper ('Realising our Potential'; 1993) on science and technology; the first for twenty years. The debate has focussed on the alleged inability of UK industry to commercialise and profit from its scientific and technological developments. The Minister for Science has said 'good science is not our problem in Britain. Our problem is making use of it'. Many theories have been advanced to account for Britain's "innovation gap". Some cite long term Government under-investment in R&D, others the skewing of publicly funded R&D towards defence, others the so-called "Hanson style of management" which is characterised by emphasis on short-term earnings (Mathews, 1993), and some the comparatively low level of private sector R&D spending in this country. Nonetheless, the Government and industry annually spend over £1.5 and £6 billion respectively on R&D[1]. Ensuring this investment is used effectively is a priority of all those involved in the management of innovation.

The industrialised world has seen a shift from labour and capital intensive industries to knowledge and technology based economies. As competition has increased in markets throughout the world, technology has emerged as the significant business factor and a primary commodity. Knowledge transformed into know-how or technology has become a major asset of companies. Today, technology[2] is necessary for a business to remain competitive. In rapidly evolving markets, such as electronics and biotechnology, new products based on new technology are essential. Even in mature markets, new technology is necessary to remain competitive in cost and quality. In the 1960's and 1970's, many businesses emphasised internal development of technology. But today, with the increasing technological content of many products, many organisations consider internal development too uncertain, too expensive, and too slow for the rapid technological changes that are occuring in the market. These drawbacks can be traced to a more fundamental cause. That is, the increasing complexity of technologies and the increasing range of technologies

1 These figures were taken from Partners in Innovation (1992). Report prepared by McKinsey and Company, in collaboration with Business in the Community and the Prince of Wales award for innovation.
2 Technology is defined as knowledge, of whatever sort, applied to products or production processes.

found within products. This has led to a shortening of product life cycles with replacement technologies following in rapid succession. Furthermore the rising costs of conducting R&D have forced many organisations to look for partners in R&D. Companies are finding it increasingly difficult to sustain R&D capability over all areas of their business as the complexity of these areas increases. In additon few companies can finance extensive and complex R&D. Internal R&D is increasingly focussed on core competences (see Hamel and Prahalad, 1990). R&D in all other business activities is increasingly covered by collaborations, partnerships, strategic alliances, or whatever term is used to describe the activity of two or more organisations working together to mutual benefit. While the activity is not new, (Alfred Marshal noted the extensive linkages between firms in his work in 1919 (CEST, 1991)), the extent of collaboration appears to be increasing. Hagedoorn (1990), for example, has shown a marked increase in the amount of collaboration between firms during the 1980's. It seems clear that more and more companies are looking for outside sources of either basic technology to shorten product development time, or of commercial technology to avoid the costs and delay of research and development. In addition, avoiding the notion of "re-inventing the wheel" appears to be high on the list of corporate objectives. Previously there was one well known exception to this and that was where a competitor was involved. Under these circumstances duplication of research was regarded as inevitable and thus acceptable. However, numerous recent technological collaborations between known competitors, for example IBM and Apple Computers, General Motors and BMW to name but a few, would suggest that even this exception is becoming less acceptable to industry.

The search for, acquisition and exploitation of developed technology is clearly of interest to virtually all sectors of industry, but it is of particular interest to R&D-intensive industries or science based industries. A recent US Government study on technology transfer stated: 'Corporations trade in technology in world markets just as they do in other goods and services'.

1.1.2 The research Project

This research was sponsored by the Science and Engineering Research Council (SERC) under the "Total Technology Programme". The programme is designed to enable research to be undertaken with an industrial partner. In this case the collaborating and sponsoring company was **ICI Chemicals & Polymers Ltd.**

This research project follows on from a previous piece of research carried out at The Innovation and Technology Assessment Unit (INTA) at Cranfield Institute of Technology.

Lefever's (1992) study of the role of intermediaries in the technology transfer process highlights a mismatch between the needs of potential innovators and the activities of information-centred technology transfer intermediaries. This deficiency was illuminated through the use of a conceptual model: Accessibility—Mobility—Receptivity (AMR). The research revealed that while much effort appeared to have been directed at providing "access" to technology little effort had been aimed at understanding the needs of organisations acquiring technology developed outside the organisation. An organisation's overall ability to be aware of, to identify, and to take effective advantage of, technology is refered to as "receptivity". Other writers have recently described such a notion, specifically in the context of R&D, as "absorptive capacity" (Cohen & Levinthal, 1990). Lefever advocates the adoption of a more 'consumer need-centred and interactive approach' to uncover the factors involved in "receptivity".

During 1989 ICI C&P established a Technology Trawling Group (TTG) to search for technology that the organisation could use to build a new business for the C&P group. This move was the direct result of an executive decision to expand operations towards the year 2000, and build a new business that was related to the overall corporate strategy of ICI C&P Ltd. The emphasis was on diversification through the identification of technology that could be developed into new products that were related to existing commercial activities (See Ansoff, 1957). The location of the Technology Trawling exercise was the USA where two thirds of the free world's research takes place (ICI, 1989).

The process of acquiring externally developed technology, bringing it back into ICI and utilising the acquired technology proved to be far more complex than was originally envisaged. The TTG was able to identify and gain access to technologies that were related to the activities of the existing businesses. However, the various ICI businesses appeared to be reluctant to adopt these technologies. Here was evidence, if evidence was required, that providing businesses with access to technology does little to foster inward technology transfer. It was clear that in order to successfully transfer externally developed technology into an organisation it was necessary to understand the process from the viewpoint of the "receiving" organisation. A study of the organisational factors involved in the process should help improve our understanding of inward technology transfer. Hence, the focus of this piece of research is:

> *an organisation's overall ability to be aware of, to identify, and to take effective advantage of technology.*

This is refered to as **inward technology transfer.** The aim of this research is to improve our understanding of inward technology transfer (receptivity). In the context of this study the notion of "receptivity" conforms to the generalised understanding of inward technology transfer.

1.1.3 Overview of presentation of research

The thesis presented here sets out to explore the inward technology transfer process previously refered to as "receptivity" by Lefever (1992). The research is undertaken from within a large multinational chemical company and analyses the process as seen from the organisation's stand point. A conceptual framework that is derived from the literature and discussions at ICI is presented in Chapter 3. This framework is made up of four elements: Awareness—Association—Assimilation—Application; later refered to as "4A". These elements provide an interesting way of looking at the inward technology transfer process. The research methods selected to explore the Inward Technology Transfer process are set out in Chapter 4. Three separate studies are undertaken to examine the factors involved in this process. Chapter 5 includes the first study which explores the issues involved in managing R&D within a large multi-national chemical company like ICI. It discusses the technology management strategy and looks at two businesses, in particular the Watercare business and the Solvents business. The first study is an exploratory study that involves a series of semi-structured interviews with research and commercial managers from ICI. The results of this study provide a typology of the factors involved in the process and an improved focus for the subsequent studies. The second study, shown in Chapter 6, attempts to uncover the factors involved in "Awareness" and "Association" using a structured interview technique. Chapters 7 and 8 contain the third and final study, which focuses on "Assimilation" and uses an elementary form of an interactive modelling technique known as cognitive mapping. A summary and integration of the substantive findings of the research is shown in Chapter 9. These emphasise the need for organisations to recognise the importance of scanning and networking in order for the organisation to remain informed and vigilant of opportunities available. It stresses the importance of internal interaction on the part of individuals within the organisation so that the organisation can learn and understand about the opportunities available to it. The conclusions in Chapter 10 locate the work within the intellectual field and evaluates the substantive findings of the research, including the use of the conceptual framework, refered to as 4A earlier.

1.2 The acquisition of externally developed technology

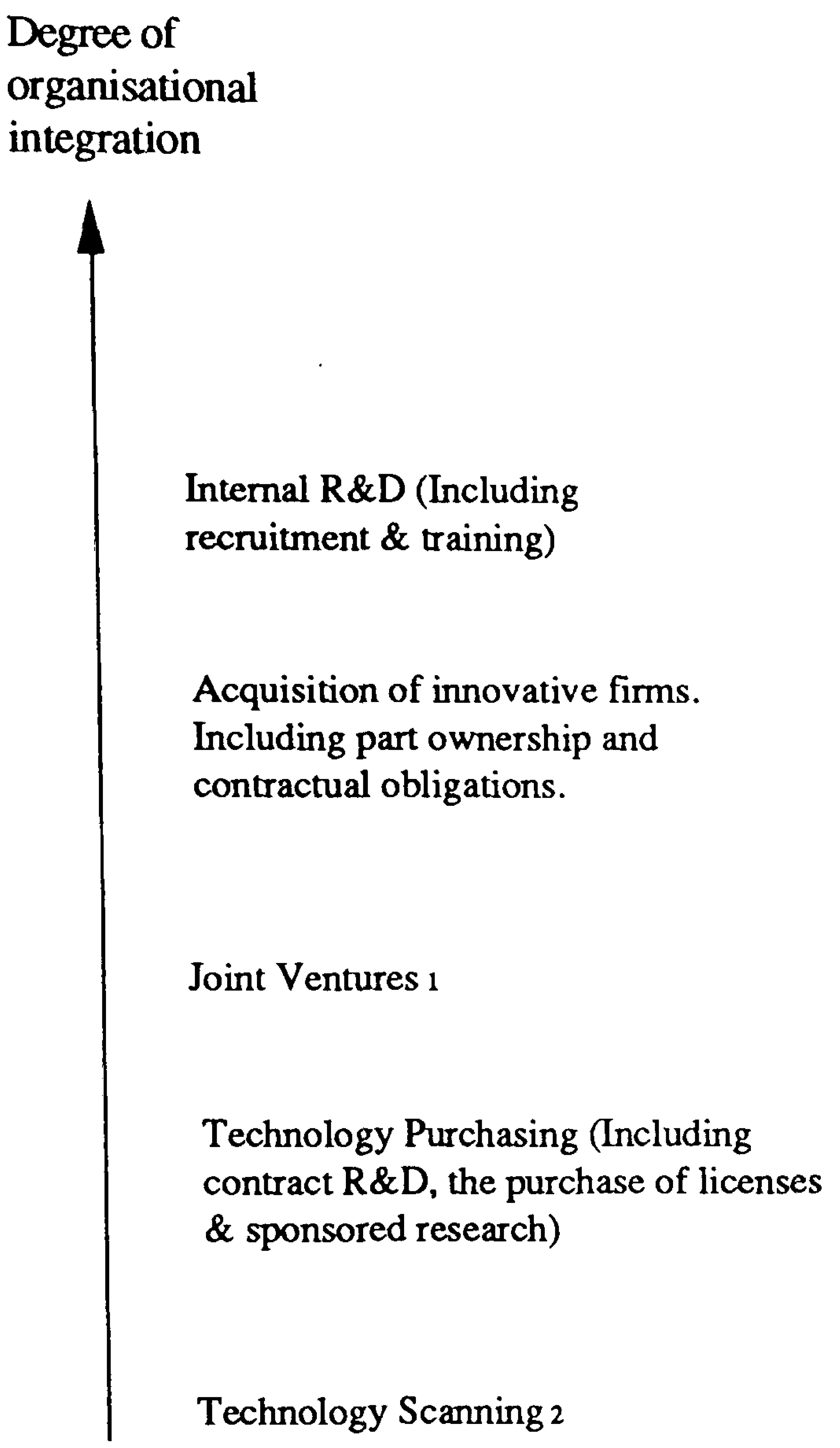
1.2.1 An introduction

A recent study of firms in Sweden, Japan and the United States revealed that the external acquisition of technology was the most prominent technology management issue in multi-technology corporations (Granstrand et al, 1992). The role of traditional R&D management, particularly in Western technology based companies has been on the management of internal R&D. One could argue that one of the most noticeable activities of Japanese companies since the war has been the ability to successfully acquire and utilise technology from other companies around the world. The British motor bike and car industries are often quoted as examples of British technology that was acquired by the Japanese and subsequently developed and exploited.

Granstrand et al suggest that the external acquisition of technology emphasises new responsibilities for technology managers. This implies that acquiring technology from outside the organisation is something new. This is clearly not the case as the long history of licensing agreements will show. However, the importance now being placed on technology acquisition by technology based companies may reveal a departure from a concentration on internal R&D and an acknowledgement that internal R&D is now only one of many technology development options available to companies. The authors offer a useful typology of strategies for acquisition and exploitation of technology. The technology base of a company is viewed as an asset that represents the technological capability that the company possesses. The authors point out, however, that strategies for technology acquisition require integration with in-house R&D. The different acquisition strategies involve varying degrees of organisational and managerial integration. Internal R&D is viewed as the most integrated technology acquisition strategy with Technology Scanning as the least integrated strategy (see figure 1.1). Technology Scanning is narrowly defined by Grandstrand as illegal and legal forms of acquiring technological know-how from outside.

Figure 1.1

Technology acquisition strategies



File: McDAqutech

Notes:
1. Joint ventures refer to inter-firm R&D cooperation in general-not necessarily formalised-for example, with subcontractors.
2. Includes formal and informal, legal and illegal forms of acquiring technological know-how from outside without any direct purchasing from its original source. Eg: Personal and company networks.

Source Granstrand (1992).

This classification provides an illustration of the numerous ways of acquiring external technology. Other classifications can be found in the technology transfer literature: Auster (1987); Chesnais (1988); Hagedoorn (1990); and Lefever (1992). All these studies offer a classification of only the formal methods of technology transfer. They ignore the many forms of informal linkages, alliances and industry associations that are known to exist and result in the extensive transfer of knowledge and technology[3]. Granstrand talks about

3 See von Hippel, 1987; Kriener & Schultz, 1990; and Rothwell & Dodgson 1991.

technology scanning as representing illegal and legal forms of technology acquisition but does not explore how organisations scan or the activities involved. Thus, while he reports that organisations perceive technology scanning to be important, we remain in the dark as to how we are supposed to do it.

1.3. Overview of the limitations of the literature

Much of the early literature on inward technology transfer centred around the ability of organisations to access technological knowledge (Gruber & Marquis, 1969) and the subsequent ability of organisations to effectively disseminate this information. Allen's work in the 1960's on the role of gatekeepers within organisations exemplifies this (see Allen 1966, '69, '77). While such a provision of technical ideas is a necessary part of technology transfer it is only one component of a more complex process (Seaton & Cordey-Hayes, 1993) as the Technology Trawling Group from ICI discovered.

The review of the technology transfer literature by Godkin (1988) reports many of the factors thought and shown to influence it. Selected factors are discussed at length and placed in their historical context. This review shows that technology transfer has largely been seen in terms of the provision of technical ideas on the assumption that increased exposure to these ideas would in some way enable industrial companies to benefit from this access (Seaton and Cordey-Hayes 1993). The emphasis on providing information about access to technology is apparent in the range of technology transfer mechanisms that have been developed over the last twenty years or so. Lefever (1992) offers a review of the limitations of recent and current models of industrial technology transfer. These mechanisms assume that technology transfer may be viewed as part of the linear model of innovation and, as such, once access is provided to these technologies, organisations will be able to take the technology back to their development labs and produce a variety of innovative products. The linear models of innovation have a number of weaknesses which are detailed by many authors including: Rothwell & Zigweld, (1985) and Turney, (1991). Cooke, (1992) argues 'that because the linear model of innovation is simple to think with, it has consequently taken a firm grip on policy making'. The developments in the dominant perceived model of industrial innovation from the simple linear "technology push" and "needs pull" models of the 1960's and early 1970's, through the "coupling model" of the early eighties to the interactive model of today are reviewed in Rothwell (1992).

1.3.1 Limitations and deficiencies of inward technology transfer mechanisms

Research at the Innovation & Technology Assessment Unit (INTA), Cranfield Institute of Technology, suggests that most current technology transfer mechanisms exhibit a number of limitations or deficiencies (see Seaton & Cordey-Hayes, 1993; Lefever, 1992).

1. They fail to understand the recipient organisations needs. That is to say, mechanisms tend to emphasise the marketing and selling of technology and as products to organisations that have explicit needs and requests rather than provide a business service that aids the process of diagnosing, searching for and matching the available technology to implicit needs.

2. The mechanisms tend to offer technology primarily in terms of technical and economic attributes and fail to consider the recipient organisation's capacity to fully utilise the technology for competitive advantage or effectiveness

3. They under-estimate the importance of the interactive processes and mechanisms between the donor and recipient, necessary for successful transfer. They fail to recognise that successful transfer seldom involves just a simple one-off transaction. It is a process of dialogue between a variety of actors in the two parties and involves a continuing relationship to the point where real benefit accrues to the recipient.

4. They assume that recipient organisations are able to diagnose their problems in terms of technological requirements.

Seaton & Cordey-Hayes (1993) argue that there has been little thought and research aimed at the difficulties of exploitation of externally developed technology within companies. They suggest that this is because technology transfer has largely been seen in terms of only providing access to technology. They emphasise the need to view technology transfer as a process. This wider view is taken to mean:

> *'the process of promoting technical innovation through the transfer of ideas, knowledge, devices and artefacts from leading edge companies, R&D organisations and academic research to more general and effective application in industry and commerce'.*

Seaton and Cordey-Hayes (1993).

1.3.2 The need for a process based approach to the study of inward technology transfer

The management literature is littered with prescriptions about what managers ought to do in order to be better managers. The central weakness of many of these prescriptions is that they appear to bear little relation to what managers actually do, and why. They are not sufficiently grounded and tested in the practical world of organisational life as it is experienced and performed. As such, they can only be of limited relevance and use.

Furthermore, the organisational innovation literature and the technology transfer literature tends to use a structural approach when exploring the factors involved in inward technology transfer and the ability of organisations to innovate. Hence, discussions are dominated by how organisational structures and management strategies affect an organisations ability to innovate or acquire technology from outside. For example, Burns and Stalker (1961) supported the view that flexible organisational forms will sustain innovation but bureaucratic firms will not. Rothwell (1975) discusses the importance of key individuals in the process; in this case the business innovator. Ansoff (1968) suggests the need for forecasting and environmental analysis techniques at the strategic management level. Rothwell (1974) stresses the importance of good communications. Similarly Daft (1986) emphasises the need for stable knowledge bases enhanced through stable communication. Rothwell (1991) argues the need for qualified scientists and engineers to increase the extent of external networking in small and medium sized firms. Rothwell (1992) offers a list of "critical success factors" necessary for successful industrial innovation. These include: company interaction with technology sources and markets; innovation as strategy; and internal control systems. All of these studies emphasise the presence or absence of certain factors rather than describing the actual activities or processes that are required by them. For example, in Rothwell (1991) what activities and processes are to be fulfilled by qualified scientists and engineers in order to increase the extent of networking for small firms?

All these studies offer a structural rather than process approach to the study of organisational characteristics involved in industrial innovation. Marcus and Robey (1988) discuss in some detail the substance of theories that have been advanced to explain how and why information technology affects organisations. Their arguments focus on the use of process models to understand organisational characteristics. They suggest that process models have been neglected in favour of the more common variance model. Variance models result from the use of a variance theory approach which tends to search for variables that are seen as a necessary <u>and</u> sufficient condition for an outcome. Whereas a process theory approach tend to produce models that identify conditions that are seen as necessary but insufficient to "cause" an outcome. Marcus and Robey argue that if these necessary conditions are then combined in a 'receipe that strings them together in such a way as to tell the story of how the outcome occurs whenever it does occcur', this constitutes a satisfactory theory. While process theories, and subsequent process models, have lower aspirations about 'explained variance', **they provide a richer explanation of how and why the outcomes occur when they occur.**

There have been few process orientated studies that address organisation characteristics on the ability of organisations to generate innovation and technological change. Two noteable exceptions are Burgleman's (1983) process model of internal corporate venturing (discussed in some detail in Chapter Three) and Pavitt's inductive study of large innovative firms. He remarks:

> *'large innovating firms in the twentieth century have shown resilience and longevity, in spite of successive ways of radical innovations that have called into question their established skills and procedures... Such institutional continuity in the face of technological discontinuity cannot be explained simply by the rise and fall of either talented individual entrepreneurs or of groups with specific technical skills. The continuing ability to absorb and mobilise new skills and opportunities has to be explained on other terms'*
>
> (Pavitt, 1991).

Pavitt identifies a number of properties of innovative activities in large firms. He places a great deal of emphasis on the concept of firm-specific competences that take time to develop and are costly to initiate. Key features of these innovative firm competences are the ability to convert technical competencies into effective innovation and the generation of effective organisational learning. This concept of the organisation retaining knowledge is developed by Willman (1991) who argues that 'the organisation itself, rather than the individuals who pass through it, retains and generates innovative capacity, even though individuals may be identified who propagate learning'. A similar view is held by Cohen and Levinthal (1990) who reconceptualise the role of R&D investment, which has traditionaly been viewed as simply a factor aimed at creating specific innovations. They see R&D expenditure as an investment in an organisation's "absorptive capacity". They argue that an organisation's ability to evaluate and utilise external knowledge is related to its prior knowledge and expertise and that this prior knowledge is, in turn, driven by prior R&D investment.

The observations above suggest a need to analyse organisational knowledge and the processes involved in realising that knowledge rather than analysing organisational structure. If we can uncover the internal processes that determine a company's response to a given technology, this may help to explain the longevity of large innovating companies. Hence, this type of investigation suggests the need for a process rather than structural approach.

1.4 Research Framework: The use of a Conceptual Model to study and evaluate the process of Inward Technology Transfer

1.4.1 Development of a process model of inward technology transfer

Given the limitations of the structural view of inward technology transfer and the lack of understanding of the organisational characteristics involved in inward technology transfer, a process view of inward technology transfer is developed in this thesis. It is argued that inward technology transfer will only be successful if an organisation has not only the ability to acquire but also the ability to assimilate and apply ideas, knowledge, devices and artefacts effectively. Organisations will only respond to technological opportunity in terms of their own perceptions of its benefits and costs and in relation to their own needs and technical, organisational, and human resources. The process view of inward technology transfer, therefore, is concerned with creating or raising the capability for innovation. This requires an organisation and the individuals within it to have the capability to:

-search and scan for information which is new to the organisation (**awareness**)

-recognise the potential benefit of this information by **associating** it with internal organisational needs and capabilities.

-communicate these to and **assimilate** them within the organisation.

-**apply** them for competitive advantage.

These processes are captured in the following stages: Awareness; Association; Assimilation; and Application. This four stage conceptual framework is developed in Chapter 3 and is used to explore the processes involved in inward technology transfer. Awareness describes the processes by which an organisation scans for and discovers what information on technology is available; Association describes the processes by which an organisation recognises the value of this technology (ideas) for the organisation; Assimilation describes the processes by which the organisation communicates these ideas within the organisation and creates genuine business opportunities; and Application describes the processes by which the organisation applies this technology for competitive advantage.

It is a conceptual tool that is used throughout the thesis as a way of studying the process of inward technology transfer. In Chapters 5, 6, 7 and 8 the framework is used to analyse the results from the three studies undertaken.

1.4.2 The role of the individual in inward technology transfer

The innovation literature has consistantly acknowledged the importance of the role of the individual within the industrial technological innovation process. (Rothwell, 1974; Szakastis, et al, 1974; Langrish, 1972; Schock, 1974; Utterback, 1975; Rothwell, 1976) Consequently a variety of "key-roles" have developed from the literature stressing the particular qualities associated with these roles (Figure 1.2 shows a summary of the predominant key-roles.) Notwithstanding this, Rubenstien et al (1976) went further arguing that the innovation process is essentially a people process, and that organisation structure, formal decision making processes, delegation of authority and other formal aspects of a so-called well run company are not necessary conditions for successful technological innovation. Their studies revealed that certain individuals had fulfiled a variety of roles (often informal) that had contributed to successful technological innovation.

Figure 1.2 **Key individual roles within the innovation process**

Key individual	**Role**
Technical Innovator	Expert in one or two fields. Generates new ideas and sees new and different ways of doing things. Also refered to as the "mad scientist"
Gatekeeper	Keeps informed of related developemnts that occur outside the organisation through journals, conferences, colleagues and other companies. Passess information on to others; finds it easy to talk to colleagues. Serves as an information resource for others in the organisation.
Product Champion	Sells new ideas to others in the organisation. Gets resources. Aggressive in championing his or her cause. Takes risks.

Project Leader	Provides the team leadership and motivation. Plans and organises the project. Ensures the administrative requirements are met. Provides necessary coordination among team members. Sees the project moves forward effectively. Balances the project goals with organisational needs.
Sponsor	Provides access to a power base within the organisation-a senior person. Buffers the project team from unnecessary organisational constraints Hepls the project team to get what it needs from other parts of the organisation. Provides legitamcy and organisational confidence in the project.

Based on Roberts and Fusfield (1981).

In a recent study of biotechnology firms Sheene (1991) explains that it is part of a scientist's professional skills to keep up-to-date with the literature. This is achieved by extensive scanning of the literature. However, she identified feelings of guilt associated with browsing in the library by some scientists. This was apparently due to a fear that some senior managers might not see this as a constructive use of their time. Many other studies have also shown that the role of the individual is critical in the technology transfer process (Allen & Cohen, 1969; Allen, 1977; Tushman, 1977;.Tushman & Scanlan, 1981).

1.4.3 A research framework

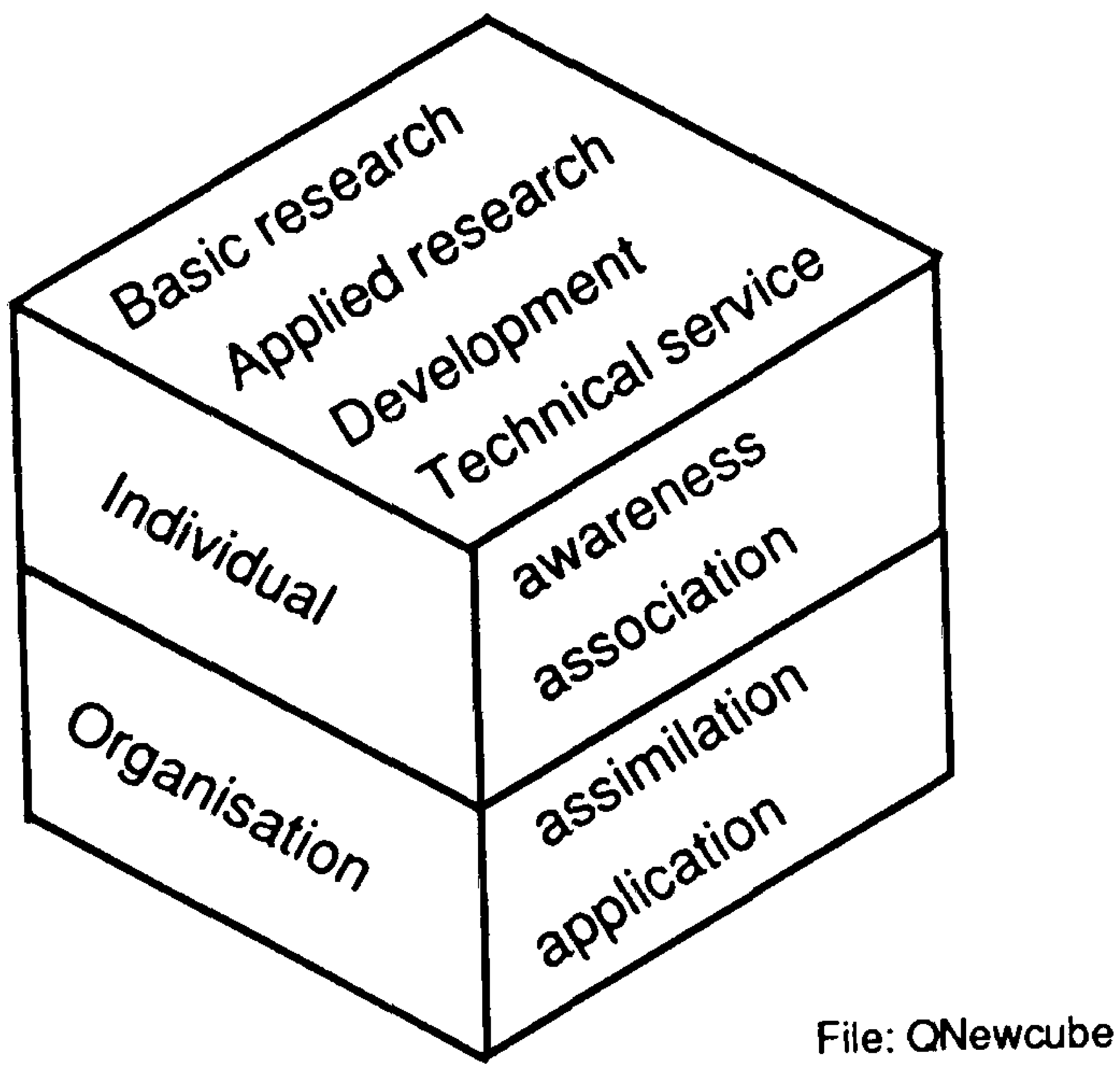
The previous discussions have established that in order to uncover the organisational characteristics involved in inward technology transfer it is necessary to analyse the processes involved. We have also established that the role of the individual is influential in the process. Thus, it would be interesting to analyse the organisational factors from the point of view of the actors involved and hence, find out what is their perception of the key processes involved. An organisation-based study centred on the role of the actors involved in the "Inward Technology Transfer" process would help to improve our understanding of the organisational characteristics involved in the process.

The importance of the issues raised in the preceding sections, namely: the weaknesses of a structural approach and the need to use a process approach, as outlined in section 1.3; the conceptual model of inward technology transfer derived in Chapter 3; and the significance of the role of the individual; are brought together in the following research framework (the detailed development of this is shown in Chapter 5). This framework also includes a breakdown of internal R&D functional activities. This is used to help focus the research. A particular area of internal R&D is selected for analysis. The many tasks which an R&D function performs are vast. They include:

- Fundamental research (often called blue sky research);
- Applied research, directed at a particular product or process;
- Development (often called new product/process development);
- Modification of existing products/processes;
- Quality control (especially in process industry);
- Provision of technical service to commercial sections.

These tasks have been combined into four main categories and are shown in the research framework[4] (Figure 1.3).

Figure 1.3



1.5 The Research Questions

The following research questions were formulated using the research framework in Figure 1.3:

- What are the key processes that affect an individual's ability to be **aware** of externally developed technology?

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4 Martin Harvey, Business Development Manager, ICI C&P was instrumental in the design of this research framework.

• What are the key processes that affect an individual's ability to **associate** externally developed technology with the needs and capabilities of their organisation?

• What are the key processes that affect an organisation's ability to **assimilate** externally developed technology?

• What are the key processes that affect an organisation's ability to be **apply** externally developed technology for competitive advantage?

The final question above caused a certain amount of unease. An investigation into whether an organisation had applied technology for competitive advantage tended to suggest a study looking for "winners". That is, a historical analysis of examples where technology had been applied successfully encourages the listing of factors contributing to the success. What is needed is a study that uncovers how these factors affected the successful application of the technology. Hence, such a study would need to be undertaken from within an organisation. Furthermore, due to the limited time available it was decided to concentrate the research effort on the other three areas. These questions formed the basis of the three research activities that were undertaken in this thesis.

1.6 Contribution of thesis to the area of study

Firstly, a contribution is made to process theory on technology transfer through the development and testing of a conceptual framework (4A) of inward technology transfer. In particular that successful technology transfer is dependent on the existence of certain internal organisational competences. Secondly, the evaluative framework developed in this thesis and used to analyse the process of inward technology transfer has uncovered issues that have not been revealed by other studies that have used a structural, top-down approach. The 4A conceptual framework used for this research was an interesting conceptual device that highlighted the importance of the following human-centred non-routine activities in the inward technology transfer process:

- Scanning and the use of networks to remain aware of technical and commercial opportunities;
- Tuned-scanning (high signal-to-noise ratio) ensures that scanning activities are tuned to the needs and capabilities of the business;
- Formal and informal methods of internal interaction ensure the organisation assimilates business opportunities;

- Credibility and respect for colleagues that is derived from a history of using knowledge effectively;
- A "spirit" within the business that can generate enthusiasm and drive the processes mentioned above.

The study has revealed the importance of social interaction at all stages of the inward technology transfer process and suggests that future investigations should take this into account before embarking on a study in this area.

Chapter Two

The receptivity of organisations to inward technology transfer: A review of the literature

This chapter reviews the main bodies of literature that have made contributions to our understanding of the receptivity of organisations to inward technology transfer. These can be divided into studies in organisational behaviour; technology transfer; and business management. The chapter is divided into three main sections. The first section (2.1) reviews previous studies on industrial innovation and inward technology transfer; the argument is that internal organisational factors are an important consideration in inward technology transfer. The second section (2.4) considers the strategic management of technology by businesses. The final section (2.5) discusses the internal organisational factors that affect the receptivity of organisations to inward technology transfer. The conclusion is that an organisation's internal activities affect its ability to engage in inward technology transfer.

2.1 Industrial innovation and inward technology transfer

The concept of receptivity of organisations to inward technology transfer adopted in this thesis is taken from Seaton and Cordey-Hayes (1993) and is explained in Chapter 1. It is repeated here: 'An organisation's overall ability to be aware of, to identify, and to take effective advantage of technology.'

This process view of inward technology transfer has similarities with the broad definition of innovation used by Myers and Marquis (1969), who placed emphasis upon technological development.

'A technological innovation is a complex activity which proceeds from the conceptualisation of a new idea to a solution of the problem then to the actual utilisation of a new item of economic or social value. (Alternatively) innovation is not a single action but a total process of interrelated subprocesses. It is not just the conception of a new idea, nor the invention of a new device, nor the development of a new market. The process is all these things acting in an integrated fashion . . .'

It is important to clarify the use of the term "new" in the context of innovation. Rogers and Shoemaker (1971) do this eloquently:

'An innovation is an idea, practice, or object perceived as new by the individual (or organisation). It matters little, as far as human behaviour is concerned, whether or not an idea is 'objectively' new as measured by the lapse of time since its first use or discovery . . . If the idea seems new and different to the individual, it is an innovation.'

Myers and Marquis' view of innovation as a process starting with the recognition of a potential demand for and technological feasibility of an item and ending with its commercialisation is an unusually broad definition of industrial innovation. In an organisational context, industrial innovation was historically viewed as internal R&D resulting in a new invention. Increasingly, however, it is understood to mean a disposition towards new ways of thinking or new ways of doing things, a willingness to develop new methods through R&D within the organisation itself, or a willingness to acquire new products, services, and processes from outside the organisation. With this in mind we are now in a position to explore the organisational activities involved in successful inward technology transfer.

2.1.1 Studies of industrial innovation in organisations

One of the earliest studies of innovation within organisations was March and Simon (1958). They argue that innovations will occur when an organisation is dissatisfied with existing performance. This dissatisfaction increases the search for alternative courses of action. The interesting point here is that existing activities will persist, not as a result of resistance to change, but rather as a result of the absence of search for new alternatives. The predicted result is that the organisation is likely to become aware of new alternative activities, that is, innovations, only when they become aware of a 'performance gap'.

The seminal work by Burns and Stalker (1961) on Scottish electronic organisations and the impact of technical change on organisational structure and systems of social relationships, suggests that "organic", flexible structures, characterised by the absence of formality and hierarchy, support innovation more effectively than do "mechanistic" structures. Mechanistic structures are characterised by long chains of command, rigid work methods, task differentiation, extensive procedures and a well defined hierarchy. The argument here is that mechanistic structures are less effective at innovation than organic, flexible structures. Many objections have been raised to this argument most notably by Child (1973). Nonetheless flexible rather than mechanistic organisational structures are still seen, especially within the business management literature, as necessary for successful industrial innovation. In general, an organic organisation is more adaptable, more openly communicating, more consensual, and more loosely controlled. As Figure 2.1 indicates the mechanistic organisation tends to be much more traditional, more tightly controlled and hierachical in its approach.

Figure 2.1

Organic versus mechanistic organisational structures	
Organic	**Mechanistic**
1. Channels of communication Open with free flow information throughout the organisation	**1. Channels of communication** Highly structured, restricted information flow
2. Operating styles Allowed to vary freely	**2. Operating styles** Must be uniform and restricted
3. Authority for decisions Based on the expertise of the individual	**3. Authority for decisions** Based on formal line management position
4. Free adaptation By the organisation to changing circumstances	**4. Reluctant adaptation** With insistence on holding fast to tried and true managemnet principles despite changes in business conditions
5. Emphasis on getting things done Unconstrained by formally laid out procedures	**5. Emphasis on formally laid down procedures** Reliance on tried and true management principles
6. Loose, informal control With emphasis on norm of cooperation	**6. Tight control** Through sophisticated control systems
7. Flexible on-job behaviour Permitted to be shaped by the requirements of the situation and personality of the individual doing the job	**7. Constrained on-job behaviour** Required to conform to job descriptions
8. Participation and group consensus used frequently	**8. Superiors make decisions with minimum consultation and involvement of subordinates**

Source: Slevin and Covin (1990)

A slightly different perspective is offered by Harvey and Mills' (1970). They view the organisation as a political system and suggest that change will result in some conflict between different units in the organisation when a unit perceives that the innovation or change might reduce its influence. Harvey and Mills also introduce the notion of routine and innovative solutions. They argue that problem situations and problem solutions are arranged along a routine-innovative dimension. A routine solution is defined as 'a solution that has been used before while an innovative solution is defined as a solution that has not been used before and for which there are no precedents in the organisation' (pp 189-190). Harvey and Mills argue that an organisation will tend to impose routine solutions unless there is pressure on the organisation's structural arrangements. These structural arrangements reinforce continuation of routine patterns around which interests have come to form. Innovative solutions will only be imposed when the organisation is in a higher stress-threat situation, which is more likely to demand innovative behaviour if the organisation is to adapt. This model expands upon Burns and Stalker's model because they indicate that there are different types of solutions, mechanistic routine and organic innovative that are appropriate for different situations.

Wilson (1966) makes a valuable contribution to the debate by advancing the notion of the 'capacity of an organisation to initiate innovations'. This study focuses on the initiation of possible innovations and recognises the importance of the role of the individual in the innovation process. He argues that the greater the diversity and complexity of the organisation in terms of activities and incentives[1], the greater the likelihood that participants will both conceive of and propose innovations. He suggests that a highly diverse organisation inhibits close supervision because it is difficult for management to monitor all the activities of the workforce. Thus individuals will have some autonomy in defining how they will do their job, and there are then more opportunities for them to become aware of ways to innovate.

Later studies by Hage and Aiken (1970) Rogers (1983) and Zaltman et al (1973) put forward additional similar models of the innovation process. A weakness of these models of innovation is that they tend to view innovative behaviour as only responding to problems experienced by the organisation. This suggests that an innovation is dependent on the recognition of either a problem or a weakness in performance; the so-called 'performance gap'. Hence, there is a tendency to see the innovation process purely in terms of problem solving and decision making and thus to focus on the actions of key decision makers.

A recent paper by Slevin and Covin (1990) has suggested that organisations have to balance entrepreneurial behaviour within the firm with the organisational structure. Following discussions with over 200 managers they put forward a model which suggests that successful firms are able to oscillate between an entrepreneurial management style and organic structure, and a conservative management style and a mechanistic structure. This is achieved in response to the external environment. The external environment will influence the style of behaviour and organisational structure required at different times. This dynamic model appears to capture the important influences that both organisational behaviour and

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[1]Wilson defines an incentive as ' any gratification, tangible or intangible, in exchange for which persons become members of the organisation' (Wilson, 1966, p 196).

organisational structure have on the ability of organisations to innovate. Furthermore it stresses the importance of an appropriate culture to support the required behaviour.

2.2 The handicap of the linear model

Despite the aforementioned studies our understanding of the industrial innovation process has progressed little. Moreover, our understanding of the specific organisational activities influencing the inward technology transfer process are even less well understood. It is generally accepted that this is because of the domination of the linear model of innovation. Cooke, (1992) argues 'that because the linear model of innovation is simple to think with, it has consequently taken a firm grip on policy making'. An example of this can be seen with the development of the science park phenomemnon. The role of science parks is to foster academic-industry linkages in the belief that subsequent technological development and industrial innovation will result. Recent research, however, into the role of science parks by Quintas, Weild and Massey (1992) suggest that current experience does not demonstrate high levels of linkages between academic research and industrial activity. Indeed they argue that the UK science park phenomenon is problematic because at its core lies a linear model of technological development.

The early literature on industrial technological innovation assumed that it was a linear process beginning with scientific discovery, followed by industrial R&D, then manufacturing and ending with a marketable product or process. In this so called "technology-push" model the 'marketplace was a passive receptacle for the fruits of R&D' (Rothwell, 1992). This model continued to dominate thinking in innovation until the 1960's/70's when work by Myers and Marquis (1969) and von-Hippel (1978) suggested that the role of the marketplace and the users in the marketplace were influential in the industrial innovation process. This led to the development of the linear "market-pull" model of innovation. Here, innovations arise as the result of articulated market needs, and R&D is seen as merely reacting to these needs.

During the 1980's the linear models of innovation received fierce criticism for simplifying what many now believe to be a complex interactive process. Rothwell & Zigweld (1985) argued innovation was neither dependent on technology push or market pull but involved feedback between marketing and R&D. Many writers have since suggested that innovation is an interactive process between market need and technological development accompanied with extensive external commercial and technological linkages (Turney, 1991; Rothwell, 1991; Rothwell & Dodgson, 1991).

The table below in Figure 2.2 shows the historical development of the dominant models of the industrial innovation process.

Figure 2.2 Table showing the chronological development of innovation models

1950/60's	Technology push	Simple linear sequential process. Emphasis on R&D. The market is a receptacle for the fruits of R&D.
1970's	Market pull	Simple linear sequential process. Emphasis on marketing. The market is the source for directing R&D. R&D has a reactive role.
1980's	Coupling model	Sequential, but with feedback loops. Combinations of push and pull.
1980/90's	Interactive model	Emphasis on integrating R&D and marketing.

Based on Rothwell (1992)

With the linear model's firm grip on policy making it is somewhat understandable then that the early studies of technology transfer between organisations centred around the ability of organisations to access technological knowledge (Gruber & Marquis, 1969) and their subsequent ability to effectively disseminate this information. Allen's work in the 1960's on the role of gatekeepers within organisations exemplifies this. (See Allen 1966, '69, '77.) While the provision of technical ideas is a necessary part of technology transfer it is only one component of a more complex process.

2.3 Internal organisational factors and inward technology transfer

Danhof's 1949 study may be described as one of the first attempts to study the inward technology transfer process. In his study of the adoption of new innovations by industrial companies he identified four different types of company:

- Innovators: the first firm to adopt a new idea.
- Initiators: the firms who adopted the ideas soon after the innovators.
- Fabians: the firms who adopted the idea only after its utility was widely acknowledged in the industry.
- Drones: the last firms to adopt new ideas.

This study revealed that there was considerable difference in the responsiveness of organisations to take up externally developed technology. Establishing the precise nature of the activities that are required to ensure that organisations can either remain as innovators or become innovators, has been the subject of numerous studies.

Carter and Williams' (1959) study of technically progressive firms uncovered a number of characteristics within organisations that facilitate innovation. In a comprehensive review of the technology transfer literature Godkin (1988) suggests these same factors would foster technology transfer. These factors are shown below:

- High quality of incoming communication;
- A readiness to look outside the firm;
- A willingness to share knowledge;
- A willingness to take on new knowledge, to licence and to enter joint ventures;
- Effective internal communication and coordination mechanisms;
- A deliberate survey of potential ideas;
- Use of management techniques;
- An awareness of costs and profits in the R&D departments;
- Identification of the outcomes of investment decisions;
- Good quality intermediate management;
- High status of science and technology on the board of directors;
- High quality chief executives;
- A high rate of expansion.

Exactly how these factors affect the inward technology transfer process is not revealed. However, Godkin's classification is one of the earliest studies, specifically on technology transfer, to recognise that the existence of certain activities within the recipient organisation is necessary for successful technology transfer. This point will be explored in detail in the following two sections.

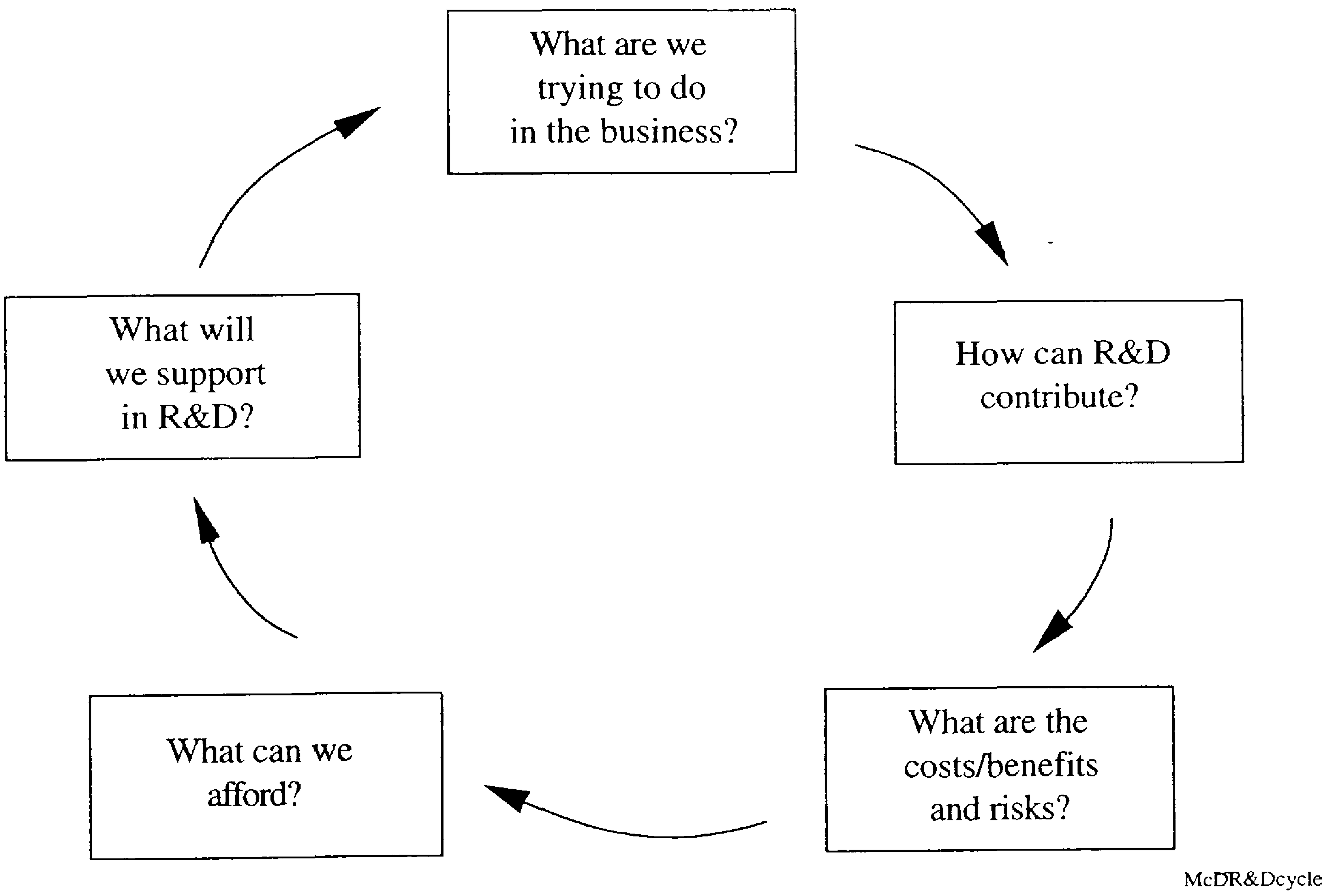
2.4 The Strategic Management of research and technology within organisations

2.4.1 Background to technology management

It is well understood that technological developments can lead to improved products and processes, reduced costs and ultimately improved commercial performance and competitive advantage. The ability to capitalise on technological developments and profit from business opportunities that may subsequently arise, requires a business to be in an appropriate strategic position. That is, it must possess the capability to understand and use the technological developments to its own advantage. This requires some form of anticipation of future technological developments and also strategic business planning. It soon becomes clear that technological forecasting and planning is fraught with uncertainty. The diagram in Figure 2.3 illustrates the iterative process involved in the management of research and technology.

Figure 2.3

The strategy cycle is an iterative and continual process



From Roussel et al (1991).

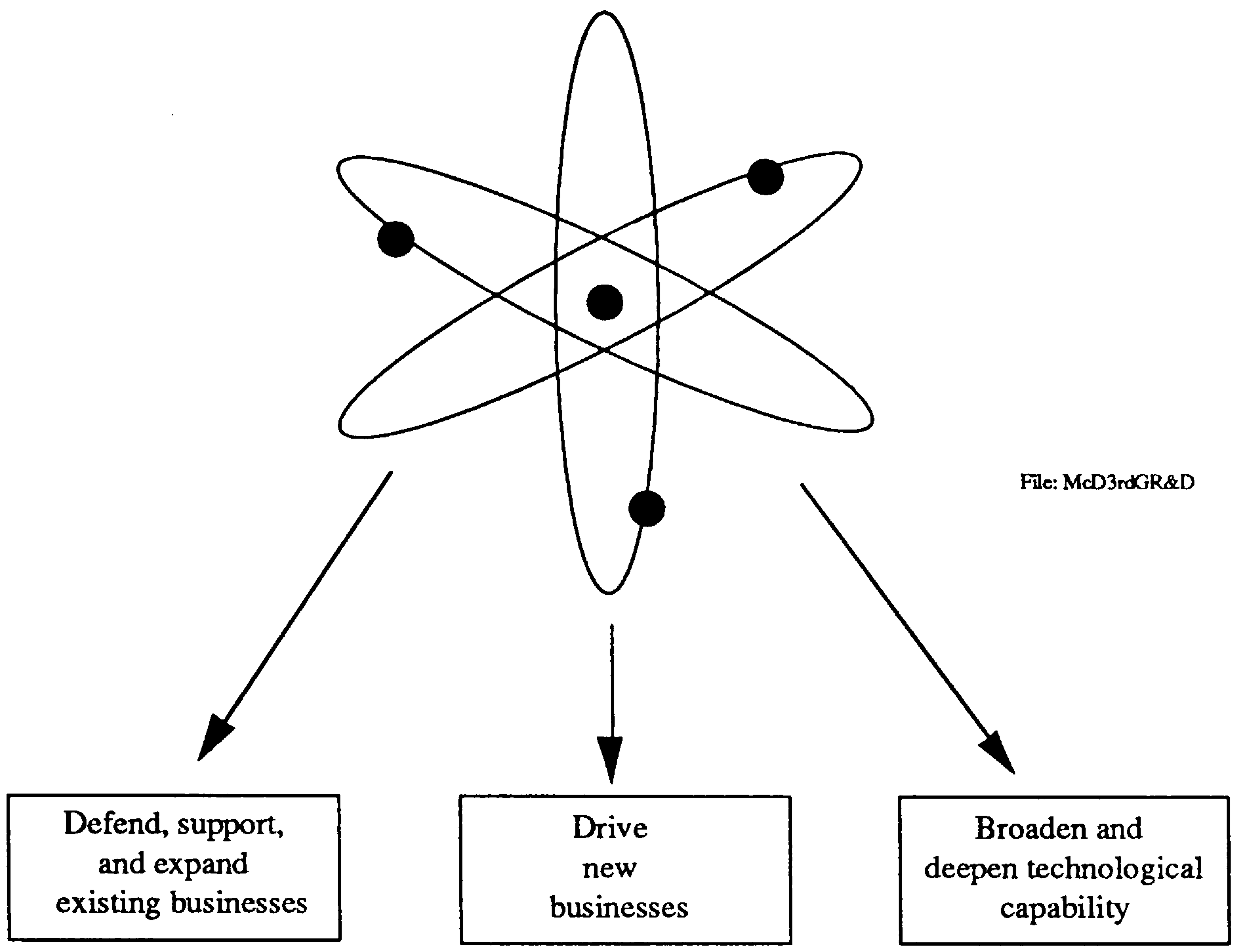
2.4.2 The management of Research and development (R&D)

The management of research and development needs to be fully integrated with the strategic management process of the business so that it is able to enhance and support the products that marketing and sales offer, and provide the company with a technical body of knowledge that can be used to develop the business in the future. Too many businesses fail to fully integrate the management of research and technology into the overall business strategy process (Adler, et al (1992).

Roussel, Saad and Erikson (1991) see industrial R&D as having three major strategic purposes, these are shown below in Figure 2.4:

Figure 2.4

The strategic purposes of industrial R&D



Source: Roussel et al (1991)

These three strategic areas, shown in Figure 2.4, are broken down into operational activities in Chapter 5, Section 5.4.1.

2.4.3 Technology Strategy

Organisations that manage products and technologies that have been built upon a strong research and development base are constantly looking for opportunities that will enable them to diversify horizontally into new product markets. For these organisations the strategic management tasks involve mobilising complementary assets to successfully enter those markets. For example "Eastman Kodak's" move into the manufacture of computer "floppy" discs enabled them to use their knowledge of manufacturing photographic film. Similarly in production-based technologies, key opportunities lie in technological advances that can be applied to products and production systems. Enabling them to diversify vertically into a wider range of production inputs. For example, the injection moulding process has had many adaptations enabling its use in an increasing range of manufacturing techniques. The point here is that companies do not have a completely free choice about the way they manage their technology (Pavitt, 1990).

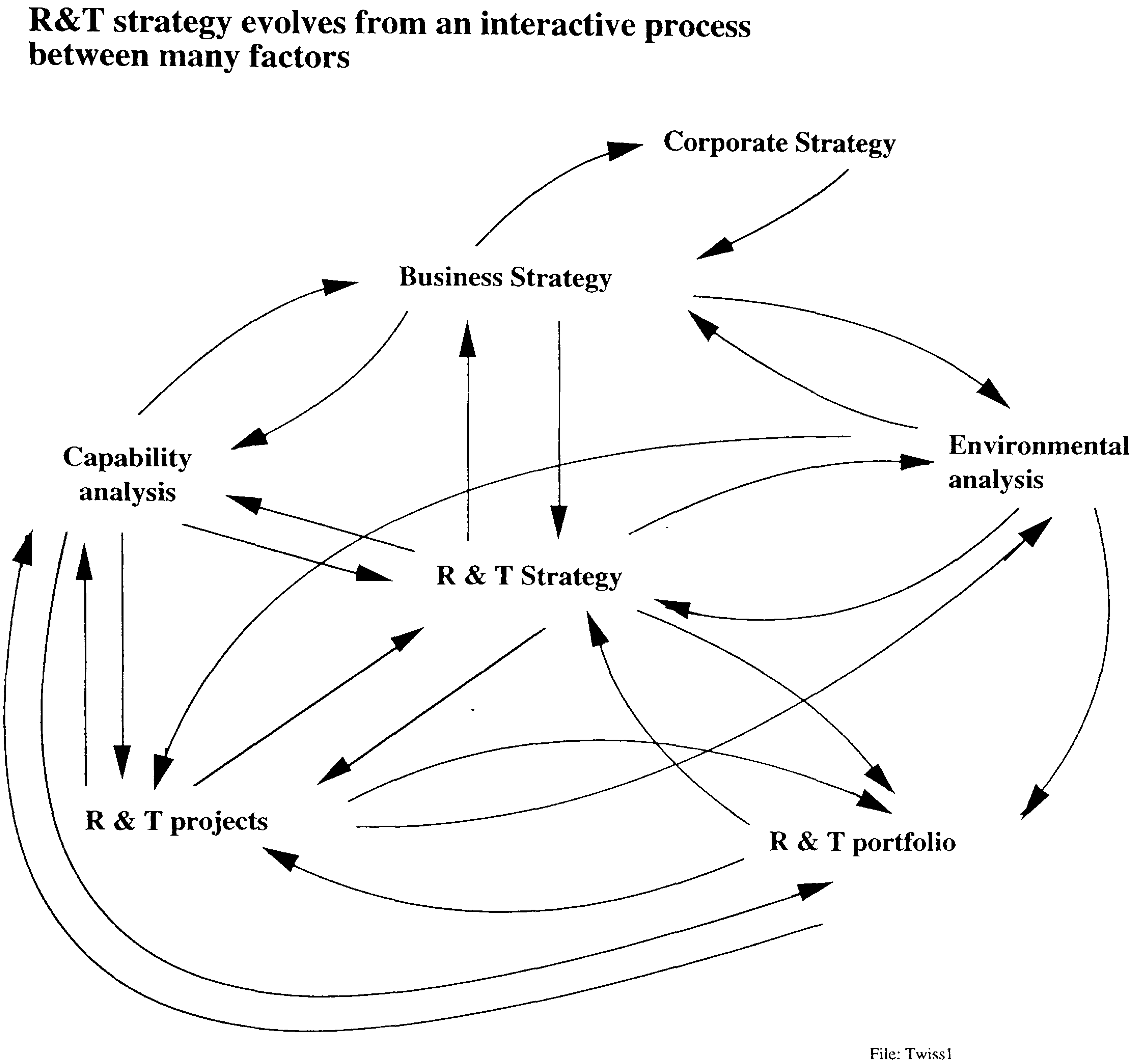
'In many areas it is not clear before the event who is in the innovation race, where the starting and finishing lines are, and what the race is all about. Even when all these things are clear, companies often start out wishing to be a leader and end up being a follower!'
Pavitt (1990)

While much has been written about the formulation of technology strategy (see Adler, 1989 for a comprehensive review of the literature) especially by the numerous business schools around the world, the misconception remains that strategy is selected or somehow arrived at in an orderly and systematic way.

The literature on technology management contains two main streams. The dominant stream, in terms of quantity, is the "content" view of technology strategy. This body of literature is mainly concerned with the content of technology strategies. In particular it is concerned with strategic analysis and its different levels or units of analysis (for example Abernathy and Utterback, 1988; Porter, 1985; Roussel et al, 1991). The other body of literature is mainly concerned with the process of developing technology strategically.

A major criticism of the "content" view of technology strategy is that it neglects the context within which, and the processes whereby, technological strategies are generated, chosen and implemented. In practice, as Figure 2.5 illustrates, formulation of strategy is often not clearly defined. The process involves continual iteration over time between the various parts until a strategy emerges (Twiss, 1980).

Figure 2.5



Adapted from Twiss, 1980; p56.

The previous discussions reveal the weaknesses in some of the commonly accepted views of technology strategy that is promoted by many business schools and management consultants. For example it is not helpful to the organisation by firstly trying to establish whether its technology strategy should be a leader or follower, product or process. Technology cannot be developed to order or acquired to fill a position in a matrix. Technology can only be successful if it is fully integrated into the company's business. This means that the company needs a range of complementary assets in other areas-marketing, distribution, etc, in order to successfully exploit its technology. Developing these skills and capabilities, and integrating these into the company takes time. Often these characteristics will be determined by the company's size its previous activities and its accumulated competences. However, it is these later factors and not the strategy, that will determine whether a company will successfully exploit its technology.

As virtually all practioners realise there is no easy formula for success. In a review of the literature on technology management, Pavitt (1990) has identified the following necessary ingredients for successful technology management:

- the capacity to orchestrate and integrate functional and specialist groups for the implementation of innovations;

- continuous questioning of the appropriateness of existing divisional markets, missions, and skills for the exploitation of technological opportunities; and

- a willingness to take the long view of technological accumulation within the firm.

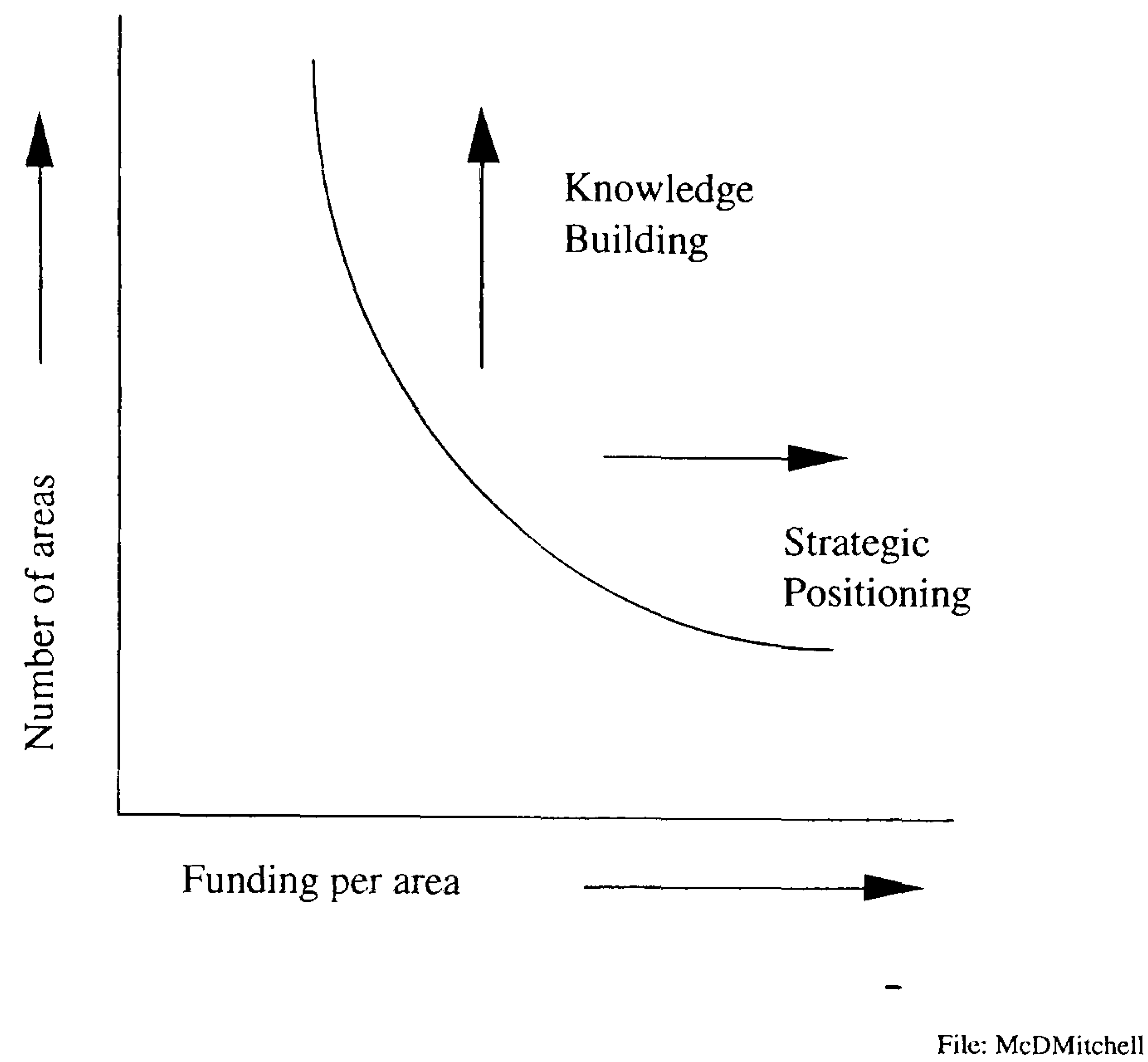
2.4.4 Managing Research and Technology in science based companies

Within the chemical industry much of the technological resources consumed by the business is in the form of engineering and development (often called Technical Service). This can be spread over a wide range of technical activities and technologies. In addition a firm will possess a number of areas of technology in which it concentrates resources and builds a technological competence. As one would expect there is a significant difference in possessing general technical service skills and possessing scientific competence in a particular area. The building and development of technological knowledge competencies take time and demands a large amount of research activity.

Mitchell (1988) suggests there is a trade-off between concentrating resources to try to build a strategic knowledge competence and spreading resources over a wider area to allow for the building of a general knowledge base. The diagram below shows the pressures on technical resources. The growth of scientific and technological areas of interest to the firm (in particular the research department) pressures research management up the curve, to fund a wider number of areas. Whereas the need for strategic positioning forces decisions down the curve, to focus resources and build strategic knowledge competences (see Figure 2.6).

Figure 2.6

Strategic Pressures on Technical Resources



Source: Mitchell, 1988.

Figure 2.6, above, highlights the potential conflict between Strategic Management and Research Management. In practice most businesses settle for an uneasy balance between the two sets of pressures.

2.4.5 The difficulty in managing capital intensive chemical process plants ~~in~~ a dynamic changing environment

Some of the ICI business, like many other chemical companies, that operate multi-million pound chemical plants around the world have a slightly different set of factors to consider than a company operating the manufacturing plant for say, tennis rackets. The hundreds of millions of pounds invested in a chemical plant means that the options open to it in terms of changes in products are limited. This is because the scrapping of an existing plant and the building of a new one may cost in excess of £200 million. There are few companies in the world who could continually build, scrap and build chemical plants in response to the demands of the market. Let alone make a profit from such actions. Hence the reason why companies operating process plants cannot respond <u>completely</u> to market needs. The chemical industry is increasingly developing smaller more flexible plants rather than the large single purpose plants that have been common since the turn of the century.

2.5 How internal activities affect an organisation's ability to acquire externally developed technology

Seaton & Cordey-Hayes (1993) assert that the range of technology transfer models that have been developed over the last twenty years have placed emphasis on providing access to information about technology. These mechanisms assume that technology transfer may be viewed as part of the linear model of innovation, and supposedly, once access is provided to these technologies, organisations will be able to take the technology back to their development labs and produce a variety of innovative products. A critique of a wide variety of these mechanisms is offered by Lefever (1992) who proposes a new conceptual framework with which to analyse the technology transfer process. This model comprises three main elements: Accessibility; Mobility; and Receptivity. Research by Lefever (1992) shows there is a lack of understanding of "Receptivity". This he defines as: an organisation's ability to be aware of, to identify and to take effective advantage of technology. We can conclude from this that an organisation's internal environment has a significant influence on on its ability to partcipate in inward technology transfer.

2.5.1 The Technological base of a company includes more than technology

Discussions concerning the technological base of an organisation tend to focus on R&D activities and other technical activities alone. However, an organisation's ability to develop new products that meet current market needs, to manufacture these products using the appropriate methods and to respond promptly to technology developments clearly involves more than technical capabilities. Nelson (1991) has argued that in industries where technological innovation is important firms need more than just a set of core capabilities in R&D.

'These capabilities will be defined and constrained by the skills, experience, and knowledge of the personnel in the R&D department, the nature of the extant teams and procedures for forming new ones, the character of the decision making processes, the links between R&D and production and marketing, etc. ' *(Nelson, 1991)*

The wide range of skills mentioned by Nelson implies that the commonly held view, of an organisation's technological base comprising of only technical matters, is too narrow. This view is upported by Adler and Shenhar (1990) who suggest that an organisation's technological base is made up of four dimensions (see Figure 2.7). These are:

• **Technological assets**- these are the most immediately visible elements of the technological base- the set of reproducible capabilities in product, process, and support areas. Technological assets can be more or less reliably reproduced; the other elements are, by contrast, fundamentally relational, which makes them much more difficult to replicate.

• **Organisational assets**- these are the resources that enable the business to develop and deploy the technological assets, specifically: the skill profile of employees and managers, the procedures for getting things done, the organisational structure, the strategies that guide action, and the culture that shapes shared assumptions and values.

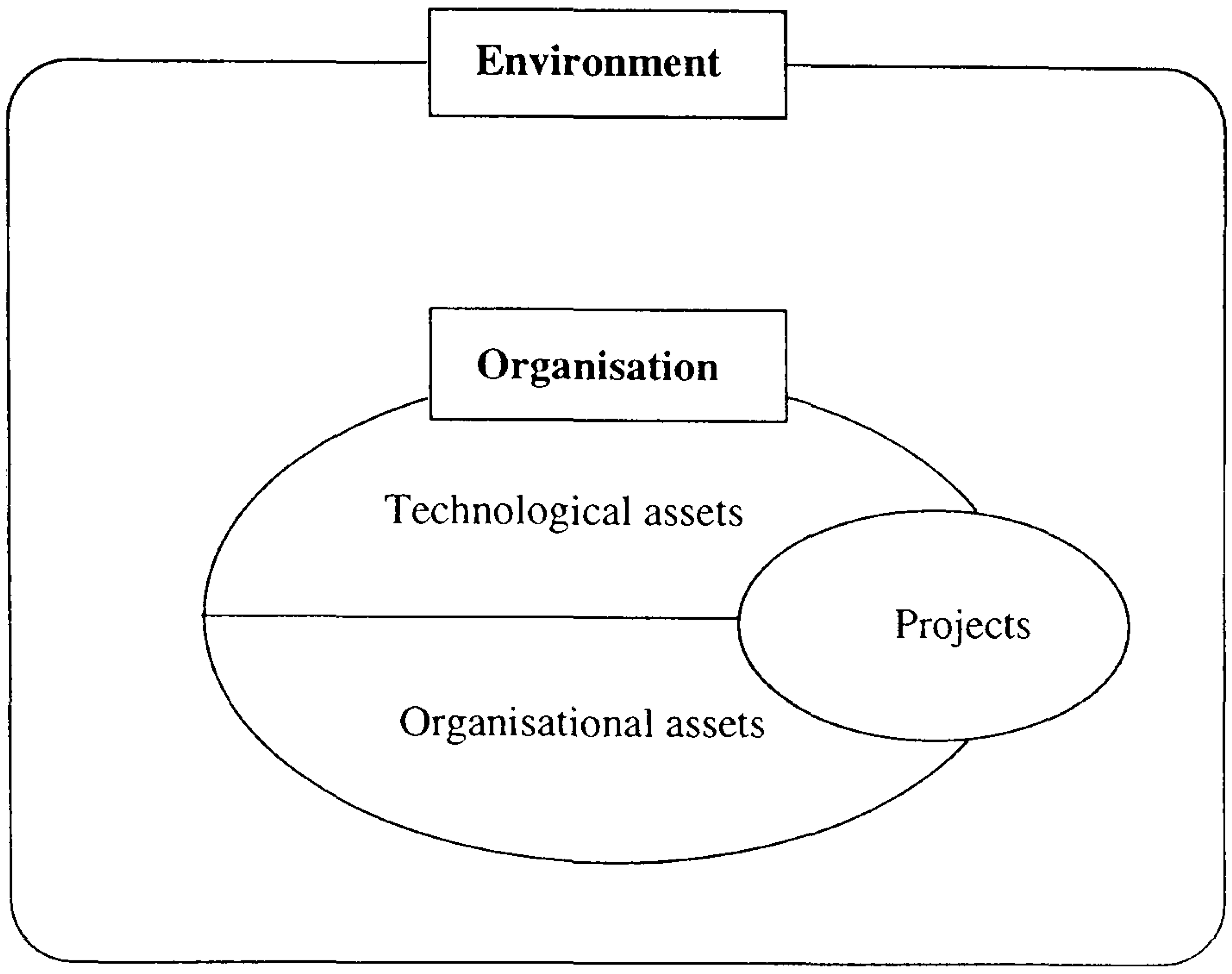
• **External assets**- these are the relations that the firm establishes with current and potential allies, rivals, suppliers, customers, political actors, and local communities.

• **Projects**- these are the means by which technological, organisational, and external assets are both deployed and transformed. Projects should be considered part of the technological base insofar as the organisation's modus operandi is a learned behavioural pattern that can contribute to or detract from technological and business performance.

This more realistic assessment, by Adler and Shenar, of an organisation's technological base shows how the various components of an organisation are interrelated (this point is addressed further in Chapter 3). The inclusion of its external networks is an important point. The formal and informal links an organisation has developed, often over many years, is a valuable asset. Pennings and Harianto (1992) include an organisation's history of technological networking within organisational skills necessary for innovation. At this point one may argue that it would be more appropriate to consider an organisation's "knowledge base" rather than select individual parts for analysis which may be like attempting to establish a racing car's performance by only analysing the engine. There are clearly other factors that will also have a dramatic impact on the car's performance.

Figure 2.7

Dimensions of the technological base



File: McDtechdim

From Adler and Shenar (1990)

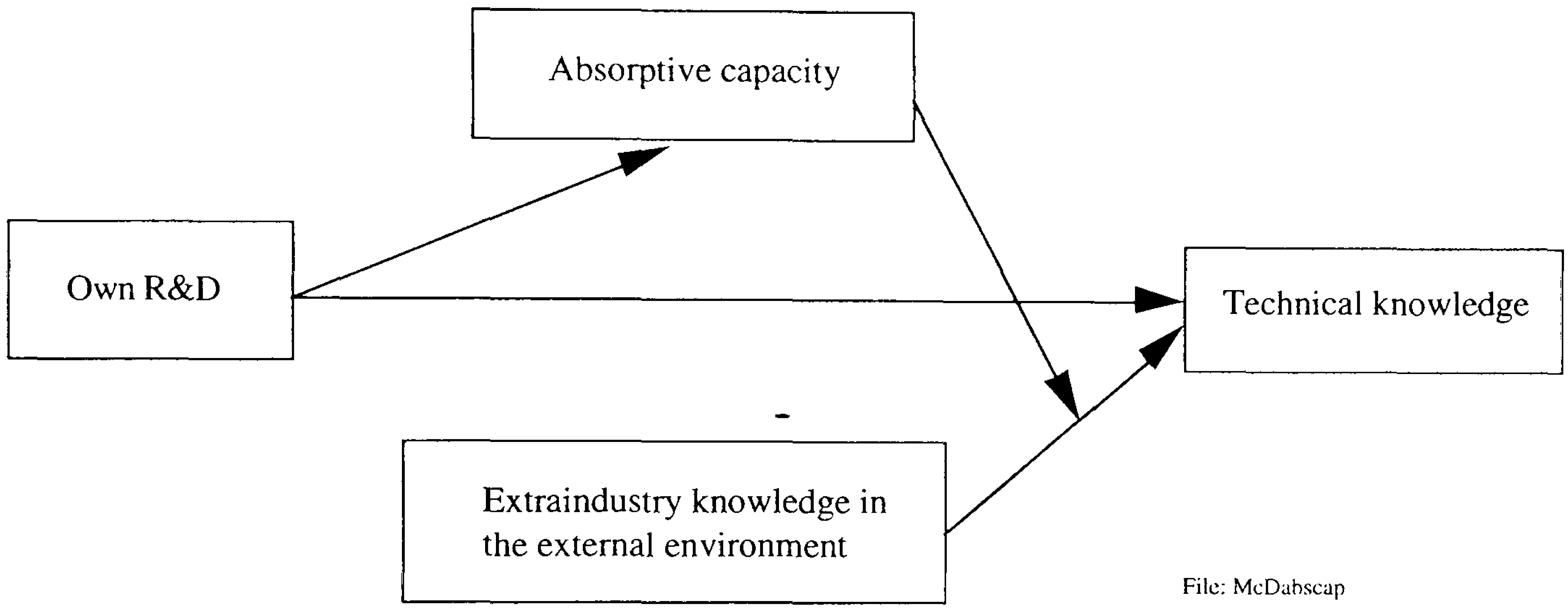
2.5.2 The importance of accumulated knowledge (competencies)

There is an emerging theory about organisational capabilities and behaviour in innovation within industrial companies (Pavitt, 1990a; Pavitt, 1990b; Prahalad and Hamel, 1990; Cohen and Levinthal, 1990; Seaton and Cordey-Hayes, 1993). These papers present a related theoretical view that centres around an organisation's ability to develop specific capabilities. These capabilities tend to be dependent on the organisation's incremental and cummulative historical activities. Elster (1983) refers to this notion as "technological trajectories" within an organisation. In terms of inward technology transfer this refers to a company's ability to develop capabilities that enable it to access, acquire and utilise externally developed technology.

The notion of "receptivity" advocated by Seaton and Cordey-Hayes (1993) suggests that there are certain characteristics whose presence is necessary for inward technology transfer to occur. In a similar vein, but within an R&D context, Cohen and Levinthal (1990) put forward the notion of "absorptive capacity". In their study of the American manufacturing sector they reconceptualise the traditional role of R&D investment simply as a factor aimed at creating specific innovations. They see R&D expenditure as an investment in an organisation's "absorptive capacity". They argue that an organisation's ability to evaluate and utilise external knowledge is related to its **prior knowledge** and expertise and that this prior knowledge is, in turn, driven by prior R&D investment. They present a model showing the sources of an organisation's technical knowledge. This shows how a firms own R&D enables it to access the wider technical knowledge base of industry in general, universities and its competitors (see Figure 2.8).

Figure 2.8

Model of sources of a company's technical knowledge



Source: Cohen and Levinthal (1990)

Cohen and Levinthal (1990) point out that a company's absorptive capacity is not simply the sum of the absorptive capacities of its employees. Absorptive capacity refers not only to the acquisition or assimilation of information by an organisation but also to the organisation's ability to exploit it. Cohen and Levinthal suggest that communication at the boundaries of the organisation and across the subunits within it is necessary if an organisation is going to make effective use of the knowledge it has captured. They suggest extensive internal communication between individuals is necessary to ensure effective sharing of knowledge. This introduces the need for diversity on the one hand to stimulate innovation, and commonality on the other to facilitate the sharing of knowledge. Over emphasis on commonality, however, may lead to the development of conditions such as "The Not-Invented-Here" syndrome. This is defined as 'the tendency of a project group of stable composition to believe it possesses a monopoly of knowledge of its field, which leads it to reject new ideas from outsiders to the likely detriment of its performance' (Katz and Allen, 1982). In a study in a large industrial laboratory Katz and Allen found that communication between project teams and external sources declined with individuals length of tenure with a project group.

The importance of a balance of such behaviour paterns for innovation is reinforced by research by Allen and McGlade (1989) whose research into the fishing patterns of Canadian fisherman in Nova Scotia identified two distinct behaviours: stochastic and cartesian. Using a detailed spatial model Allen and McGlade show that the presence of both behaviours is necessary for the long term survival of the fishery. In a similar vein the behaviour patterns of individuals within the organisation would also appear to require a combination of **efficency and exploratoration**.

While the theoretical paper by Cohen and Levinthal shows the importance of a firms internal activities in determining its ability to acquire externally developed technology, it does not examine in a detailed way the activities undertaken by organisations . Hence, apart from increased R&D expenditure we do not know what **activities** are necessary to foster effective absorptive capacity.

The importance of a strong research and innovation tradition was also highlighted by Freeman (1989) who showed the dominant role played by a few leading companies in the world chemical industry over a long period. Freeman suggested that this long period of innovative success was due to "technological accumulation". And that 'such accumulated strength and experience appears to outlive particular individuals'. This suggests that it is the organisation, rather than the individuals who pass through it, that is responsible for accumulating and retaining technical competence. The issue of an organisation's capacity to acquire knowledge was addressed by Nelson and Winter (1982) who emphasised the importance of 'innovative routines' suggesting a need for some structure. They argue that the practiced routines that are built into the organisation define a set of things that the organisation is capable of doing confidently. These routines are refered to as an organisation's core capabilities[2]. It is important to note that the notion of routines here does not necessarily suggest a mechanistic structure. The point here is that over long periods of time organisations build up a body of knowledge and skills through experience and learning-by-doing.

2.5.3 Uncovering the internal processes necessary for successful inward technology transfer

Defining precisely what activities are required on the part of the organisation and the individuals within it are not explored by any of the above authors. So while there is some conformity on the importance of the accumulation of organisational knowledge and

2 This is similar to Prahalad and Hamel's (1990) notion of core competencies.

capabilities, there is little written about the processes required by the organisation to achieve this desirable state of "receptivity". (A similar argument is made by Bessant et al (1993) who advocates a need to develop understanding of the routines associated with "incremental innovation"). The following chapter addresses this point and analyses the literature to try to uncover the internal organisational processes that contribute to "receptivity". A simple conceptual framework is developed that captures the main elements of the inward technology transfer process. This framework will be used to analyse the inward technology transfer process to uncover the activities involved.

2.5.4 Organisational knowledge and learning

The concept of the learning organisation has received an unprecedented level of attention in the management literature. A special edition of Organisational Science has been dedicated to the subject. And it has received the attention of mainstream economics (Malbera, 1992). The emphasis of much of this literature has been on the past history of the organisation, and that what an organisation can do in the future is strongly influenced by its previous activities and what it has learnt (Pavitt, 1991; Dosi, 1988; Nelson and Winter, 1982).

The major mechanism by which organisations learn about technology is through their internal R&D efforts; which as has been shown also enables them to absorb external knowledge.

Chapter 3

Towards a conceptual framework for Inward Technology Transfer

This chapter examines the non-routine activities undertaken by individuals within an organisation that enables it to participate in inward technology transfer. It is suggested that the complete range of activities necessary for inward technology transfer can be usefully portrayed within the set of processes of "Awareness", "Association", "Assimilation" and "Application" (4A).

The structure of the chapter is as follows. The first section deals with the need for external information and suggests that industrial innovation is a process of know-how accumulation. It also shows how individuals on behalf of the organisation acquire technology from outside via the process of scanning; the argument is that "awareness" is a necessary first stage of inward technology transfer. The next section shows the importance of (1) understanding the organisation's internal capabilities and (2) coupling commercial scanning with technology-scanning. This multiple linking process is captured in the process of association. In addition the notion of tuned-scanning is advanced as a useful concept during the process of association. The final section looks at how the organisation captures and processes these business opportunities; the argument here is that the organisation has to learn and understand the technology. This complex internal process is defined as assimilation.

3.1 The need for external information

It has long been recognised that a key characteristic of technically progressive firms is their high quality of incoming information. In 1959 Carter & Williams reported this in almost 200 firms over a wide range of industries. Many other studies have since demonstrated the value and importance of external information for successful innovation. For example SPRU's Project SAPPHO confirmed the need for high quality external linkages (1971); Peters and Waterman (1982); CEST (1990). Furthermore, previous research shows that industrial companies who conduct their own R&D are better able to access externally available information (eg. Tilton, 1971; Allen, 1977; Mowery, 1983).

The process of search and acquisition of technical information is a necessary activity for organisations in order to maintain their knowledge base. (See Johnson & Jones, 1957). It seems that this can be effectively achieved by scanning the technological environment either through the scientific literature or through interactions with other people (often called networking). Thus it seems reasonable to suggest that innovation in firms is a process of know-how accumulation based on a complementary mix of in-house R&D coupled with R&D performed elsewhere, via the process of technology-scanning.

Each organisational research effort or technological activity represents a fraction of the world's total scientific and technological activity. Organisations are constantly surprised by the amount of technology that is around that they do not know about. Hence organisations must somehow ensure their personnel are aware of technological developments done elsewhere. During the sixties and seventies this question of how to keep personnel aware of technological developments was the subject of intense study (cf Allen, 1966; Allen & Cohen, 1969; Allen, 1977; Tushman, 1977). Some interesting and useful concepts were developed that helped to improve our understanding of the complex nature of how individuals within organisations acquire technological information.

The literature on the flow of information tells us that accessing external information is important for successful innovation but it fails to specify how to achieve this. Tom Burns' (1969) frequently quoted phrase: "Technology Transfer is one of agents not agencies" implies that interaction is a necessary ingredient its frequency of use also implies that our understanding of the processes involved in the acquisition of externally developed technology has progressed little. Recent literature from Japanese management scholars, developing a contemporary frame of reference in firm management, has emphasised the importance of "Tacit Knowledge" in the innovation process (Nonaka (1988; 1990; 1991).

'Tacit knowledge is highly personal. It is hard to formalise and, therefore difficult to communicate to others. It is deeply rooted in action and is context specific. It is embodied by the term know-how. It is difficult to articulate meaningful know-how in text and figures . . . The knowledge is alive because it changes continuously' (Nonaka, 1990).

It seems that one of the most effective ways to capture this know-how is through personal interaction (networking).

3.1.1 The role of technology-scanning[1] in the process of acquiring technological knowledge.

Scanning by individuals on behalf of the organisation is often regarded as an informal and unassigned activity. But in order for individuals to practice the process effectively organisations must recognise the value of the activity. It appears that because organisations are unaware of its value they do not provide the organisational support for the process. Research by Oakley (1988), on the subject of search for technical knowledge, argues that small firms do not recognise the importance of external technical contacts, suggesting that they do little if any technology-scanning. Furthermore, Oakley concludes that R&D is poorly managed in many high technology small firms.

Research at Aston University has also shown that organisations that do not possess boundary spanning individuals (scanning) will be restricted in the degree to which the organisation becomes aware of and can assess the relevance of innovations in the first place (Newell & Clark, 1990).

During the sixties research at Massachusets Institute of Technology, and in particular work by Allen, into the acquisition of information specifically within technological environments suggested that scientists and engineers differed in their sourcing techniques. The research revealed that scientists tended to get information from literature whereas engineers tended to get information from personal contacts.

Further research by Allen in 1966 on the performance of information channels in R&D laboratories suggested that R&D groups that used external sources had a lower level of performance than those groups who used internal sources. Allen posited that this was due to a mismatch of information coding schemes (organisation specific language) across the organisational boundary. He suggested that the possible existence of key individuals, "gatekeepers", may overcome this impotence.

'Every institution develops a coding scheme with which to order its world. This coding scheme enhances the efficiency of communication although it can also adversely affect

[1]Technology-scanning is defined as the process of search and acquisition of technical information via structured and unstructured, formal and informal methods of information search. It includes the interaction of people resulting in the informal trading of Know-how (commonly refered to as networking).

communication when interacting with holders with a different coding scheme' Allen *(1966).*

In 1969 Allen and Cohen developed the research further by suggesting that "gatekeepers" were also "information stars" that possessed a high degree of awareness of the external environment. This was achieved through either extensive reading of the literature or extensive external contacts (scanning and networking). Furthermore, people in the laboratory would often turn to "gatekeepers" for information. The authors suggested organisations should recognise the important role played by "technological gatekeepers" in keeping the organisation informed.

A criticism of Allen & Cohen's work is that it tends to suggest that organisations should have a number of key scanners who are responsible for the collection of information for the organisation. Although gaining information from the external environment for use by the business was often regarded as a senior management activity; evidence suggests that there is no greater overall scanning activity by upper level management than middle level management (Aguilar 1967; Keflas & Schoderbek 1973; Hambrick 1979). Recent research by the author at ICI has revealed that in practice all members of the organisation collect and absorb external information in what may be described as a huge osmosis process (Trott, 1992).

3.1.2 A variety of scanning models

It is important to emphasise here that the scanning process is not an ad hoc irregular activity, to be undertaken only when technical problems are encountered. The process should be recognised as a continuous strategic activity that constantly updates the knowledge base of the organisation. Fahey and King (1977) present three models of environmental scanning: irregular, regular and continuous. These models vary from reactive scanning to proactive, continual scanning of the whole business environment. They posited that to be effective technology-scanning needs to be recognised by the organisation as a continuous process.

Fahey and King (1977) analysed twelve large organisations about their scanning activities. They discovered that, unlike information generated internally, information that is generated outside the firm is not routinely collected, organised and disseminated throughout the organisation. They discovered that scanning is not seen as an on-going, institutionalised activity and few organisations have integrated environmental scanning into their planning.

Today many large organisations try to ensure that a certain amount of external scanning is recorded and disseminated throughout the organisation. For example the distribution of sales representative visit reports is not uncommon in large organisations.

3.1.3 Effective technology-scanning

This thesis argues that scanning should be viewed as a continuous process of information acquisition incrementally strengthening the knowledge base of the firm. It should not be thought of as an irregular process used only in problem solving. Johnston and Gibbons (1975) argue that information plays an active rather than passive role and criticises the simplistic linear models of information flow as completely inadequate in describing the innovation process. This is an early critique of linear models of innovation.

Much of the research on information usage in technological environments deals with the resolution of technical problems and contains an implicit assumption that people are aware that they have a problem. The following type of question is common:

When you encounter a technical difficulty where do you turn for help?

Johnston and Gibbons (1975) further argue that a wide range of information inputs is necessary for successful innovation; that is printed and personal sources. There are many studies in the field of innovation that emphasise the importance of external contacts for technological information (see Rothwell, 1991; Newell & Clark, 1990; Peters and Waterman 1982).

Johnston and Gibbons (1975) state:

'The critical role of information is often not that of completing an unfilled chain, but rather suggesting completely different approaches to the problem at hand.'

3.1.4 The importance of external linkages

Allen (1977) argued that engineers unlike scientists were unable to develop similar informal colleges[2] because of the imposition of organisational barriers in the form of intelectual property rights and secrecy laws.

Recent research by Rothwell (1991) has shown that innovative small and medium sized enterprises (SME's) have dense external networks in a variety of marketing and manufacturing relationships. These linkages are often informal alliances and industry associations. Nonetheless these networks are often the stage upon which much know-how is exchanged. Ghoshal and Kim (1986) state that 'information about the immediate business environment is usually only available from business associates'. Hence this information tends to be acquired via personal interaction (networks) (See Kriener & Schultz, 1990 and von Hippel, 1987). However, it appears that not all firms have the capacity to forge and develop effective external linkages, formal or informal. Rothwell and Beesley (1989) posit that the most significant factor determining a SME's propensity to and ability to access external technology is internal to the firm; most notably "the employment of qualified scientists and engineers (QSE) and the outward-lookingness of managers". In other words, the lack of internal technological know-how can inhibit external know-how accumulation. (See Cohen and Levinthal, (1990) for an analysis of the dual role of R&D). It is not clear what Rothwell means by "the outward-lookingness of managers" but the process of scanning and the recognition by the firm of the need for technology scanning would contribute to improving a firm's receptivity to externally developed technology.

Thus it would appear that many SME's, are in fact, disadvantaged in their ability to forge and develop external linkages because they lack internal specialists. While SME's have many behavioural advantages over large firms, in the innovation process, they also have some important material disadvantages (Rothwell and Dodgson, 1991).

Rothwell (1991) suggests technology strategy should combine internal technological accumulation with external technological accumulation, and it should be viewed as a complement to, rather than as a substitute for, internal R&D. While these are fine words, unfortunately, like much of the strategic management literature, they do not explain how one should go about achieving this laudable goal.

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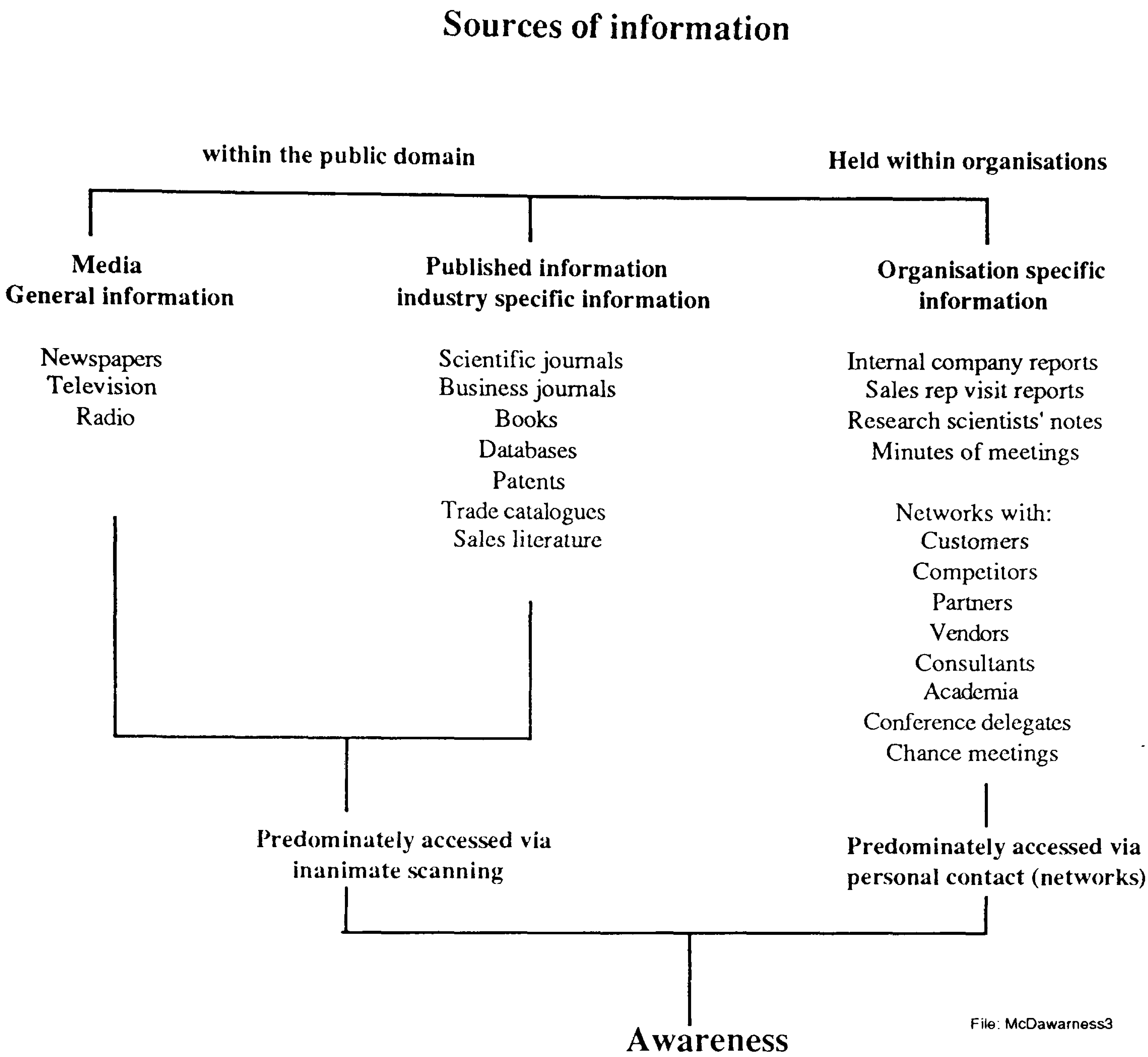
2 The concept of invisible colleges was developed by de Sola Price in the 1960's. Price argued that in a given field of science a small number of scientists write half the production and a good deal more than half the value. This small hard core constitute an invisible college. See Price (1963).

3.2 Awareness: The first stage in inward technology transfer

Given the importance of the need to be aware of external information and the role of technological scanning and networking that appear to enable an organisation to access this wealth of potential knowledge, "awareness" is seen as the necessary first stage in the inward technology transfer process. It is defined as *informed and vigilant of ones technical and business environment, using a variety of information sources especially the processes of scanning and networking* (see diagram below). Scanning is defined as *purposeful search and undirected viewing, often termed browsing*. It includes informal and formal, structured and unstructured methods of information search. The use of networks or "networking", as it is often called, is the process of interaction with other people resulting in the informal trading of knowledge (von Hippel, 1988). This includes formal and informal interactions.

The diagram below (Figure 3.1) shows the variety of sources of information available to individuals within organisations and shows how scanning and networking provide access to this information.

Figure 3.1

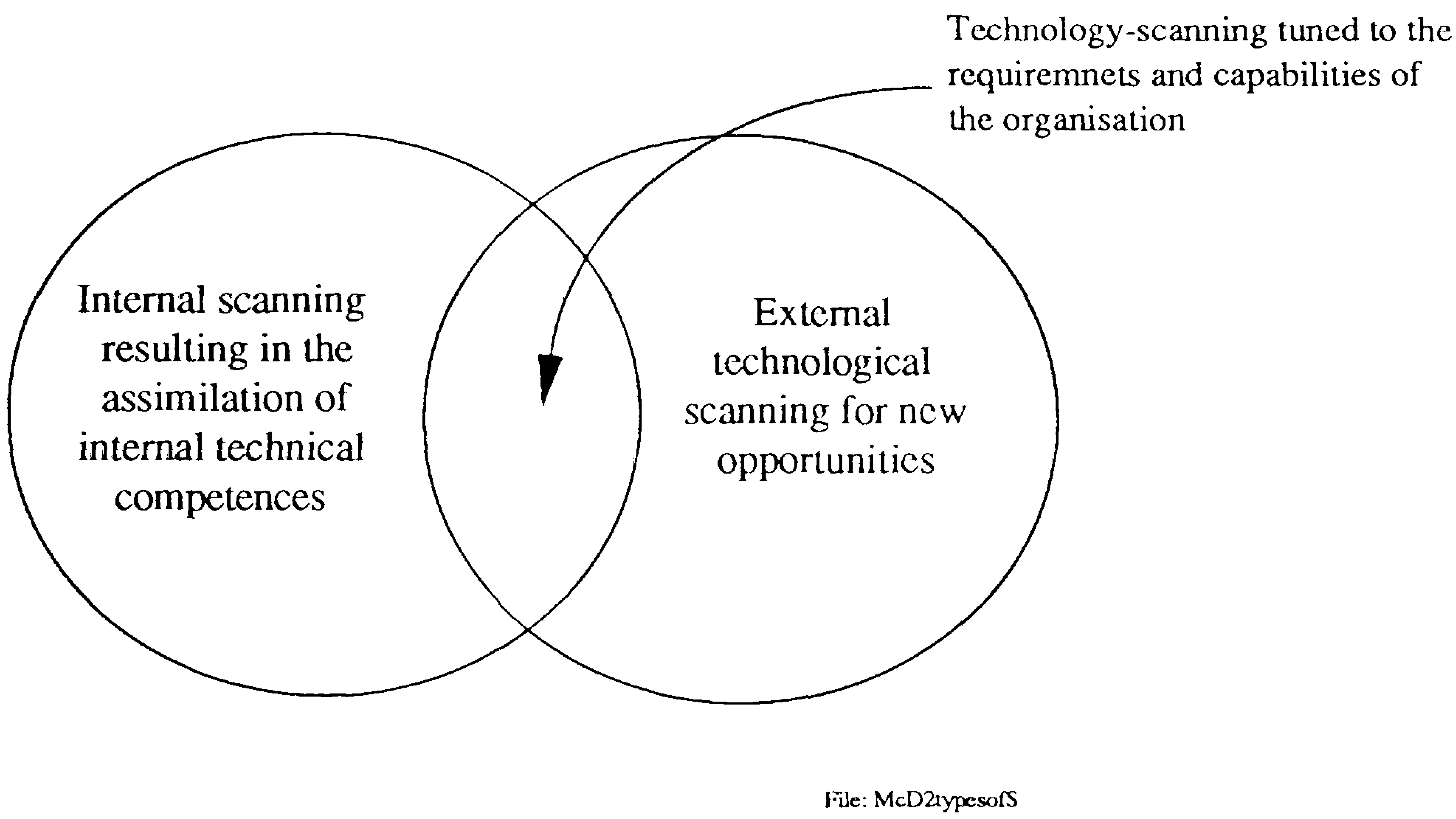


3.2.1 The need to scan internally as well as externally

Many internal organisational needs are not expressed explicitly as a need, they may be more appropriately described as 'opportunities' that exist. Virtually every organisation will possess a variety of opportunities, many of these may remain unfulfilled, others will be taken and changes introduced. For example, "opportunities" often exist to improve a process or a product by reducing costs associated with it. These opportunities tend to be needs that are not perceived in technical terms. In a study of small firms Anstey (1993) found that small businesses do not perceive their needs in technological terms. They are often seen purely in financial terms of reducing costs and increasing revenue. As a result business opportunities are not perceived, and certainly not expressed, by the business as a technology requirement. Hence, such companies would be unlikely to be involved in technology-scanning.

In order for an organisation to search and scan effectively for technology that will match its business opportunities it needs to have a thorough understanding of its internal organisational capabilities. It appears that this can be effectively achieved via the processes of internal scanning and networking, which will enable it to become familiar with its internal activities. The following diagram (Figure 3.2) represents the coupling of internal technological-scanning with external technology-scanning activities.

Figure 3.2



3.2.2 The need to couple technology-scanning and commercial-scanning

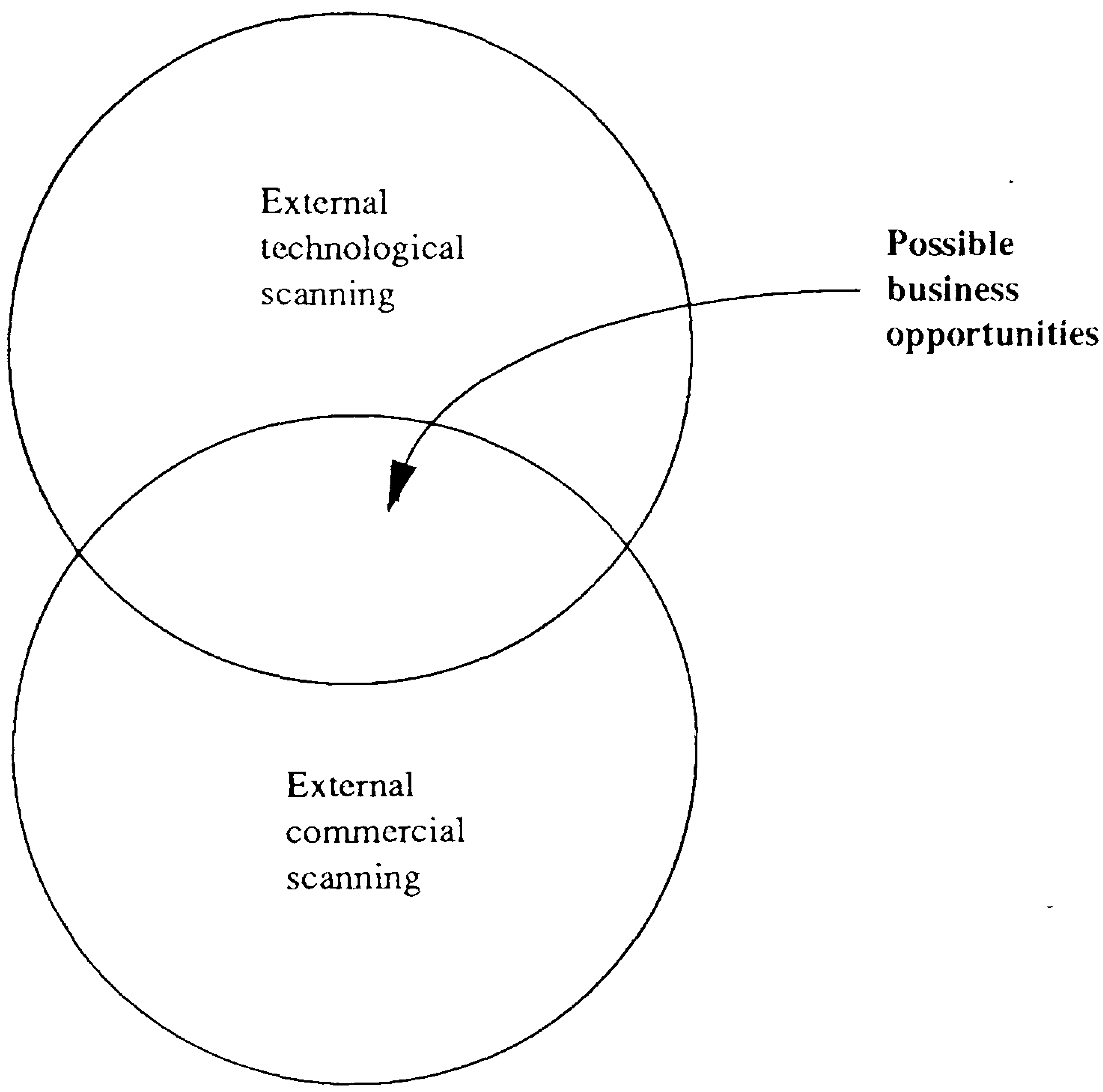
In Britain we are constantly reminded that technological knowledge alone is insufficient for successful innovation (see Government White Paper on science and technology, 1993). A criticism that is often levelled at British industry is that it fails to exploit or commercialise the technology it has developed. We are constantly reminded of the Hovercraft and the Concord as examples of seemingly outstanding technologies that were commercial disasters. While R&D, or more specifically technology, is a necessary part of innovation it is an insufficient ingredient for a firm's success.

Inward technology transfer involves more than identifying interesting technology; it is necessary to match technology with a market need, thus producing a potential opportunity for the business. Hence, the scanning process needs to incorporate commercial scanning as well as technology scanning so that technological opportunities may be matched with market needs (see Figure 3.3).

The strategic management literature offers much advice on the innovation process, particularly on the need to couple technology with market needs (Gigure, 1988; Nevens, 1990; Flemming, 1991). But they fail to say specifically how to do it.

Figure 3.3

Coupling technological scanning with commercial scanning



File: McD2C

The process shown above explains how firms can amass both technological know-how and commercial know-how. However, to exploit technology the firm must have a range of internal business capabilities, part of which includes the appropriate technical skills. Furthermore, it is the assimilation of these potential "business opportunities" with the organisation's capabilities that will create viable "business opportunities". Finally, the co-ordination of these organisational resources is necessary for successful technology transfer and the ultimate production of competitive products (Grindley, 1991).

Many people fail to recognise that using other people's information is much more difficult than using your own (Macdonnald, 1992). Others have developed their information often over a long period of time, with the unwitting help of many different people and using organisational routines and techniques that are not easily explained or transfered. Furthermore, much of this information is tacit knowledge. Consequently other people's/firm's technology may not fit the circumstances of another firm. Moreover, other people's technology may be very difficult to apply and use profitably. For information to be beneficial for the organisation it needs to be disseminated and be in a usable form. Tushman & Scanlan (1981) argue that there is no evidence to suggest that information gathered from external sources is disseminated within the organisation.

Technology can only be effective if it is fully integrated into the firms activities and this can only be achieved if the new technology is aligned with existing competences both technological (Prahalad & Hamel, 1990) and commercial. A study by Adler & Shenhar (1990) of two companies in the defence industry suggested that the technological base of the organisation incorporates more than just the physical technology and technical skills held within the organisation. They argue it includes four components: Technological Assets, Organisational Assets, External Assets and Projects (see section 2.2.1). This is a far more comprehensive and realistic assessment of what constitutes the complex notion of a firm's "technological base".

Clearly not only must new technology be linked to a market opportunity it must also be aligned with a variety of internal firm capabilities. In a similar way, but in a different context, Slevin & Covin (1990) argue that there must be a fit between the organisational structure and the type of behaviour in which it engages. In fact, they suggest that entrepreneurial behaviour, because of its risk taking nature, is not always good for a firm. Similarly it seems that new technology may not always be beneficial to the firm.

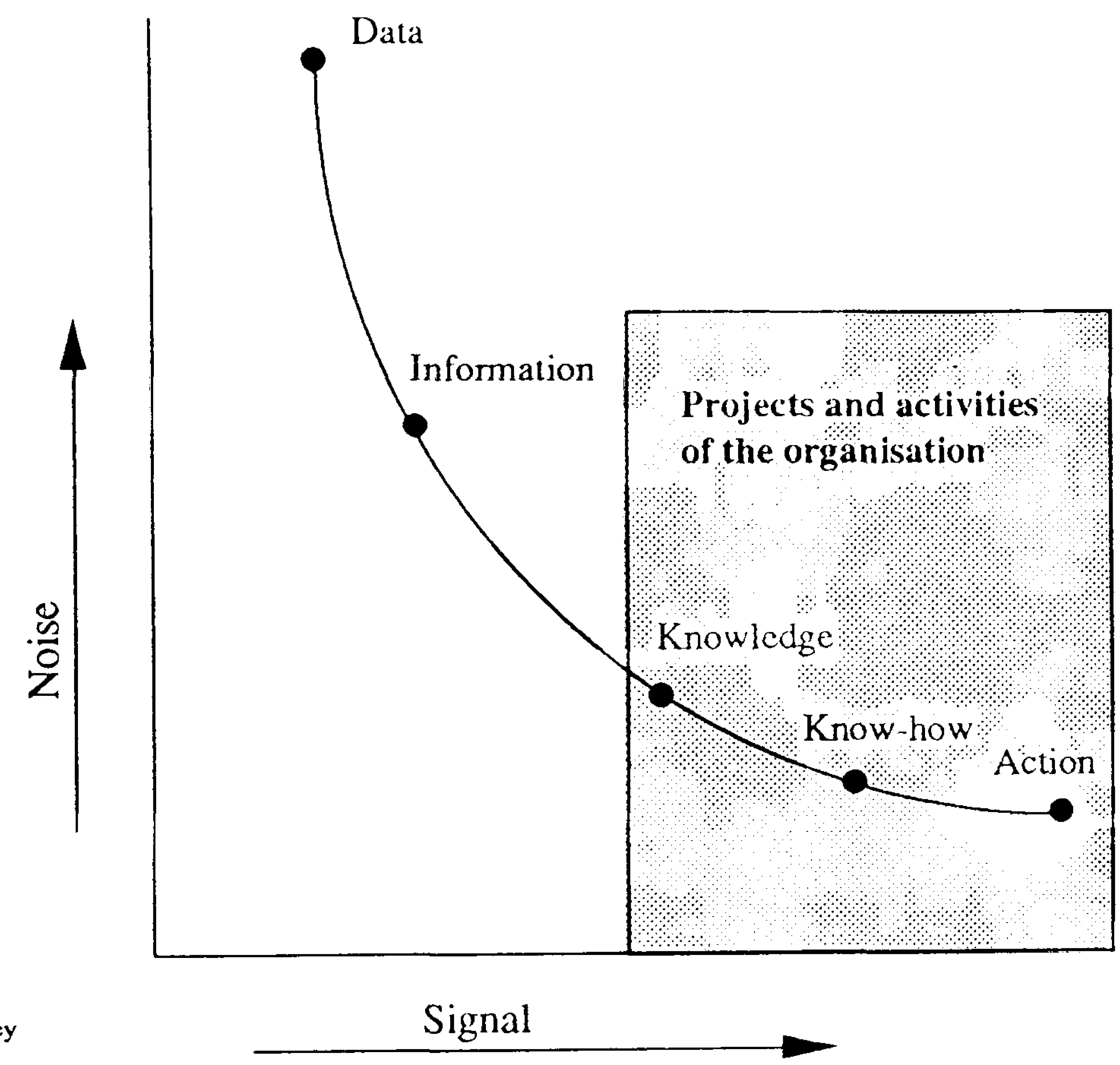
3.2.3 Tuning the scanning process: Reducing the level of noise in the signal

Cooley (1987) criticises the popular view that we are living in an information society; and argues that much of the so called information and information systems are data systems. He suggests there is a large gap between information and positive action. Beji (1987) also stresses the importance of accessing external knowledge rather than external information, and warns: 'a firm looking for knowledge is likely to encounter all kinds of information in its environment'.

This concept of signal-to-noise ratio[3] can be usefully applied to the scanning process. External scanning without a full understanding of the organisations capabilities and future requirements is likely to produce much noise along with the signal. To use Cooley's words 'the signal is frequently dimmed!' Thus "tuned-scanning", via internal assimilation of an organisation's activities, as opposed to "untuned-scanning" will produce a higher signal-to-noise ratio. In the diagram below (Figure 3.4) we see how the noise in the signal decreases the more the information is related to the organisation's activities.

Figure 3.4

Noise-to-signal ratio



File: McDCooley

Adapted from Cooley (1987)

3.3 Association: The second stage of inward technology transfer

The preceding discussion highlighted the importance of maintaining a high degree of awareness of both internal activities and the external opportunities available to an organisation. Such levels of awareness appear to increase the probability of individuals being able to develop and create "associations", on behalf of the organisation between, an internal opportunity and an external opportunity. The inward technology transfer process appears to be dependent on the creation of linkages between internal and external situations and commercial and technical opportunities. This process appears to be made almost

3 See appendix A for an explanation of the concept of signal-to-noise ratio.

exclusively by individuals on behalf of the organisation, who are able to combine these linkages (Lewis, 1990; Burgleman, 1983). This process of "association" is seen as the second stage in inward technology transfer.

It has been shown that identifying new and potentially useful technology is not difficult; it is clearly more difficult, however, to find technology to match a company's needs and capabilities. The tuned-scanning process enables businesses to generate genuine "business associations" and limit the production of "noise" by matching technology and markets with organisational capability.

To evaluate technology effectively it is necessary to have a correspondingly competent technological ability. It is not a coincidence that the world's largest licensors are also some of the world's biggest spenders on technology development (see section 2.3.5).

This introduces a potential paradox. In order to search one has to know before one searches, but if one knows, search is no longer needed! This can be resolved if a firm has a generalised idea of what is required (Bouling, 1968). The Chairman of Sony recently reminded us of a well known example of such a generalised technological objective (Morita, 1992): President Kennedy's technological mission in 1961 to get a man on the moon by the end of the decade. Many viewed it as a fantasy, but in the summer of 1969 a man did indeed walk on the moon.

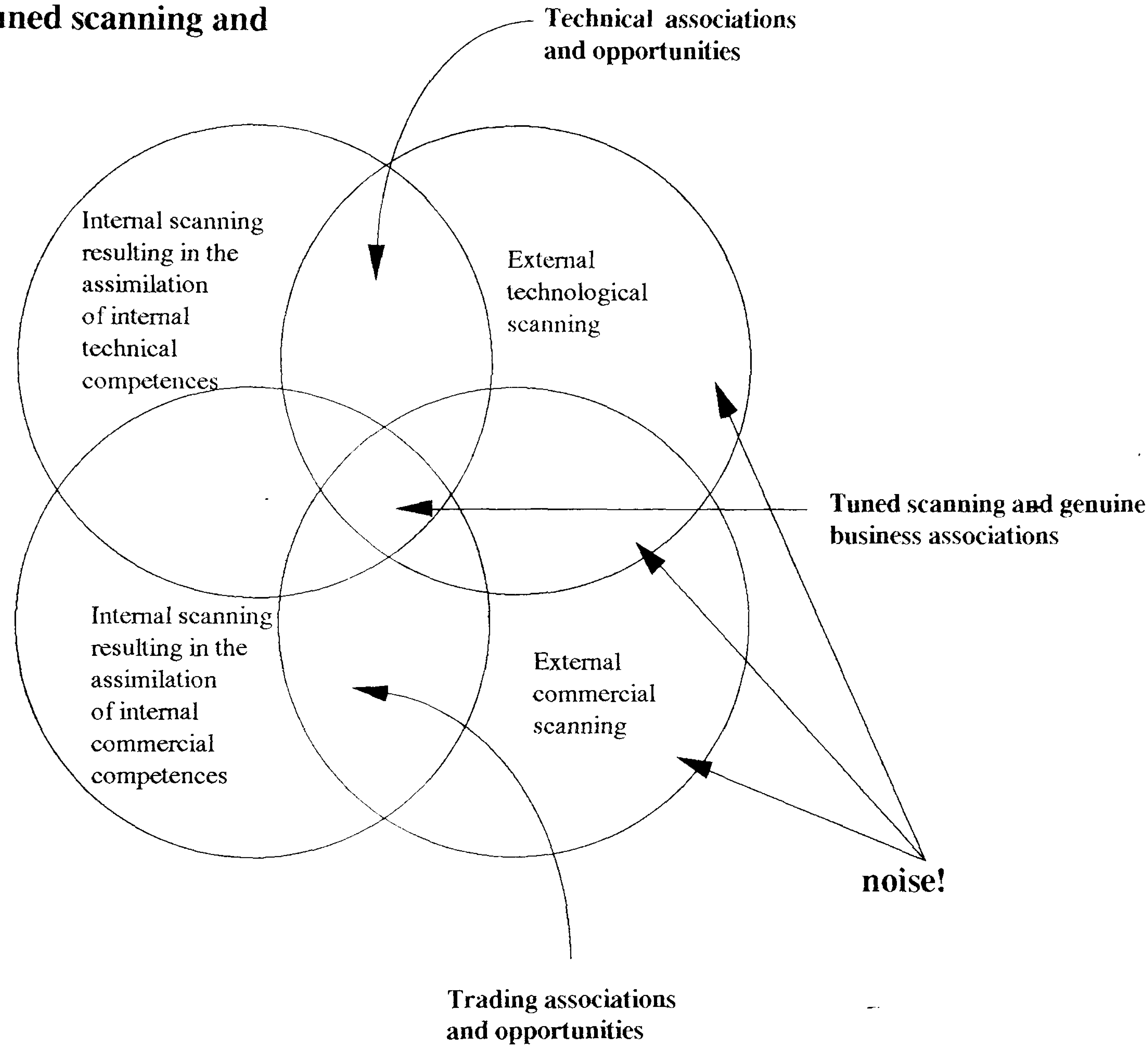
"I believe this nation should commit itself to achieving the goal, before this decade is out, of landing a man on the moon and returning him safely to the earth." (Kennedy J F, 1961).

The ability to relate seemingly unrelated things helps bring in new ideas. It appears being able to generalise specific technological needs provides individuals with scope for imagination and development. Such a general description might elicit several suggestions of how technology could be applied in different ways; thus enabling a wider variety of technological options to be considered (See Nonaka, 1990).

The complete tuned-scanning process (shown diagramatically below) ensures that the scanning activities are tuned into the appropriate needs of the business. This ensures that all identified technology and marketing opportunities are assimilated with existing technical and commercial competences, that is "organisational capability". The result is a process that produces a high level of business opportunities for consideration by the business as opposed to "noise" in the form of information that is inappropriate for consideration by the business. Furthermore, without tuning, the scanning process may consume vast amounts of resources without producing any benefits. (Figure 3.5, below, is a development of Figures 3.2 and 3.3.)

Figure 3.5

The awareness and association processes- Tuned scanning and noise!



File: McD4Cnew

3.4 The assimilation of "business associations" by the organisation: The third stage in the inward technology transfer process

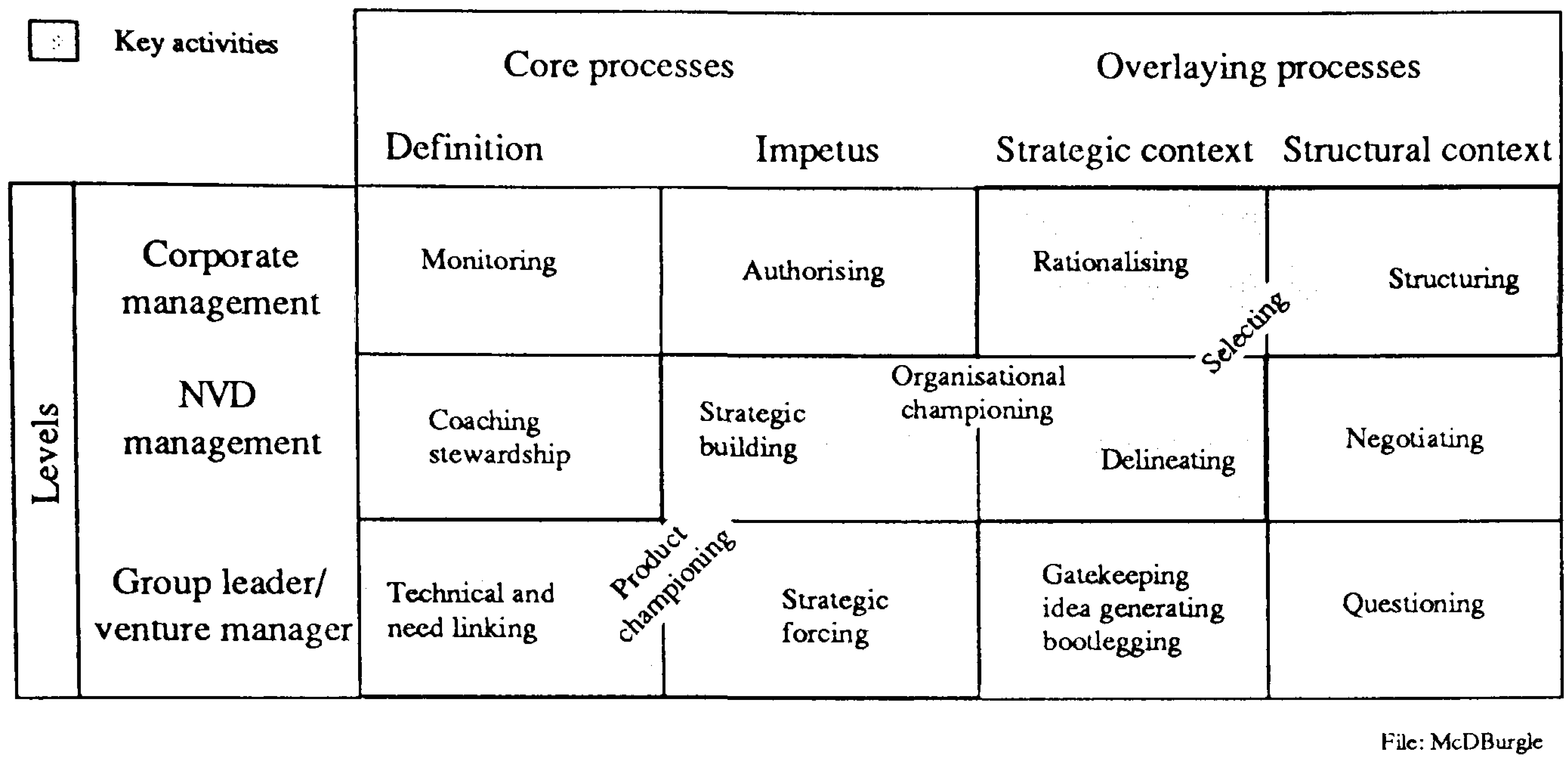
The next stage of the inward technology transfer process is commonly refered to in the literature as adoption (Rogers and Shoemaker, 1972; Zaltman, Duncan and Holbeck, 1984) and is dominated by references to champions, either product or business. Such key people, it is argued, are required in order to promote the business idea internally and push the idea through to final exploitation. In a seminal article on radical military innovations Schon (1963) identified the role of a champion. He contended that in order to overcome the indifference and resistance that major technological change provokes, a champion is required to associate with the idea, to promote the idea actively through informal networks, and to risk his or her position and prestige to ensure the innovation is adopted by the organisation. Schon's work has had a significant influence on innovation studies. Numerous field and case studies have found support for Schon's argument that the adoption of an innovation by an organisation is dependent on the presence of a champion (Roberts, 1968; Chakrabati, 1974; Rothwell, 1974; Burgleman, 1983; Howell and Higgins, 1990). Yet, despite these studies it seems that the presence of a champion, while necessary, is insufficient to ensure the adoption of technological innovations by organisations. The experience of the Technology Trawling Group at ICI is clear evidence of this (see Chapter Five).

It would appear that the so called process of adoption of technology by the organisation is a far more complex process than some writers would have us believe. The role of a champion is only one of many different factors. Not least of which is the integration of new technology with the existing knowledge base of the organisation. For example, one would not expect a company specialising in the manufacture of glass bottles to readily accommodate new injection moulding technology for the manufacture of polyethylene bottles without significant changes to the organisational knowledge base.

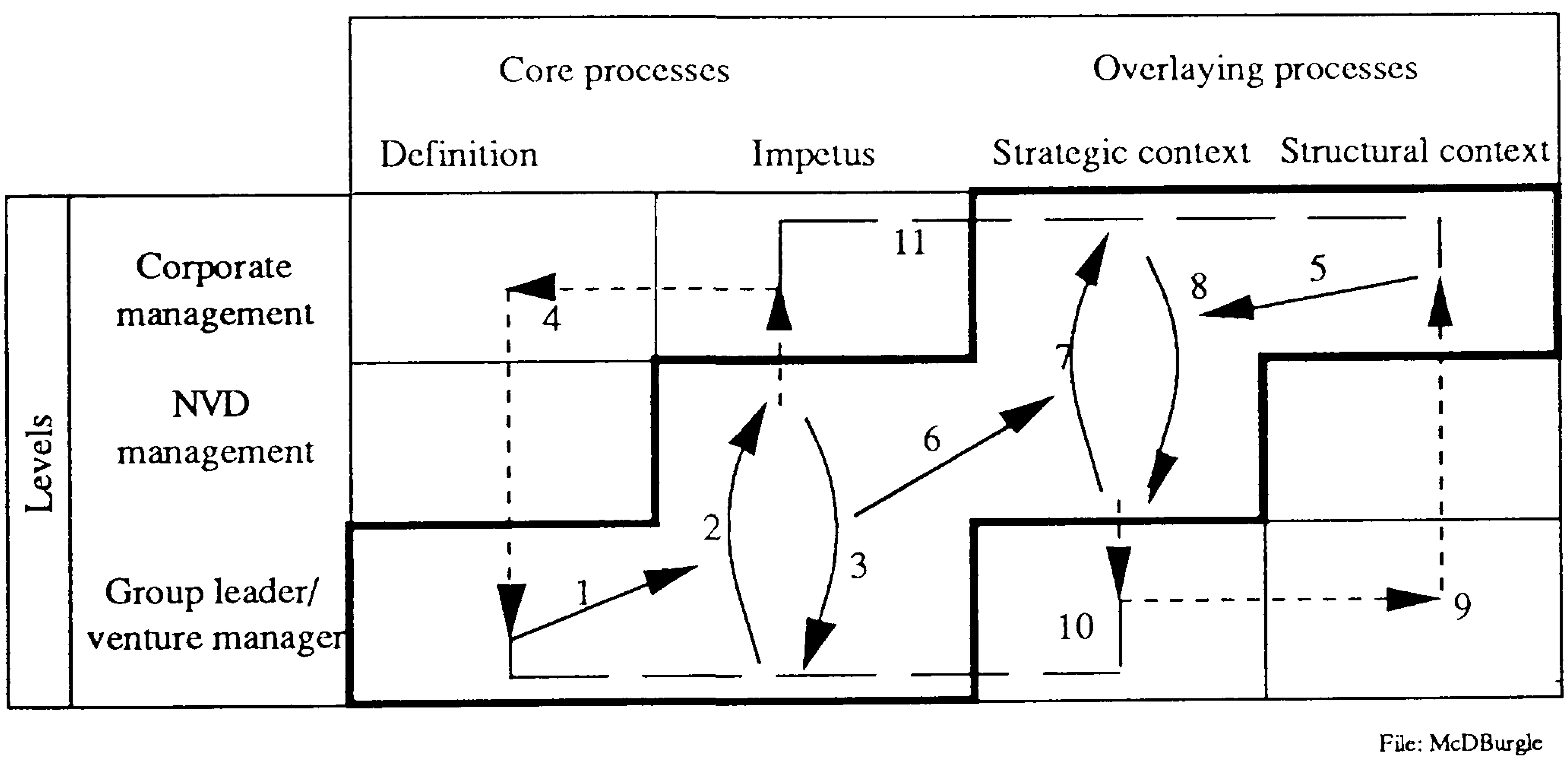
The previous discussion demonstrates some of the organisational processes involved in the adoption of externally developed technology. It also demonstrates the emphasis on the need to understand the activities undertaken by the organisation in learning about the technology and then adopting technology.

In a study of the internal corporate venturing (ICV) process by Burgleman (1983) the complexity of the internal organisational activities were revealed through the development of a grounded process model. This model shows that while championing is an important part of ICV, there are a variety of interlocking key activities of managers at different levels of the organisation that are also necessary for successful ICV. Burgleman showed that successful ICV efforts depend on the availability of autonomous entrepreneurial activity on the part of operational level participants, on the ability of middle-level managers to conceptualise the strategic implications of these initiatives in more general terms, and on the capacity of senior management to allow viable entrepreneurial initiatives to alter the corporate strategy (see Figure 3.6).

Figure 3.6



Flow of activities in a process model of ICV



1, . . . , 11 Sequence of activities in the process

——— Strong connection between activities in the process

- - - - - Weak connection between activities in the process

——— - Delayed effects in the process

Source: Burgleman (1983).

Although this particular model concerns the ICV process it does have a number of similarities with the internal technology transfer process especially at the so-called adoption stage where individuals within the organisation have generated ideas for it in the form of "business associations". Individuals must raise the awareness of the organisation to these business ideas so that it is in a position to adopt and exploit the technology.

If we explore this point a little further it seems that in order for an organisation to move from a position of being informed of a business opportunity to a position where it intends to exploit it, the organisation will have gone through a process of learning and understanding details and facts associated with it. Hence, it is proposed, that the organisation will have "assimilated" a body of knowledge specific to that business opportunity. Hence, "assimilation" is defined as: *The internal organisational process of transforming technical or commercial ideas into genuine business opportunities.* A genuine business opportunity is defined as *an opportunity that the business has an intention to exploit.* The process of **assimilation** is seen as the third stage in the inward technology transfer process.

3.4.1 The organisational knowledge base

It is important to recognise that the knowledge base of an organisation is not simply the sum of the individual knowledge bases. If this were the case, and knowledge was only held at the individual level, then organisations would change simply by employee turnover. The wealth of experience built up by an organisation through its operations is clearly not lost when employees leave. The employment of new workers and the retirement of old workers is not equivalent to changing the skills of a firm. There are several tangible representations of this knowledge such as: data banks of customers, operating procedures, manufacturing quality control measures, as well as less tangible representations such as tried and tested ways of operating. Nelson and Winter (1980) argue that such learning by doing is captured in organisational routines. It is evident that the knowledge base of an organisation will be greater, in most cases, than the sum total of the individual knowledge bases within the organisation (Willman, 1991). This is so because, he argues, knowledge is also embedded in social and organisational relationships (Cohen and Levinthal, 1990; Nelson and Winter, 1982). Moreover, Nonaka (1991) argues that Western managers fail to understand the nature and concept of organisational knowledge and consequently they are unable to manage it- let alone exploit it. This is because the traditions of Western management have been ingrained by the writings of Fredrick Taylor to Herbert Simon who saw the organisation as merely a machine to process information. According to this view the only useful knowledge is formal and systematic; hard data and codified procedures. Similarly the measurement of this knowledge is hard and quantifiable: increased efficiency, lower costs improved return on investment etc. Nonaka suggests there is another way to consider organisational knowledge, and it is found most commonly in highly successful Japanese companies. Nonaka explains:

'The centre-piece of the Japanese approach is the recognition that creating knowledge is not simply a matter of processing objective information. Rather, it depends on tapping the tacit and often highly subjective insights, intuitions, and hunches of individual employees and making those insights available for testing and use by the company as a whole.'

The knowledge base of an organisation is defined here as *the accumulation of the knowledge bases of all the individuals within an organisation* *and* *the social knowledge embedded in relationships between those individuals*. These relationships are often recognised as organisational processes and procedures (Kogut & Zander, 1992; Nonaka, 1991). The interactions and relationships between individuals may be said to represent a form of "organisational-cement" that performs two functions. Firstly it combines individual knowledge bases into a larger body of knowledge. Secondly it enables individual knowledge bases to be accessed by the organisation; effectively via interaction with other individuals.

3.5 The application of the technology

The final stage in the inward technology transfer process is the application of the business opportunity for competitive advantage. This is the stage where the organisation brings about commercial benefit from the technology. This could be in the form of increased sales through the launch of a new product or an improved product, or through the result of reduced costs.

Whether the organisation utilises this genuine business opportunity involves an analysis of further organisational decision making processes. The question of an organisation's capacity to exploit a business opportunity is beyond the scope of this research.

Chapter Four

The design of the research

4.1 Introduction

The research has been designed around the need to understand more fully the inward technology transfer process. In particular there is a need to analyse the role of the individual within an organisational setting thus uncovering the activities and processes that affect an organisation's receptivity to externally developed technology. Chapters One and Two highlighted the extensive debate that has endured over the past twenty years about the the ability of organisations to acquire externally developed technology, and the factors which affect this take-up. As well as providing a background to the study this review of the literature also showed the complexity of this area. The thesis presented here recognises that designing a piece of research within this complex field is itself problematic. The development of the 4A conceptual framework in Chapter Three helps to clarify the area under investigation and provides an interesting and unique way of looking at the inward technology transfer process. The research methodology adopted in this thesis is described as phased research or progressive research, with each piece of research building on the findings of the other. It may be useful at this point to reiterate the research objectives which were presented in Chapter One as research questions:

- What are the key processes that affect an individual's ability to be **aware** of externally developed technology ?

- What are the key processes that affect an individual's ability to **associate** externally developed technology with the needs and capabilities of his/her organisation ?

- What are the key processes that affect an organisation's ability to **assimilate** externally developed technology ?

The research questions presented in Chapter One and the conceptual framework presented in Chapter Three directed the form of the research design. A qualitative multi-method approach was chosen as the best way to arrive at an encompassing view of inward technology transfer.

This chapter will provide an explanation to the design of a three part fieldwork programme that included:

1. A historical analysis of documentation within ICI together with a series of unstructured interviews that would provide a thorough understanding of the organisation and the environment in which further research would take place. It would also support the design and analysis of future fieldwork.

2. A survey of two businesses within ICI that would provide comprehensive qualitative and quantitative data about the processes of awareness and association.

3. A series of in-depth interviews with key people in three businesses. Two ICI businesses and one non-ICI business. The data collected from these interviews enabled the assimilation process to be modelled using cognitive mapping.

The preliminary analysis of the organisation would provide a rich source of data from which a number of propositions could be developed to try and establish the specific data required to answer more fully the research questions. Similarly the data gathered from the second piece of fieldwork would also aid the development of further propositions for the final piece of fieldwork.

It is further recognised that merely identifying the types of factors involved is only part of the problem associated with inward technology transfer. There are already numerous studies of this type: (Carter and Williams, 1959; Rothwell 1974; Beasley, 1987; Rothwell, 1991). Such structured approaches fail to show <u>how</u> these key factors affect the process. Hence, their findings have been of limited value to businesses. Future research needs not only to identify the factors involved in the process but to show how they affect the process. This implies a need to model the factors involved in the process. The direct interactive modelling technique of cognitive mapping, using unstructured interviews, was thus selected as an appropriate method for revealing the complexities of the internal organisational processes involved in the assimilation process.

4.2 Rationale for a qualitative multi-method approach

There were a number of criteria that had a significant impact on the design of the research. The first of these was the need to analyse the inward technology transfer process <u>from within an organisation</u>. This presents a number of difficulties. Firstly, there is gaining entry into an organisation to conduct the study. Secondly, such internal studies are very time consuming as it is necessary to understand the organisation and the environment in which the research will take place. These factors limit the number of organisations that can be studied in this way.

In this field of management research within organisations, there is the inevitable dilemma: Should research produce numbers with their rigour, precision and reliability or the more descriptive, phenomelogical qualitative data, with its richness of detail and nuance (Mostyn, 1985). There are clearly strengths and weaknesses with both. The decision must depend on the particular requirements of the research. Mostyn outlines the findings of George (1959) who suggests that in certain circumstances quantitative analysis is not sensitive enough:

'The qualitative analysis of a limited number of crucial communications at one moment in time may often yield better clues to the particular intentions than more standardised quantitative methods'.

Mostyn argues that:

'. . . the quantitative analyst typically gives each unit or category of analysis equal weighting, which is totally unrealistic. Qualitative analysis no doubt captures the richness, complexity, and gestalt of the material, while quantitative methods, particularly those employing the computer, are intolerant of ambiguity.'

Another strength of a qualitative approach is the ability to study participants as people. The researcher is more able to see the world from the respondents' point of view. Such an approach is more likely to provide a better understanding of the everyday experiences of managers and scientists within large organisations. This type of approach implies that the researcher has a thorough understanding of the area under investigation.

The need to acquire an understanding and a "feel" for the subject inevitably constrains the planning and design of fieldwork procedure, and by implication the formation of rigid hypotheses. Lemon (1992) argues that 'if these hypotheses are set without empathy for the subject, it is possible that they will become "esteemed for" themselves and work as an absurd symbol of science', with the danger that the researcher may be unlikely to modify his or her hypotheses as his/her knowledge of the subject improves. Hence, the research did not follow a rigid design it was flexible, especially in the beginning, and firmed-up as more and more data was collected and the understanding of the area developed. Lemon

(1992) shows how Agar (1981) outlines the practical problems of pursuing a research design without this "feel" for the subject.

> *You can't specify the questions you're going to ask when you move into the community; you don't know how to ask questions yet. You can't specify a sample; you don't know what the range of social types is and which ones are relevant to the topics you're interested in'.*

The empathy or feel for the subject was established through two methods (1) a historical analysis of documentation from within the organisation such as: business meeting minutes, memos, internal reports, letters, notes and legal papers; (2) a series of unstructured interviews with a variety of people within ICI who were or had been involved in inward technology transfer. These two methods form Phase One of the research.

The dangers of masking, or distorting factors in observing them has led to the use of multiple methods or triangulation methods. Analogous to the navigational method of fixing ones position by reference to two, or more markers, a triangulation approach makes use of two or more research methods in an attempt to eliminate, or to draw attention to the masking effects. Hence the use of unstructured interviews, structured interviews and cognitive mapping.

The importance of the role of the individual has already been highlighted in a brief review of the literature in Section 1.4.2. (A collection of these roles is detailed in Figure 1.2). In addition this point was confirmed from the findings of phase one of the research. ICI C&P, like virtually all other organisations, absorb vast quantities of information every day. This information is captured and disseminated within the organisation by a huge osmosis process via the people within it. These people continually make many decisions based on their own beliefs and perceptions. For example:

- the importance and usefulness of the information;
- where and to whom the information is passed;
- the amount of detail to relay to others in the organisation;
- the time at which to pass on the information;
- the selected method to pass on the information.

Such activities and subsequent decisions not only regulate the <u>flow</u> of information into an organisation, they also affect an organisation's ability to communicate and assimilate this information. Thus, they influence an organisation's effectiveness at promoting technical innovation.

The need to concentrate on the role of the individual within the organisation is now evident. Hence, a method was required to uncover the activities of the individual. Central to this discussion was the balance selected between structured, semi-structured and unstructured elicitation formats. The elicitation of process, as discussed in Chapter One, was seen as a prerequisite to the selected techniques. The sending of questionnaires from outside an organisation may lend itself to quantitative methods and statistical analysis but it does not lend itself to detailed rich data of the kind required to uncover the internal activities and processes of individuals. Who will be operating in an industrial organisation against a background of fluctuating company fortunes, generating an overall atmosphere of uncertainty.

4.3 Research Setting

Prior to the commencement of the research programme a preparatory meeting was organised between the researcher, the university (INTA) and the collaborating organisation (ICI). The purpose of this meeting was to: (1) establish the terms of the research for all involved; (2) to ensure that the organisation was in a position to offer an environment suitable for such a research project; and (3) to ensure the collaborating organisation was fully aware of the demands that would be placed upon it and was willing to offer the necessary resources for the project in terms of access to people, their willingness to offer time, etc. This meeting also provided an opportunity for all parties to build useful relationships and ensure that this could be a viable and realistic piece of work in the limited time available. This prior review provided considerable help towards the management of the research project for all concerned.

It is worthy of note in this research design section to mention the receptivity of the organisation to research in general and to this piece of research in particular. ICI is a science and technology based organisation. Consequently many managers within ICI have experience of research, indeed, many of those interviewed had completed a PhD. This was a significant factor in the relationship of the researcher with the participants. Interviewees were largely friendly, hospitable and sympathetic to the role of the researcher. Moreover, they were not only interested in the area of research they were also interested in the method of research (sic). While this is a tremendous asset it puts the onus on the researcher to keep his/her participants informed of developments and to provide feedback.

A study from within the collaborating organisation, has a number of advantages. Specifically regarding entry and access to key people within the organisation and added credibility of the research. A study exclusively within one organisation allows for a thorough in-depth study. However, such single organisational studies do not provide the opportunity for any comparative data between organisations.

While the vast majority of the data in this research was collected from within ICI another large multinational chemical company was used to enable some limited comparison of the data. For reasons of confidentiality this second organisation did not wish to be identified. This organisation will therefore be refered to as Redsoap.

4.4 Understanding ICI through immersion within the organisation: Phase one of the fieldwork

4.4.1 Aims of Phase One

To enable the researcher to gain an understanding of the organisational environment in which the research was to be conducted and to gain a feel for the subject. This would enable the researcher to identify a number of themes and facilitate design of subsequent fieldwork.

4.4.2 Factors influencing choice of research methods

Prior to any internal organisational study it is necessary to understand the organisation. This involves learning about what the organisation does; how it works; and how the people within the organisation work. Hence, to achieve this in the limited amount of time available requires some form of "immersion" within the organisation to "acclimatise" oneself with the environment. In addition this provides the opportunity for the researcher to build trusting relationships with people within the organisation.

As a means of an introduction to the organisation <u>and</u> as a way of uncovering some of the historical context of the area under study an internal documentation is a useful starting point, especially for a organisation based study. Marshall and Rossman (1989) suggest historical analysis is particularly useful in qualitative studies for establishing a background prior to interviewing. Gaining access to internal organisational documentation is normally extremely difficult for an external researcher. In this case, however, access to internal ICI contemporary records and confidential reports was provided by ICI.

While extremely useful in providing background information, historical analysis has several weaknesses as a method used on its own as outlined by Marshall and Rossman (1989) :

> *Documents may be falsified deliberately and are subject to incorrect interpretations on the part of the recorder. Words and phrases used in old records may now have different meanings ... Errors in recordings as well as frauds, hoaxes, and forgeries pose problems in dealing with the past.'*

Nonetheless it is a complementary method to interviews, and was used as such.

In this particular field of research the most serious weakness with historical analysis is that it tends to focus on the formal organisational processes and does not provide access to the informal organisational processes. To uncover the informal and unstructured linkages and processes demands an inductive qualitative study.

The value of the interview as a research method is convincingly stated by Brener, Brown and Canter (1985) who suggest that

"as long ago as 1942, Allport pointed out that if you wanted to know something about people's activities the best way of finding out was to ask them".

They go on to say that interviews provide access to valuable sources of particular information by treating individuals as the "heroes of their own drama".

Hence the selection of semi-structured interviews. This preliminary study involved spending time with people at ICI, interviewing and discussing issues with them. A series of semi-structured interviews were conducted with a variety of people in ICI over a period of ten months. The interpretive procedure that was adopted for these interviews is discussed in Chapter Five.

The interviews provided an understanding of the organisation and found support for the 4A conceptual framework. They also helped to provide some guidance for the design of the second piece of fieldwork, in particular, the development of a series of propositions.

In conclusion, it was not the intention to use the semi-structured interviews to provide a comprehensive evaluation of the inward technology transfer process. Neither was it intended that they would provide anything more than a preliminary understanding of the subject under study. Their purpose was, firstly, to enable the researcher to gain an understanding of the organisational environment in which the research was to be conducted and secondly to identify a number of themes that would support the design and analysis of the subsequent fieldwork. The objective of this early fieldwork was, therefore, to gain a feel for the subject rather than to provide a specific contribution for analysis.

4.5 The development of a set of propositions for research phase two

The results of the preliminary studies highlighted the importance of the role of the individual within inward technology transfer, specifically with regard to the technology-scanning activities of individuals within the organisation. This preliminary study also found evidence of the importance of informal processes as opposed to formal processes. These findings led to the development of a series of propositions which are derived below:

Positive search and scan activities are elements which would appear to distinguish a receptive organisation from an unreceptive organisation. There is a significant weight of evidence to suggest that a high degree of awareness may be assembled through scanning and interacting with others (Aguilar, 1967; Rothwell, 1991; Kreiner & Schultz, 1990; & Lewis, 1990). Consequently an individual who remains hermetic, is likely to possess a lower degree of awareness suitable for inward technology transfer than an individual who devotes a certain amount of time interacting with appropriate people <u>both</u> within the organisation and outside the organisation.

Nevertheless, scanning and networking are non-routine activities that requires high trust on the part of the organisation. Such non-routine activities concern the degree of freedom that individuals have within their organisation and the degree of freedom that they themselves perceive to hold within their organisation. Consequently the level of scanning and networking undertaken by individuals within an organisation will depend on the facilitative, implicit and explicit, support provided by the organisation for these non-routine activities. This support may present itself in a variety of forms:

1. Financial controls;
2. Socialisation controls;
3. Norms of behaviour.

Hence proposition 1 and 2:

(1) Effective technology-scanning depends on the explicit recognition by the organisation of the importance of technology-scanning.

(2) Effective technology-networking depends on the explicit recognition by the organisation of the importance of technology-networking.

It would clearly not be possible for every idea or every interesting piece of technology to be brought into ICI for careful analysis. Virtually everyone at ICI, and especially those involved in technology development, filter ideas/technology using some form of criteria. This criteria appears to be based upon knowledge of the business's operations and activities including: the markets in which the business operates, the technical capabilities of the business, the types of customers who use the business's products and the future plans of the business. Thus it is suggested that without this prior knowledge individuals will not be able to scan effectively on behalf of the business.

Hence proposition 3:

A thorough understanding of the business' operations, technical capabilities, markets and future business plans are essential for effective scanning and networking.

Having a high degree of awareness of <u>both</u> internal activities and capabilities, and external opportunities would appear to increase the probability of an individual being able to create an "association" between an internal opportunity and an external opportunity. The inward technology transfer process appears to be dependent on the creation of such linkages, which previously did not exist. This is, by definition, a **creative process.** Furthermore, this process appears to be made almost exclusively by individuals on behalf of the organisation (Lewis, 1990; Burgleman, 1983).

Hence proposition 4:

The coupling of internal and external, technical and commercial, scanning will produce business associations and subsequent genuine business opportunities.

4.6 A study of technology-scanning: Phase two of the fieldwork

4.6.1 Aims of phase two

To collect sufficient reliable data to test the validity of propositions 1, 2, 3 and 4.

4.6.2 Factors influencing the choice of research method

Any study of a business's internal activities also needs to take into consideration a business's external operating environment. This is because a business does not operate independently of its external environment, hence a business's external operating environment may be a significant factor in determining a business's receptivity to externally developed technology. For example in times of growth the business may be more receptive than in times of decline. To accommodate these external environmental factors a comparative study of <u>two</u> businesses from ICI was designed.

It could be argued that some of the Chlor-Chemicals' businesses would not be very receptive to any technology whatsoever whether internally or externally developed. This is because many of these businesses possess processes and plants that have been running for 20 years or more. Product changes in these businesses are very slow and tried and tested methods are often resistant to change. The science and technology is very mature hence changes in technology within these businesses are commonly with respect to enabling systems, for example, computer support systems, minor plant improvements, etc.

The amount of R&T expenditure by the businesses may help to identify those businesses that one might expect to have a more positive approach to technology-scanning. Within ICI R&T expenditure is dependent on predicted growth (see Chapter Five). As is outlined in Chapter Five and Appendix B some of the Chlor-Chemicals businesses spend very little on R&T whilst others spend substantial amounts.

Technology development within Chlor-Chemicals is foremost in two growth areas, the Electrochemical Technology business and the Watercare business. By contrast the Solvents business has one of the lowest R&T expenditures.

By way of a contrast and as a useful comparative study two businesses from within the Chlor-Chemicals group were selected to provide a rich mix of the factors involved in inward technology transfer; a high growth, new business, Watercare, and a mature, low growth business, Solvents. As an added incentive, due to the current circumstances of these two businesses (see Section 5.3), ICI believed they would be very interested in the study.

Having selected a comparative study there are clearly a variety of methods available to acquire the type of data sought. However, these methods vary in their suitability given the circumstances of the research; a central feature of this study is the role of the individual within an organisational setting. A number of the most common approaches used in comparative studies are analysed below.

The data sought in this second study relates to a particular set of activities of individuals within the organisation. **Observation** techniques are often used to reveal such activities, though normally in less frenetic environments. Overt observation of participants from within the setting is not appropriate in an commercial operating business like ICI. This is because the environment tends to be dominated by extensive discussions both formal and informal punctuated with telephone calls and meetings with ICI and non-ICI people. This raises numerous problems for the potential observer not least the ethical issue of infringement of intellectual property rights via unwitting access to highly sensitive company information not necessarily belonging to ICI! (See True and True (1977) for an elaboration of this point). Furthermore, following discussions with people at ICI this technique was the least favoured because they believed it would cause considerable interference with their day-to-day work.

The type of information sought by **questionnaires** tends to be about the distribution of a characteristic or a set of characteristics, or a set of attitudes or beliefs. In deciding to survey a sample of a population a critical assumption is made that this characteristic or belief can be described or measured accurately through self-report (Marshall and Rossman, 1989). Furthermore, in using questionnaires one relies totally on the honesty and accuracy of the participants responses. This limits the usefulness of questionnaires in delving into tacit beliefs and deeply held values. Thus this type of approach is not ideally suited to the type of information sought here.

At this point it is worth noting an important point for the benefit of future management/organisational research of this kind. As with many other large multinational organisations ICI receive literally hundreds of postal questionnaires every week from keen research students, market research organisations and consultants from across Europe. Many managers revealed that they were unable to complete questionnaire, after questionnaire, even though they had sympathy for the researcher; many of these managers were once in a similar position themselves. Even the ones that were completed were done so in great haste and with little attention to detail. The consequence of this is that the questionnaire as a research technique is viewed with even greater scepticism within ICI. Moreover, the eventual results derived from these surveys received a low credibility rating by managers in ICI. This commonly held view within the organisation steered the researcher away from the use of the questionnaire as a research technique and provided a further constraint on the choice of research method.

Finally, questionnaires are often used when entry into an organisation is either difficult or not possible. In this particular case, ICI offered the researcher full access to the organisation. With the above discussion in mind it would appear that a more interactive technique is what is required.

The interview has a number of strengths as a method of data collection. Probably the most important of these is that it allows both parties to explore the meaning of the questions and answers involved. Thus any misunderstandings on the part of the interviewer or interviewee can be checked immediately in a way that is not possible when questionnaires are being completed. In addition to the value of negotiation in the interview, there is the advantage that it gives rapid, immediate responses.

There are also a number of weaknesses which should not be ignored. The technique requires a variety of skills on the part of the researcher. These are often defined under the umbrella of "interpersonal skills". A considerable amount of time is also required to design the interview schedule. Another weakness is that because the contact between the interviewer and respondent is face-to-face and may be intensive, there is ample time for bias to occur. Some of this bias can be reduced through recording of interviews. Finally, it is often extremely difficult to conduct interviews within an organisation, especially with key decision makers in middle or senior management with their busy schedules.

Following the preliminary study and the resulting propositions, a technique was sought that could explore in a detailed and thorough way the particular concepts of awareness and association. Furthermore an approach was required that enabled a comparative analysis to be conducted. In addition the second study was able to build on the experiences of the first. In the first study, using **semi-structured interviews,** respondents tended to talk about some of the wider and additional issues. While this was appropriate for a preliminary study, it was felt this would be less appropriate for the second study which had a more focussed objective. In this case an in-depth study was required to probe deep into specific issues and uncover the precise activities of individuals. Hence a detailed **structured interview** was developed that contained sixty five questions. The design of this structured interview is explained in Chapter Six.

In conclusion the purpose of this second phase of the research was to explore in a detailed way a specific set of propositions that were put forward following the preliminary study. These propositions centred around the concepts of "awareness" and "association" and concerned the scanning activities of individuals within an organisational setting. However, the creation of **possible** business opportunities is only part of the inward technology transfer process. Understanding how an organisation transforms these opportunities into **genuine** business opportunities[1] was the third area of study.

4.7 A study of the "assimilation" process: Phase three of the fieldwork.

4.7.1 Aims of Phase Three

The findings from phase two of the research highlighted the need to look at the organisational processes and culture that are not part of its routine activities yet enable it to assimilate business opportunities.

Effective assimilation of externally developed technology by an organisation depends on individuals disseminating the information and knowledge, gathered through scanning, throughout the organisation. Only then can it formally and or informally assess any business opportunity. It follows that in order for individuals to inform the organisation of possible business opportunities and in order that the organisation may learn about these opportunities, a variety of internal processes must be in place. This will enable the organisation to absorb the necessary information and apply it in a constructive and

1 Genuine business opportunities are defined in Chapter Seven as: an opportunity that the business has an intention to exploit.

competitive way. Such activities will include ensuring that the appropriate people within the organisation are aware of the technology.

4.7.2 Factors influencing the choice of research method

With the emphasis on organisational processes and culture a single organisation study presents a number of weaknesses. Thus an additional organisation was used in this third phase of research as a comparative study. This information will be used as a comparative reference point at the final analysis stage.

The focus of the fieldwork is to uncover the key organisational factors that affect the **assimilation** of externally developed technology by the organisation. Accessing data of this type can be extremely difficult. Research by Eden et al. (1983) has shown that while individuals working within an organisational environment are all too often aware of the activities that constitute a process, in this case "assimilation", they find it difficult to articulate these in a coherent form because they are embedded in experience and taken-for-granted routines and procedures. In order to uncover the factors involved in the assimilation process it is necessary to access from individuals their mental map of the process under investigation.

Collection of data for aggregation suggests survey methods of a fairly traditional kind eg. questionnaire, structured interview, but these would not meet the requirements for rich qualitative data of the kind that would appear to be necessary to uncover the process of assimilation. Neither would these traditional methods be likely to reveal the truth, or more importantly nor would they be completed by the respondents. A basic premise was that "assimilation" occurs when a series of decisions (to act in a certain way) act in concert. Brown (1992) argues that such decisions are taken by the sort of people who would not be likely to fill in survey forms, that is, highly qualified and very experienced scientists and business managers (see Section 4.3.3 on surveys and questionnaires).

Mindful of the complexities of the process and the wide variety of informal activities involved (see Section 5.6), a normative structured investigation would have denied the chance to explore and uncover the actual process of assimilation as perceived by the actors in their own terms. The problem with the questionnaire and structured interview method is that one tends to impose one's own model on to the structure, thus implicitly indoctrinating the client under study. Marcus (1991) argues that the questionnaire, and to a lesser extent structured interviews, can often take the form of a verification process. Thus, a strictly scientific, deductive approach using a priori premisses was felt to be inappropriate. What is required is an elicitation method where one uncovers and draws out from participants their own "mental model" of the assimilation process. An inductive method was needed, where data are gathered without preconceived notions about their significance or orientation. It is clear that these data would have to be gleaned in such a manner, that, whilst not constraining the participants comments, their discourse would remain pertinent to the areas under investigation. Furthermore, effective interpretation of qualitative data relies upon maintaining the variety of response at the same time as identifying common themes.

This narrowed the option to a range of face to face elicitation techniques as follows:

Personal construct theory was first developed by Kelly[2], an educational psychologist, in the study of deviant behaviour in children. It is claimed that each individual develops a range of constructs based on his/her experience and that these constructs influence his/her perceptions and the way in which he/she behaves. It is used extensively by psychologists to delve deep into a person's view of the world in which they live. It is a highly skilled technique that requires many hours of training. In addition, interviews using personal construct theory can be very time consuming; Marcus (1991) states that Gray (1980), Bannister (1981) and Shaw (1983) all suggest a time of one and a half to two hours for each interview. This begs the question as to whether such lengthy intrusion into a senior manager's working day is reasonable or acceptable. In view of the points raised above this technique was felt to be inappropriate.

Expectancy value theory is used extensively in market research to uncover people's attitudes towards certain things. A person's attitude towards something is essentially determined by no more than five to nine beliefs about it. These beliefs, which are taken to determine attitude, are known as salient beliefs (Towriss, 1979). While this technique reveals the views people hold it does not attempt to uncover why people hold these particular views. Thus this technique would provide insufficient depth of enquiry to enable modelling of the process of assimilation.

Cognitive maping is a soft systems approach that enables the researcher to establish people's views and why they hold these views. The technique is fairly simple to use and hence does not require extensive training; typically interviews last about an hour (Eden, 1983). Furthermore it is a modelling technique that elicits a person's understanding of a process in their <u>own words</u>. The constructed cognitive map (model) uses the participants own language and thus facilitates ease of understanding of the model. This is particularly

2 See Kelly (1955; 1963) for a detailed explanation of personal construct theory.

important for receiving feedback on the developed model. Immediate problems are presented if the model cannot be easily understood by the participant.

A number of studies have suggested that an in-depth interview, of the style required for cognitive mapping, cannot be started without detailed knowledge and preparation (Marshall and Rossman, 1989). Burgess (1984) recommends that it is essential to get to know the people before a detailed conversation can occur. In this case this criterion has been met following the earlier studies.

In a study of the internal corporate venturing process Burgleman (1983) was able to develop a process model through the use of unstructured interviews. This model shows the relationship of several internal factors involved in internal corporate venturing. (This model is shown in Chapter Three, Section 3.4).

The direct interactive modelling technique of cognitive mapping, using elite unstructured interviews, was thus selected as an appropriate method for revealing the complexities of the internal organisational processes involved in the assimilation process. Chapter Eight offers a more detailed analysis of cognitive mapping and the design of this third piece of fieldwork.

Due to the circumstances of this research, specifically the total cooperation and support of ICI and Redsoap, the researcher had the opportunity to conduct direct interactive modelling using elite interviewing. An elite interview is a specialised treatment of interviewing that focuses on a particular type of respondent. Marshall and Rossman (1989) offer the following explanation of elite interviewing:

"Elites are considered to be the influential, the prominent, and the well-informed people in an organisation or community. Elites are selected for interviews on the basis of their expertise in areas relevant to the research". *Marshall and Rossman (1989).*

A senior manager from both ICI C&P and Redsoap was able to identify a relatively small number of key people who played influential roles in the inward technology transfer process.

Finally, the researcher was able to design into the technique a mechanism for feedback and verification of the models produced. The simplicity of cognitive mapping as a modelling technique facilitates this feedback process. Thus the researcher was able to return all the cognitive maps produced to all the participants for verification and corroboration.

In conclusion the objective of this third phase of the research was to uncover the complex internal processes involved in assimilation. Cognitive mapping was selected as a relatively simple and easy-to-understand direct interactive modelling technique that also permitted the researcher to gain valuable corroboration of the models produced.

Chapter 5

Understanding ICI and ICI Chemicals and Polymers Ltd: Phase One of the research

This chapter is divided into six sections. Section One explains how the document analysis was used prior to the interviews. It also explains the design and application of the semi-structured interview. Section Two presents the findings from the analysis of the documentation and the interviews and discusses the organisational form of ICI. Useful background information concerning the two ICI businesses selected for the comparative study is presented in Section Three. The wide variety of tasks undertaken by the Research and Technology department is reviewed in Section Four. The area of new product development is shown to be an area of considerable activity for both the ICI businesses unvolved in this study. Section Five discusses the management of research and technology within ICI and offers a model, developed by ICI, linking business strategy to research activity. Finally, Section Six discusses the area of inward technology transfer (ITT) at ICI and uncovers the importance of technology-scanning in the ITT process.

5.1 Introduction to the research methods used

Chapter Four discussed the importance of fully understanding the research setting before conducting any detailed investigation. This was the main aim of phase one of the research, to uncover as much as possible about ICI Chemicals and Polymers Ltd and in particular technology transfer into the businesses of ICI and the role of the Technology Trawling Group. This was to be achieved using two methods: firstly, a historical analysis comprising of a study of documentation, and secondly, a series of 30 semi-structured interviews with a sample of managers from ICI. Hence, the view of the organisation presented here represents the researchers interpretation of the findings from the two research methods used.

5.1.1 Documentation analysis

The document analysis was used as a preliminary study to establish background information prior to interviewing. Primary sources were used that included: business meeting minutes; memos; internal reports; letters; and notes. Of particular interest were the files from the Technology Trawling Group that represented the activities of the group over a two year period. These findings are discussed in Section six.

The flow diagram in Figure 5.1 is an example of the type of data uncovered during the study. It shows the formalised procedure for the evaluation of new business ideas. However, as will be revealed in Chapters Seven and Eight,this is an over-simplified model. It does not show the many informal activities that influence the acceptance or rejection of new ideas, for example the leadership style of the business and an awareness of the technical and commercial capabilities of the business. These will be discussed in greater detail in Chapters Seven and Eight. Nonetheless, the document analysis was particularly useful in presenting a wider picture of ICI and its businesses, hence, providing a historical context for the research.

5.1.2 Design of the semi-structured interview

An exploratory interview study was designed along with background information, to uncover, what people in the businesses within ICI believed were the key issues involved in inward technology transfer. A variety of research managers, commercial managers and business managers were selected, by a senior manager within ICI, as a representative sample of those who have a variety of experiences of managing technology within ICI Chemicals and Polymers (see Figure 5.3 for details of all participants). It is important to note that as this first series of interviews was designed to glean background information, and, as such, little of substance could be offered in return to the participants for their time and efforts, the researcher had to make the interviews pleasing and enjoyable. Hence, a semi-structured interview was used which comprised of six questions (see Figure 5.2). The style of the interview took the form of a 'conversation with a purpose' (Mayhew, 1851); the purpose being to elicit a picture of the organisation as perceived by the participant and to uncover some of the key factors involved in inward technology transfer.

Questions 1 and 5 are general concerning the role of the individual within the organisation. They enable the participant to describe his understanding of the organisation. Question 4 addresses the wide subject of the management of technology within ICI and attempts to get an understanding of how the managers of an organisation view this subject. Unfortunately this question proved to be too far-reaching and nonspecific for many participants to offer any meaningful contribution. Questions 2 and 3 try to focus on the subject of inward technology transfer and attempt to get a feel for what the managers operating within the organisation see as the important issues.

Figure 5.1 **ICI flow model showing procedure for dealing with new ideas**

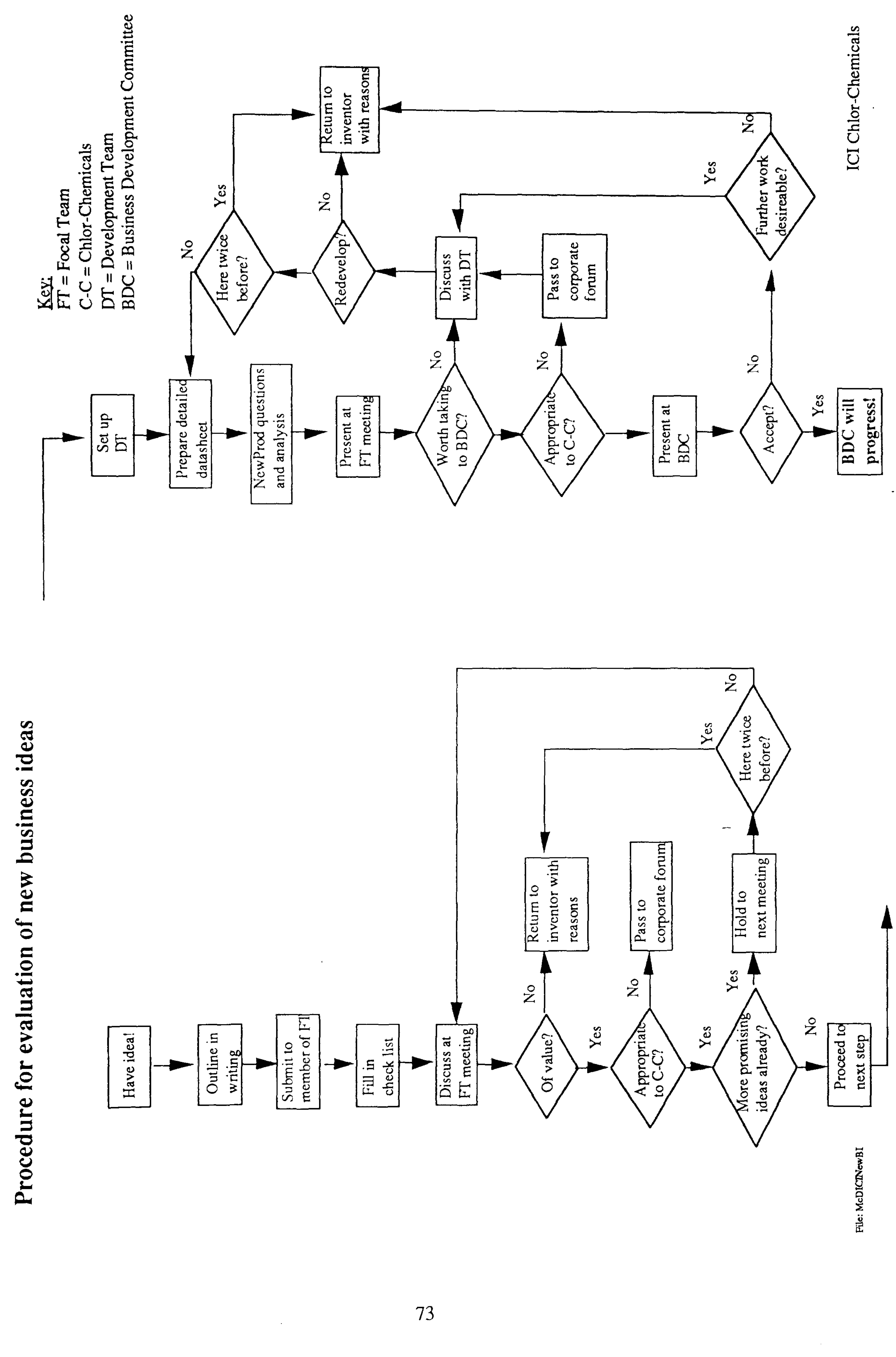


Figure 5.2

The Semi-structured interview schedule used in phase one

1. What is your role within ICI C&P/ your business ?
2. How is technology transfered into ICI C&P/ your business ?
3. What in your view are the key factors involved in transfering technology into ICI C&P/ your business ?
4. How is technology and research managed in ICI C&P/ your business ?
5. How are you made aware of the activities and developments of other functions within the business/ R&T ?

5.1.3 Application of the semi-structured interview

Over a period of six months 30 interviews were conducted with 22 different people within ICI. As was previously mentioned the aim of these interviews was to provide the researcher with a "feel" for the organisation and an insight into how it operates. During this period the researcher was immersed within the organisation thus facilitating acclimatisation with the research-setting. It is worthy of note that such acclimatisation could only otherwise possibly be achieved through being an employee of the organisation.

All interviews (discussions) took place in private offices or interview rooms and were conducted in an informal atmosphere and on a one-to-one basis. Detailed transcripts were taken during the interviews and where necessary follow-up telephone discussions were arranged to clarify and explain ambiguous or uncertain points.

Figure 5.3 Details of participants

Interview No	Function and Business	
1	Business Development Manager, ICI C&P	x 4
2	Group Research Associate, ICI C&P	x 4
3	Project Manager, ICI Chlor-Chemicals	
4	Research Manager, ICI Resins	
5	Research Scientist, ICI Resins	

6	R&T Manager, ICI Chlor Chemicals
7	Secretary, R&T Dept
8	New Business Development Manager, ICI C&P
9	Technical Manager, ICI Watercare
10	Business Development Manager, ICI Chlor Chemicals
11	Business Development Mgr, ICI Electrochemical Technology
12	Division Research Associate, ICI C&P
13	New Business Development Manager, ICI Chlor-Chemicals
14	Business Manager, ICI Electrochemical Technology
15	Business Production Manager, ICI Watercare
16	Research Manager, ICI Membranes
17	New Business Manager, ICI Cleaning Systems
18	Research Manager, ICI Watercare
19	Business Development Manager, ICI Chlor Chemicals
20	Planning Manager, ICI C&P
21	Project Manager, ICI C&P
22	Information Services Manager, ICI C&P

5.1.4 Analysis and presentation of the findings

The findings from the data gathered from both the document and interview analyses has been organised into a logical structure; begining with background information about the organisation followed by an introduction to some of the interesting organisational forms and finishing with a closer look at some of the issues uncovered about inward technology transfer. Hence, the findings presented may be said to represent the researchers "model" of the organisation.

5.2 Findings from documentation analysis

5.2.1 Background to ICI and ICI C&P Ltd

In comparison with many organisations today ICI is seen as an old and established business. Yet by the standards of general history it is very new. It was formed in 1926 by bringing together the four largest British chemical companies of the day: Nobel Industries

Ltd; Bruner, Mond & Company Ltd; the British Dyestuffs Corporation Ltd; and The United Alkali Company Ltd. It represented the largest merger operation undertaken in Great Britain and was capable of tackling any branch of the chemical industry at that time. The board of ICI commissioned W J Reader to write a book on the history of ICI- this stands at three large volumes. For further information on the history of ICI see Reader (1970).

5.2.2 ICI Chemicals and Polymers Ltd and Chlor-Chemicals

ICI Chemicals and Polymers was formed in 1986 through the combination of six separate ICI businesses: Soda-Ash Products; Fertilizers; Petrochemicals and Plastics; Chlor-Chemicals and Chemical Products and Fibres. It essentially contained the industrial chemicals operations of ICI's businesses. The main customer industries were: agriculture, furniture, iron and steel, clothing, fashion and leisure-wear, pharmaceuticals, plastics, glass-making, food and drinks industry, computer and electronics, electrical, communications, automotive, construction, oil, chemical, water, aviation, retail, defence and aerospace, dry cleaning, paper, printing, mining, engineering, domestic appliance. This vast group employed more than 30,000 people, had a turnover of £4 billion and sales from Western Europe of £1 billion[1].

A study of a business this size presents numerous problems including trying to understand its activities and operations within a limited time scale, complex organisational structures, and complex managerial relationships. To attempt a study of inward technology transfer of a business of this size would limit the ability of the research to delve in-depth into complexities and processes under investigation.

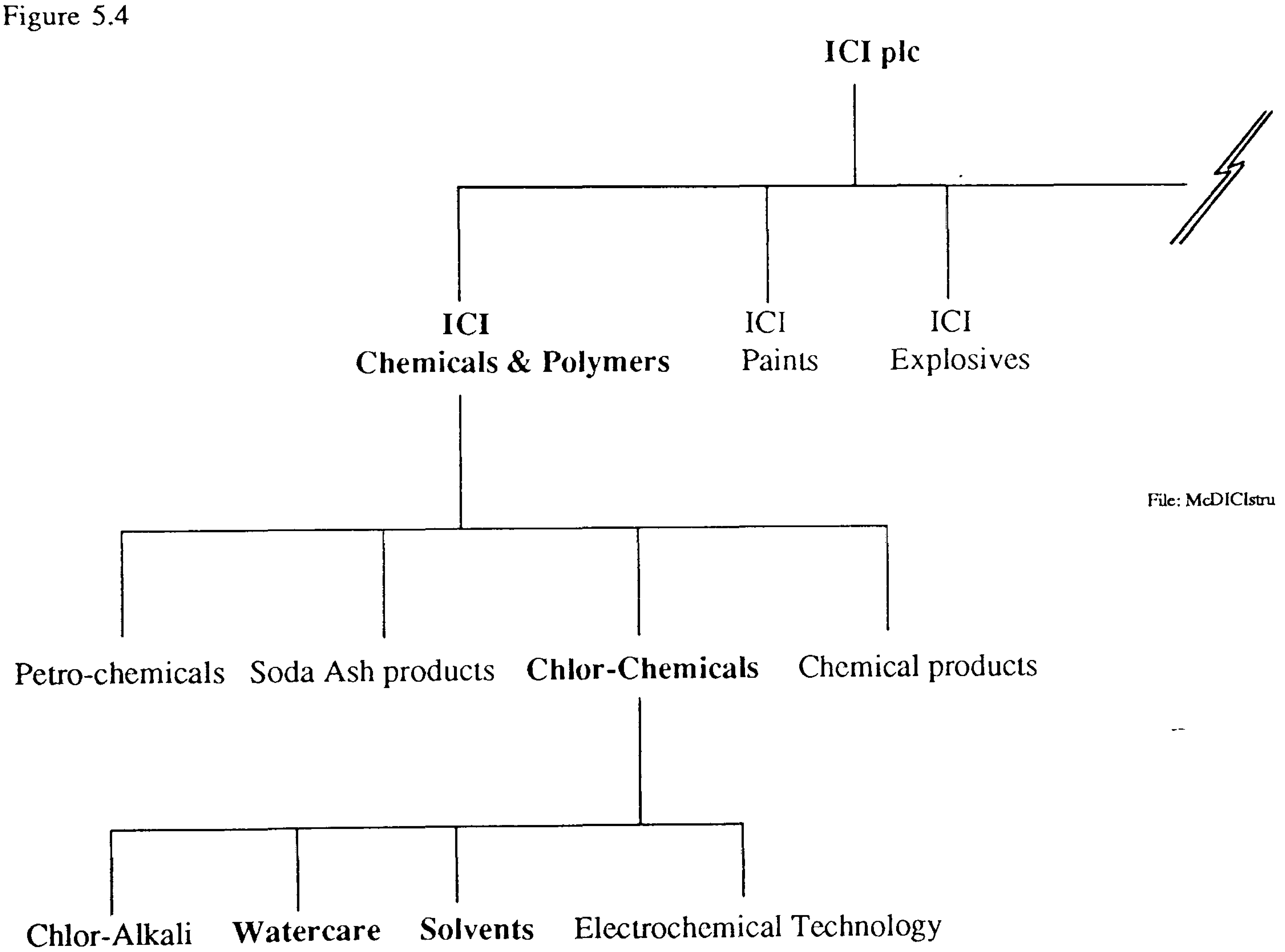
The organisational chart shown in Figure 5.4 shows Chemicals & Polymer's (C&P) link with the rest of ICI plc. In addition this chart shows the businesses contained within C&P. However, by general industry standards these businesses themselves are very large indeed. For example the Chlor-Chemicals business is the fourth largest producer of chlorine in the world and the second largest in Europe with a group turnover of almost £400 million in 1989 (ICI, 1989). As a business the Chlor-Chemicals group was one of the most successful businesses within the whole of the ICI group. With a profit from sales figure in 1987 lower only than that of the pharmaceutical and polyurethane businesses.

The Chlor-Chemicals business produces a range of commodity chemicals to meet essential industrial applications. Included in this are chlorine for water treatment, dry cleaning and

1 Figures from ICI literature, 1988 (C&P1).

engineering solvents, together with PVC, chlorinated paraffins. The organisational chart in Figure 5.4 shows a break down of the businesses within the Chlor-Chemicals group. This contains four separate businesses. These businesses while still fairly large by UK industry standards are regarded by ICI as independent business units. In effect this is the primary business unit within ICI. These units are independent profit centres. Of these four business units two were currently facing major challenges. The solvents business was an old established business that was currently having to respond to environmental legislation that will remove several of its products from the market. At the other end of the business life-cycle was the Watercare business. This was a new business that was trying to establish itself and its products in the water industry. These two businesses form the focus of the study.

Figure 5.4



5.2.3 Defining "the business"

During interviews at ICI C&P respondents refered to "the business" as meaning all commercial activities associated with the running of the business, but excluding R&T[2] and

2 Within ICI Research and Technology (R&T) represents all those activities traditionaly associated with Research and Development.

production. "The business" includes activities such as: marketing; distribution; accounting; sales; etc. This clear distinction between activities of "the business" and activities of R&T and production can be traced back through ICI's history. It seems to have developed from when the research and production at ICI employed the vast majority of people. The total commercial activities of the organisation in comparison employed very few people. Hence people were either employed within a technical role (R&T) or a commercial role (the business). Today, the total commercial activities of the organisation employ more people than R&T. This interesting feature was also found to be the case at Redsoap, another large chemical manufacturer in the North West of England.

5.2.4 Matrix organisational form

ICI C&P operates within a matrix organisational structure[3]. This structure and associated culture and behaviour pattern has evolved over time. The result is an operating environment that is particular to the organisation. Operating routines and accepted ways of working have developed over the past sixty years and are well known and understood by those within the organisation but extremely difficult for those outside of the organisation to fully comprehend.

Within the literature, matrix organisational structures are associated with dual lines of communication and authority (Tushman & Nadler, 1978; Lawrence, Kolodny and Davis, 1988). They are seen as cross-fuctional because they involve bringing people together from two or more separated organisational functional areas. This can be seen in Figure 5.5 which shows the matrix structure at ICI. The traditional hierarchy is functional, the horizontal overlay consists of business areas known as business teams. Business Team 1 comprises of one full-time member from marketing, one full-time member from R&D, one full-time member from sales, one full-time member from production and one full and one part-time member from finance. Between them this group would manage a number of projects. There would be a team-leader for each business team. However, this person would not necessarily, and is often not, the most senior member of the group. The choice of business team leader is based on the type of project the team is undertaking. For example, a team looking at the introduction of new products is likely to be led by someone from the marketing function, even though there will almost certainly be someone more "senior" from another function within the business team.

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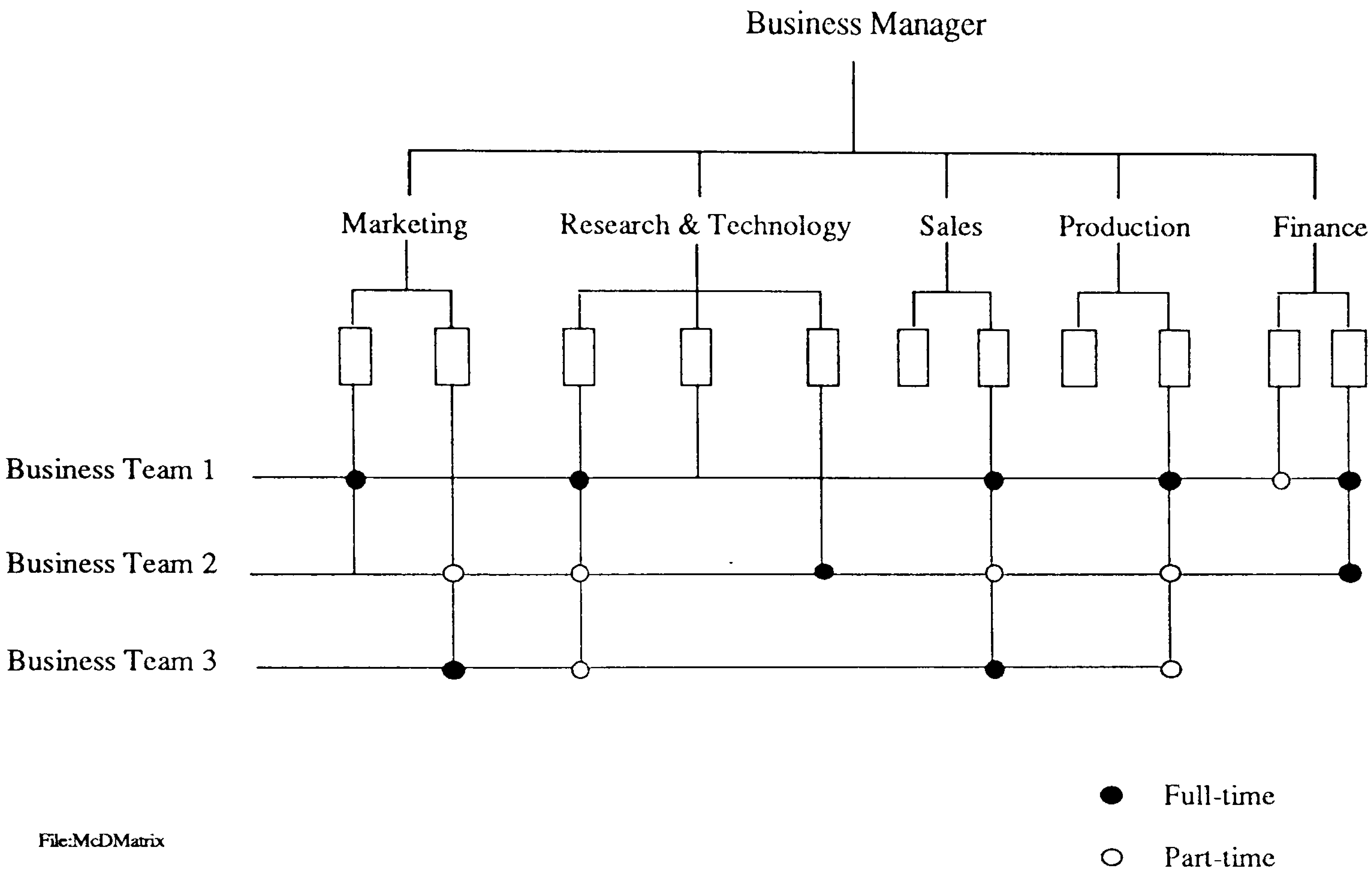
3 A matrix organisational structure is defined as any organisation that employs a multiple command system that includes not only a multiple command structure (management structure) but also related support mechanisms and an associated organisational <u>culture and behaviour pattern</u> (Ford and Randolph, 1992).

Figure 5.5

Model of the matrix organisational structure at ICI C&P



While it is not the objective of this research project to discuss the advantages and disadvantages of the matrix organisational structure[4] per se, there are a number of issues associated with the matrix organisational structure and culture and behaviour patterns at ICI that appear to influence the inward technology transfer process. These factors were detected during the first stage of interviews and are supported within the literature (Allen, Lee and Tushman, 1980; Katz, 1982; Wolf, 1982). However, it is relevant here to mention that Ford and Randolph (1992) argue that there is a lack of empirical research in the area of matrix management. The following are some of the features/benefits of a matrix organisational structure that have been identified in the literature:

- **Provision of additional channels of communication**

The combination of a matrix structure and the use of business teams ensures there is extensive lateral communication between functions. The diagram in Figure 5.6 shows how marketing personnel involved in business teams 1,2 and 3 bring back to the marketing

4 For a full review of matrix organisation and project management see Ford and Randolph (1992).

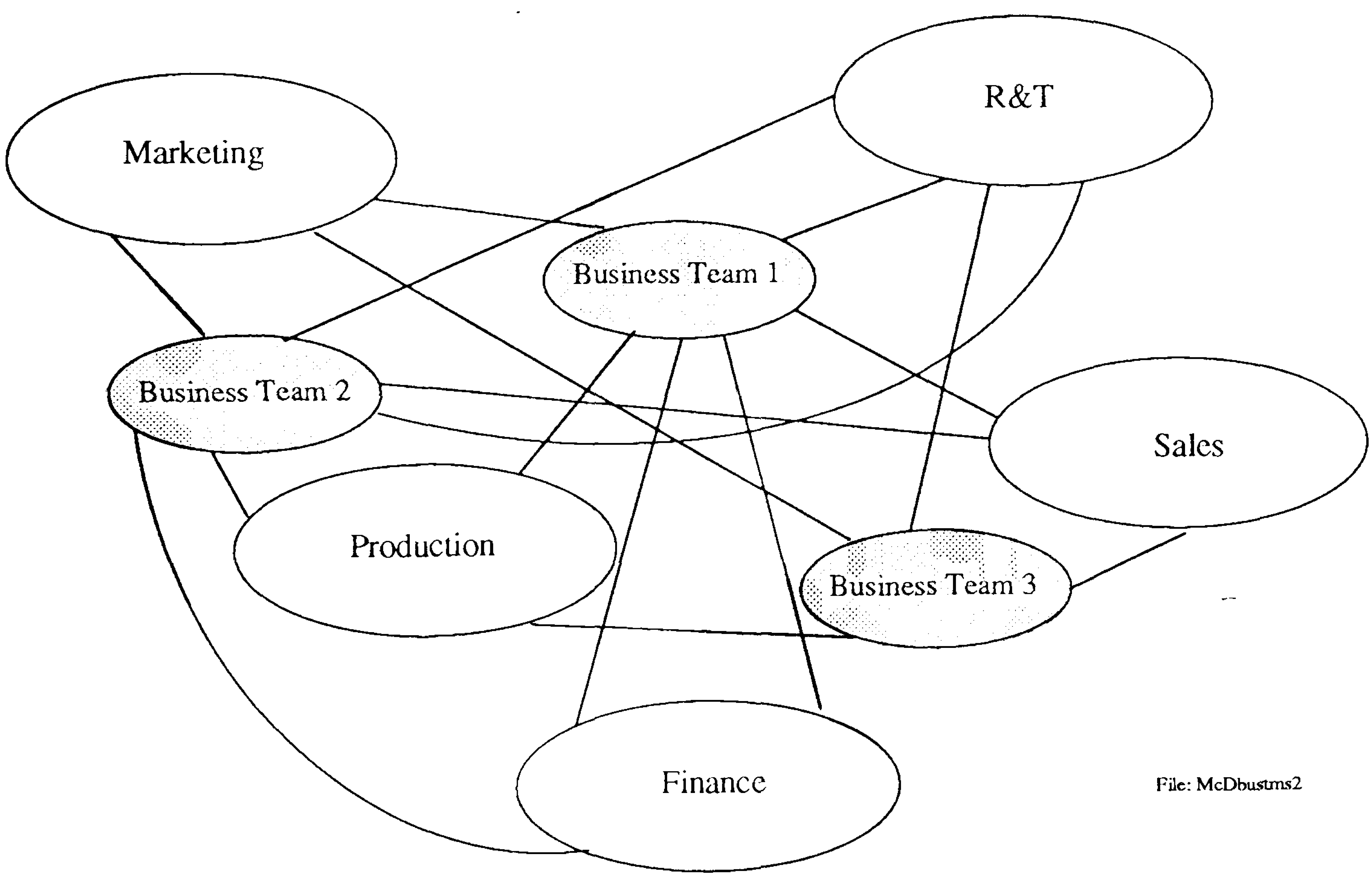
function knowledge of activities of the other functions. Communication skills are also developed as individual business team members learn the "languages" of the other functions. For example:

"You soon begin to learn and develop an understanding of the business language used by the marketing people" (extract from discussions with an R&T business team member (ref A5)).

This view is supported in the literature by Allen (1983); Davis and Lawrence (1977); Galbraith (1971).

Figure 5.6

Channels of communication resulting from matrix organisational form and the use of business teams



The channels of communication above are taken from the matrix organisational form shown in Figure 5.5.

- **Increase in informal communication channels**

In addition to the increase in formal linkages, there is also an increase in informal networks between personnel from different functions. These develop from friendships and cooperation formed as a product of the formal linkages.

- **Increase in information loads**

The increase in formal and informal channels of communication means that individuals collect more information. This information is brought back into the function and disseminated amongst colleagues in the group. There is support for this view in Joyce (1986).

- **Increase in diversity for individual**

Some individuals may be involved in two or three business teams. Their role may be part-time or full-time. This enables them to work with a variety of people from a variety of backgrounds and disciplines across the organisation.

'I can discuss thoughts and share ideas with people from different functions. This allows you to bounce ideas off each other' (extract from interview with an R&T business team member (ref A3)).

This type of working environment enlarges an individual's experience and outlook and provides them with an improved understanding of the organisation's entire activities. Davis and Lawrence (1977) and Kolodny (1979) support these findings.

5.2.5 The role of Business Teams

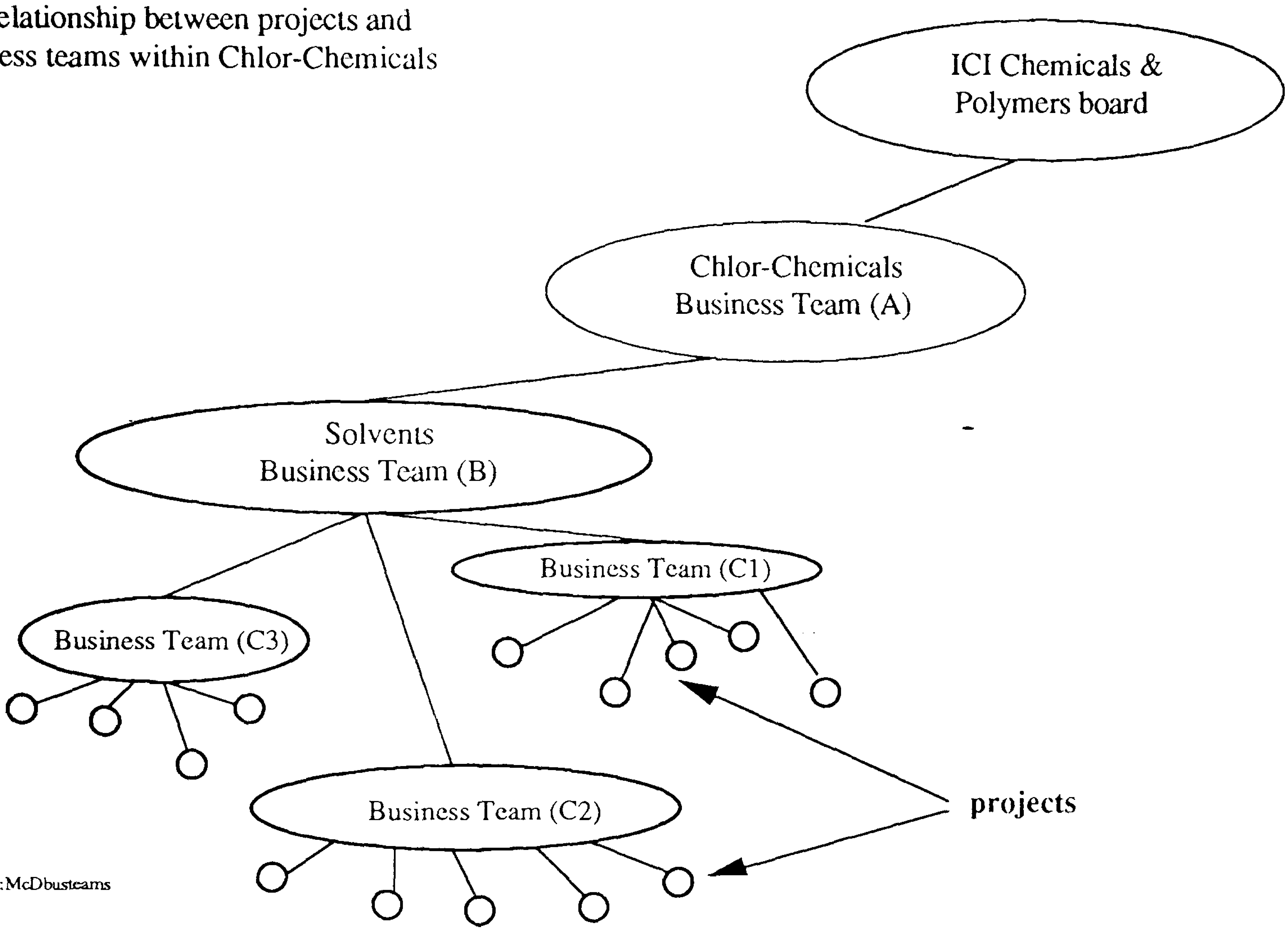
Figure 5.7 attempts to show the relationship between projects and business teams within the Chlor-Chemicals business. Each business within Chlor-Chemicals (Solvents, Watercare, Chlor-Alkali etc) has a business team (B) which is responsible for managing a number of projects. This business team is led by the business manager who has ultimate responsibility for that business. The projects are often grouped together and managed by a "junior" business teams (C_1, C_2, C_3, etc) which are essentially made up of people from within an individual business. There is also an overall "senior" business team which comprises the business managers from the individual businesses within Chlor-Chemicals (A). This team reports to the ICI Chemicals &Polymers board.

Each business team (B) generally comprises of the following:
Business manager;
Business accountant;
Business planner;
R&T Manager;
Production manager.

Each business team will have a number of project teams and each project team will have a number of current projects. The diagram below shows how each project within a business is responsible to a business team. And how each business team is then responsible to other business teams. Thus creating a web of internal interaction.

Figure 5.7

The relationship between projects and business teams within Chlor-Chemicals



File:McDbusteams

Each business team within the Solvent's business and the Watercare business comprises between four to six people. The team leader for each business team will select people who he believes are necessary for the management of that business, this may or may not include an R&T representative. It is important to note that there is no line management structure within a business team.

5.2.6 A "fuzzy" management style

To operate such systems effectively requires all personnel to be fully familiar with the management approach of the company. In ICI's case this has been achieved through extensive training, which ICI provide to all staff throughout their career, especially in the early years. Furthermore, the blurring of chains of command through the matrix organisational structure adopted means that individuals cannot rely on the traditional "one-boss" principle of management. Responsibility and accountability is vague, as individuals may have to take directions from, and answer to, people less senior than themselves [sic]. The identification of a hazy management style within ICI is confirmed within the literature by Marsh (1989) who has described it as "fuzzy". According to Marsh this arises because no single part of the management function is given overall control. Relationships are left deliberately vague. This framework has led to a style of management that emphasises informal communication and provides a great deal of freedom and autonomy for individuals. Such a fuzzy management style has fostered what one may describe as a "professional" culture where individuals are respected for their role as opposed to their rank. The style of management and behaviour patterns of individuals within the organisation demand high levels of mutual confidence and reliability from everyone involved in order to ensure the organisation functions effectively. Such organisations may be described as "high-trust organisations" (Cordey-Hayes, 1992).

A weakness of this organisational structure and the resulting "consensus" style of management is that the decision making process is frequently extended. Reaching an acceptable agreement often involves extensive discussions. In addition the style tends to introduce the feeling that management within the organisation is overly cautious as decisions appear to take a long time and can often be moderated by consensus.

5.2.7 Recruitment of high quality staff

Over the years ICI has built a reputation for recruiting high quality staff. In terms of graduate recruitment, it has been a policy within ICI that only graduates with good degrees are considered. There is also a tendency, rare in industry, to recruit those with research doctorates into roles other than just research. For example there was even a time when PhD chemists were recruited to run chemical plants in the belief that this was the best way of getting hold of high-calibre managerial elite. Over the years other methods were found to yield more satisfactory results. However, the aim of recruiting the "best" has remained consistent. This recruitment policy appears to be more than merely nice words on paper. A piece of research by Jones (1992) showed that postgraduate scientists viewed ICI as the ideal employer. In a range of pharmaceutical companies ICI was rated above many other well known companies such as 'Glaxo', 'Wellcome' and 'SmithKline-Beecham'. The research established that postgraduate scientists were concerned with academic freedom and believed that 'ICI has an almost academic reputation for the quality of its science'.

Finally the employment of high quality staff helps to ensure that there will be mutual respect for individuals throughout the organisation further reinforcing the concept of a "high-trust organisation".

5.2.8 The recognition of the value of information within ICI

The businesses within this study operate within an "information rich" environment. This finding is consistent with the chemical industry in general, which has a long history of providing its scientists with extensive information resources. The large chemical companies have long recognised the importance of keeping their research scientists informed and up to date with technological developments. The 1919 report from the British Chemical industry commission on German chemical companies in the occupied region of Germany, established the target for British Chemical industries to aim:

"The lavish and apparently unstinted monetary outlay on laboratories and technical staff implies implicit confidence among the leaders of the industry in the ability of science ultimately to repay with interest heavy initial expenditure." (Report by British Chemical Commission, 1919).

This suggests a recognition by the chemical industry in general and chemical companies in particular of the importance of information to the business's scientific and technological activities.

5.3 Two particular businesses within Chlor-Chemicals

5.3.1 The Watercare Business

In 1988 ICI was looking at the Public Health market. A study group, looking at opportunities in water treatment, wanted to offer solutions to problems rather than offering simply chemical treatments. This study group identified a latent market need for water treatment. The concept for a business developed from a combination of this report and the realisation that ICI had a number of related areas of technical competence within the (ICI) group. Prior to Watercare seventeen parts of ICI used to sell their separate wares to the water industry (ICI, 1993). Thus, the Watercare business concept was born by combining this market opportunity with internal technical abilities. The idea was to establish a new business focused on the needs of the water treatment market. The business started with no assets of its own but acted as a channel to the water treatment market. It took over a sales portfolio of existing chemicals. The intent was to add value to the existing offerings through formulation and packaging, providing complete treatment systems. From the outset the business maintained that, as one of the world's major scientific groups, ICI had the resources and unrivalled expertise in the formulation, manufacture and distribution of specialist water treatment products world-wide to be successful in this market (ICI, 1992).

The early days of the business were plagued with regular internal battles with the other businesses within the Chlor-Chemicals group to gain recognition as a viable new business. The General Manager of the Watercare business fought hard to turn the concept into an operating business. Gaining the initial support and backing from the Chlor-Chemicals group for the idea took many months of extensive and intense negotiations. This was ostensibly because the Watercare concept was, and remains, unique within the Chlor-Chemicals group. The Group is traditionally a plant-intensive, high-volume, commodity-producing group. Therefore launching a new business outside the groups traditional area of expertise, that is large chemical plant technology, was a major strategic change for the group.

Many people within ICI have since suggested that if it had not been for the particular Business Manager who was leading the Watercare business it would probably have been shelved (Ref: A1, A2, A9, A15). An aggressive, dynamic, market-focussed, risk-taking approach has been needed to sustain development.

The development of the business has been and continues to be a difficult struggle. The Watercare business is attempting to develop and establish new products in the new and evolving market of water treatment. It aims to serve the needs of industries whose operations involve the use of water. Some of the business's major customers are the newly privatised water companies.

At the time of the research the Watercare business has been operating for approximately two years. During this time the General Manager has intentionally brought together a collection of "techno-commercial" people, who are technically competent and in addition have keen commercial interests. They have been recruited from a variety of businesses within ICI C&P. The absence of any chemical plants means that the Watercare Business is considerably different to other Chlor-Chemicals businesses. Hence, the Business Manager believes that if the business is going to be successful the business should not necessarily operate like other businesses within the Chlor-Chemicals group.

5.3.2 The Solvents Business

In many ways the Solvents Business is at the other end of the business life-cycle. It is an extremely old and well established business with some of the products dating back to 1890. Even before ICI existed the large chemical plants in Widness and Runcorn were producing a variety of solvents for use by industries all over the world. The manufacturing processes, the products and the operating markets have changed, admittedly some only slightly, but the products are derived from chlorine and ethylene as in the 1800's. The business is asset intensive with large plants all over the world. Management of the total business (all aspects of the business) includes the day to day operation of these chemical plants.

The Solvents business has traditionally been a bulk chemical business supplying manufacturing industries. During periods of growth the business has been one of the most profitable businesses within-the ICI C&P group. In marketing terminology it is viewed as a successful "cash-cow". That is, it requires minimal investment to produce high returns. The business is operating in a very mature market. Consequently the market is highly competitive with many companies offering similar products. Within this type of environment the focus of the business is on increasing volume and attempting to protect, and where possible increase, profit margins on sales.

In addition to running current operations the business is having to respond to external environmental pressures to introduce new, cleaner products. The environmental legislation in the 1990's will force many of their existing products off the market.

The impact of this legislation and the strength of the environmental lobby has forced the ICI C&P board to look closely at the long term future prospects for the business. The damaging publicity from the manufacture of a product that is seen as "harmful to the environment" does not fit easily with ICI's corporate image of being "world class". Hence, the arguments to withdraw gracefully from this market are clearly visible. However, there is a less clear argument, but nevertheless a compelling one, to remain in the solvents business. This hinges on the fact that as one of the world's leading suppliers of solvents, the Solvents business has an extremely large customer base. Companies usually work extremely hard to build a customer base of this size; the solvents business is not an exception. Yet, the business considered walking away from this loyal market. These customers rely on ICI solvents for many of their supplies; for example the dry-cleaning industry and many manufacturing industries which require the removal of oil and grease during manufacture. These customers were looking to ICI Solvents to develop alternative cleaning products that they could use.

The implications of this mean that the long-term future of the business, at the time of the research, was in some doubt. However, in the short term the Solvents business is developing new replacement products. Previously the business was able to concentrate on increasing market newness through its extensive commercial activities. Now it is having to engage in new product development.

5.4 The Focus on new product development within ICI Watercare and ICI Solvents

Figure 5.8 shows the different product development strategies for the two ICI businesses previously discussed, and the strategic move taken by the Solvents business in response to external environmental conditions.

A classification of product development strategies

Figure 5.8

Increasing technological newness →

Product objectives	No technological change	Improved technology	New technology To acquire scientific knowledge and production skills new to the company
No market change	Sustain	Reformulation To maintain an optimum balance of cost, quality, and availability in the formulas of present products.	Replacement To seek new and better ingredients of formulation for present company products in technology not now employed.
Strengthened - market To exploit more fully the existing markets for the present company products.	Remerchandising To increase sales to consumers of types now served by the company.	Improved product To improve present products for greater utility and merchandisability to consumers.	Product line extension To broaden the line of products offered to present consumers through new technology.
New market To increase the number of types of consumer served by the company.	New use To find new classes of consumer that can utilise present company products.	Market extension To reach new classes of consumer by modifying present products.	Diversification To add to the classes of consumer served by developing new technological knowledge.

Increasing market newness ↓

Solvents

Watercare

Key

Previous strategy of Solvents business

Existing strategy of Solvents business

Existing strategy of Watercare business

File: McDJ&J

Adapted from Johnson & Jones (1957).

From the previous discussions it can be seen that both businesses are actively involved in developing new or replacement products. The classification of (available) product development strategies developed over thirty five years ago by Johson and Jones (1957), and shown in Figure 5.8, is useful here to show the particular emphasis on research and development (technology) activities undertaken by the two ICI businesses. It also highlights the different new product development strategies of the two businesses. The matrix shows how the strategy for the Solvents business has changed from a strategy of no technological change and increasing market newness, to no market change and increasing technological newness. Hence, the Solvents business is engaged in developing improved or new technology for existing customers whereas the Watercare business is developing new technology for new customers.

5.4.1 A range of activities within research and technology

The range of activities undertaken by a science based company engaged in research and technology activities is extensive. In an investigation into communication channels within an R&D laboratory in a major American corporation. Tushman (1977) suggests 'tasks can differ by (1) length of time required for feedback; (2) specific problem versus general problem orientation; and (3) their generation of new knowledge in contrast to their use of existing knowledge.' Using these attributes Tushman developed four task categories. These are shown in Figure 5.9.

These categories were agreed with a senior manager at ICI as being an accurate representation of the range of activities undertaken by the Research and Technology department at ICI (Ref A1).

Figure 5.9 Categories of Task Characteristics

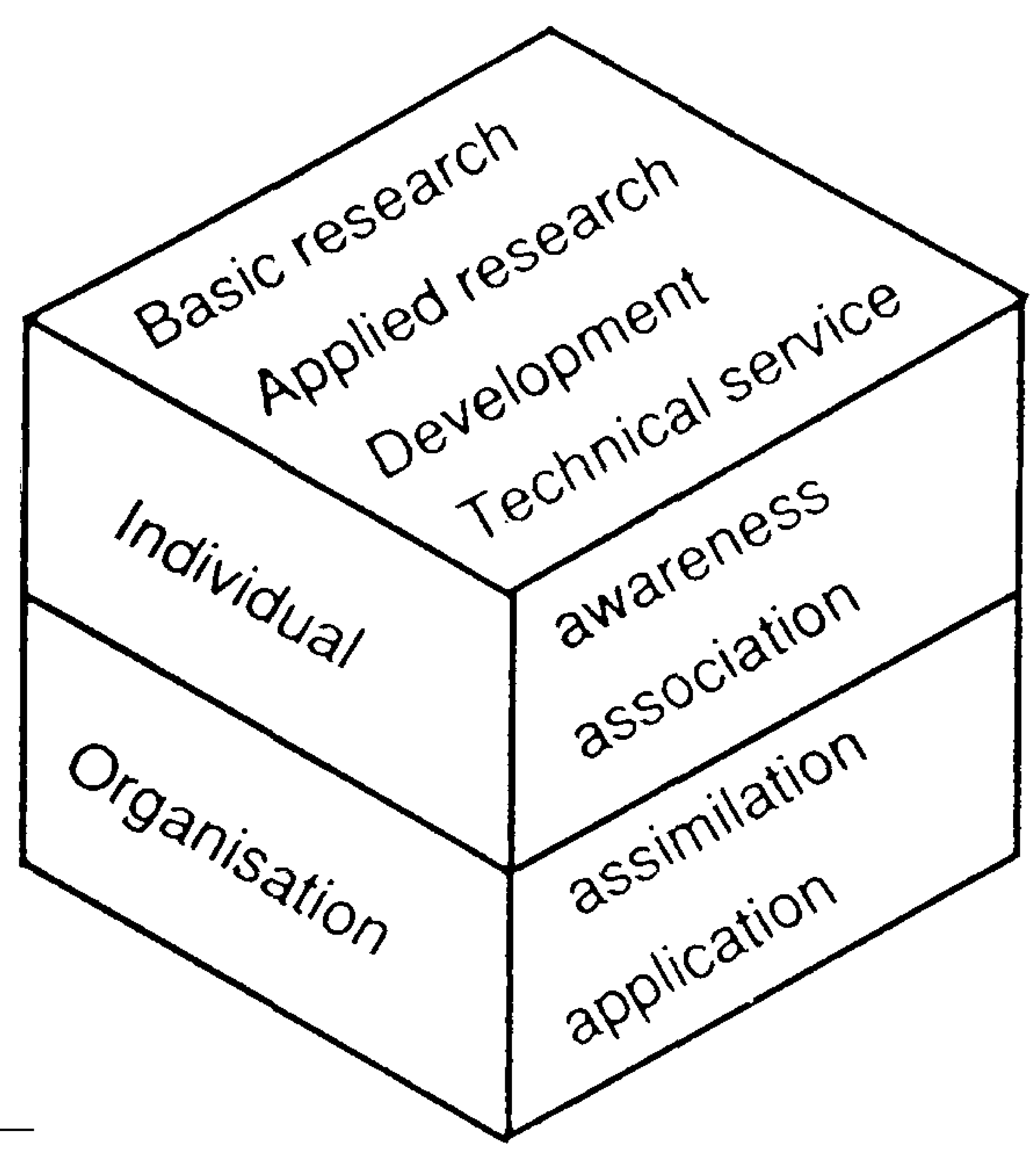
1. Basic Research	2. Applied Research	3. Development	4. Technical Service
Work of a general nature intended to apply to a broad range of applications or to new knowledge about an area.	Work involving basic knowledge for the solution of a particular problem. The creation and evaluation of new concepts or components but not development for operational use.	The combination of existing or feasible concepts, perhaps with new knowledge, to provide a distinctly new product or process. The application of known facts and theory to solve a particular problem through exploratory study, design and testing of new components or systems.	Cost/performance improvement to existing products, processes or systems. Recombination, modification and testing of systems using existing knowledge. Opening new markets for existing products. File: McDTush

Source: (Tushman, 1977)

The decision to focus on "New Product Development" activities within the inward technology transfer process provides additional focusing of the research. If this is combined with the focus provided in Chapter One, of the role of the individual within an organisational setting, with the four stage process model developed in Chapter Two, it is possible to create a typology of the factors that form the backcloth for the research[5]. This typology is shown in Figure 5.10.This served as a useful tool in guiding the second and third phase research activities.

Figure 5.10

A typology of factors involved in inward technology transfer



5 Martin Harvey, Business Development Manager, ICI C&P was instrumental in the design of this research framework.

5.5 Research & Technology management at ICI C&P

5.5.1 Research & Technology strategy within ICI C&P

Within the chemical industry in general, and ICI in particular, research has traditionally been viewed as a good thing that has over, the years, produced many financial benefits to those who have been involved in it. ICI's position as the largest spender on R&D in the UK is evidence of this philosophy (see R&D Score-board; DTI, 1993). Needless to say such a philosophy influences management thinking and strategy development. Within ICI the role of technology receives a high profile and is consequently discussed at senior strategic management meetings. As the following statement from a senior strategic planner shows:

> *'Within ICI C&P it was the accepted view that if the businesses could afford research they should have some'.* *(Ref: A20).*

Thus the amount of "directed" or applied research was generally governed by how much each business could afford; allowing for a little "strategic research"[6].

Prior to 1987 the amount of research activity undertaken by each business was based around the annual budgeting process. Each Business Manager and Research Manager of each business would present their case for a tranche of the R&D budget. Many senior managers believed that decisions regarding the amount of research activity to be undertaken by each business were arbitrary and not consistent. The process consisted of fierce and passionate debates, and decisions were based largely on "gut-feel". This was because the Business Managers were regarded as "Barons" who fought hard to protect and build their "fiefdoms". This behaviour was understandable as few people wanted to belong to a "fiefdom" that was in decline. Accepting a cut in R&D expenditure was viewed, within ICI, as similar to allowing someone to saw at the branch on which you were sitting! An indication of the lengths Research Managers would go to secure funding was made clear during the interviews.

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[6]Strategic Research or Basic Research is defined as areas of research that are of interest to the business or group in general. A small part of the total R&D budget is allocated to "Strategic Research" or basic research.

"*If we told management that Du Pont* [competitor]*was doing work (R&D) in this area it was almost guaranteed that we would get funding.*" (Extract from discussions with researchers at ICI)

It was generally accepted by the Business Managers and Research Managers that in times of growth and profits the research groups would normally continue with the possibility of the creation of new groups. However, in times of downturn and slumps research groups would often be trimmed and sometimes cancelled.

In 1987 at the formation of ICI Chemicals and Polymers Ltd. the head of Research and Technology wanted to try to adopt a more strategic approach to this decision making process. He sought a process that was based more on theoretical argument and less on "gut-feel". As a result of this the Strategic Management Group at ICI C&P were given the task of addressing this issue of research activity allocation. They wanted to ensure that the appropriate type and quantity of research activity was allocated to the appropriate business. In order to do this they developed a model[7] which aided the decision-making process and provided a more defensible and arguably more accurate method of allocating research activity. The model is shown in Figure 5.11. The following discussions offer an overview of the development of this model.

5.5.2 Classifying the strategic position of a business

Within the bulk chemicals industry traditional marketing tools and methods for classifying the strategic position of a business have been less successful when compared with other industrial sectors. This is mainly due to its dependence on the costs of feedstocks. Decisions in the commodity markets and decisions by governments can cause a major shift in the price of coal or electricity which radically alter the cost of feedstocks. This may turn a highly profitable business into a loss making business. Consequently a large amount of research activity within a business whose profitability is largely determined by the cost of feedstocks is fraught with danger as it may be wasted by a single governmental decision. Hence in allocating research activity these wider additional issues must be considered.

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7 The complete development of this model by Schofield (1989) is shown in appendix B.

5.5.3 The influence of technology on a business's competitive position

The following arguments are based on the simple premise that the type of research should be related to the extent of influence that technology has on the business' competitive performance. The difficulties faced by research managers can be highlighted with the use of portfolio planning theory and in particular the 'Boston Consulting Group' portfolio planning model. For example, two businesses with high growth and high market share would be classified in the same business category, that of "Star". If this business classification is then adopted by research and technology planners one would expect a similar research activity for these businesses as they are in the same category. However, where a business's competitive position is largely dictated by, for example, the cost of feedstocks, then the spending of large sums of money on the development of new technological processes could be wasted by a slight change in the price of feedstocks. Hence, the business needs to be aware of the extent of influence its technology and its technological base has on its competitive position. This is termed Technology Leverage[8]. Hence, the research policy of the ICI C&P Research & Technology Executive:

> *"Where the technology leverage is low the objective should be to maintain the technology position. Where the technology leverage is high the objective should be to grow the technology position as well as to seek competitive advantage in technology."*

As indicated earlier within the high volume, bulk commodity, chemical industry technology leverage will depend upon the influence of other factors in the cost chain such as feedstock and distribution costs, and also on market opportunities (or growth). This means that a business's position must be regularly reviewed as its technology leverage may change over time. In general, technology leverage will be high when the influence of feedstock and distribution costs are low.

5.5.4 The development of a model to aid allocation of research activity[9]

The relationship between research activity and business characteristics (contained within the technology strategy) can be shown by combining the classification of business category with the classification of technology strategy. This model (developed by Scholefield (1989)

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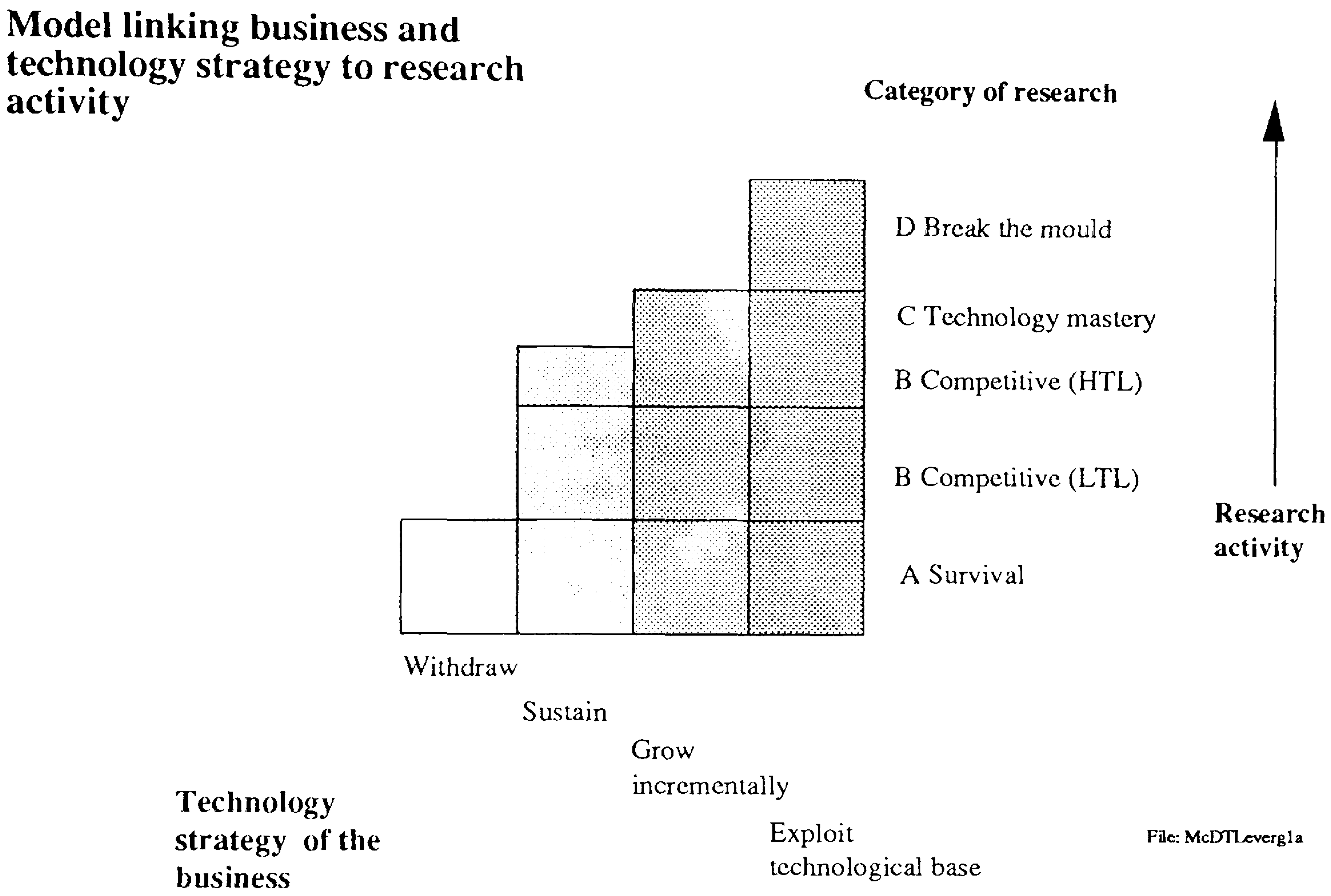
8 See ICI internal report by Scholefield (1989) for a more detailed explanation.

9 See appendix B for a complete development of the ICI Technology Leverage Model.

and shown below) offers guide-lines for the allocation of research, taking into account a number of characteristics. These guide-lines are based on the simple premise that the type of research should be related to the extent of influence that technology has on the business' competitive performance. This will be embodied in the technology strategy for that business (see Figure 5.11).

Figure 5.11



Hence, a business with a business/technology strategy of "withdraw", should be conducting "survival" research. Whereas a strategy of business growth by "exploiting the technological base" should be conducting "break-the-mould" research.

5.6 Inward technology transfer at ICI

The findings from the interviews revealed that ICI C&P have a formal technology transfer activity, that is the "Technology Trawling Group", and an informal technology transfer activity. These will now be explored.

5.6.1 The Technology Trawling Group.

During 1989 ICI Chemicals and Polymers (C&P) Ltd established a "Technology Trawling Group" (TTG) to search for technology that the organisation could use to build a new business for ICI C&P Ltd. This move was the direct result of an executive decision to expand operations towards the year 2000. The Technology Trawling Group's objective was to build new businesses that were related to the current activities of ICI C&P Ltd. The emphasis here was for diversification through related products and related markets. The focus of this technology trawling was centred on the U.S.A. where two thirds of the free worlds research takes place[10], and where access is facilitated through a "freedom of information" culture and common language.

ICI C&P's business activities range from 'Chlor-Chemicals' to 'Fibres'. Hence, there is clearly a vast range of activities and technologies that would be of potential interest to the businesses. This proved to be the case. During the search process the TTG continually uncovered technology, which they believed would be of interest to one or more of the existing businesses activities. Consequently the search for a new business incorporated a "technology scanning" process for the existing businesses.

The process of acquiring externally developed technology, bringing it back into ICI and utilising the acquired technology proved to be far more complex than was originally envisaged. While the TTG was able to identify and access technologies that were related to the activities of the ICI C&P businesses, the businesses seemed unwilling to adopt them.

The TTG clearly established that identifying and gaining access to technology was only part of a more complex process. They also established that in order to identify technology for individual businesses they had to understand the requirements and needs of these businesses.

The TTG at ICI decided to adopt a "cantilever bridge" style approach to the problem. This type of bridge is constructed by building outwards from each side until the construction meets in the middle. Using this analogy the team decided to place one member of the group within ICI C&P, where he would attempt to understand and establish the needs of the businesses. The other member of the team would operate in the USA where he would continue to search for technology to meet these needs. However, herein lay the problem. The businesses were, in general, unable to generate a "shopping list" of requirements that could be used by the TTG.

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10 Figures from research conducted by ICI.

5.6.2 Substantive findings from investigation

The initial investigation set out to try and uncover from a variety of people within the organisation who had been involved in previous attempts to acquire technology from the TTG. This initial investigation used a semi-structured in-depth interviewing technique. The aim was to get the participant to discuss the general area in their own terms. The following factors were uncovered:

- the technology did not complement existing activities;
- the business possessed insufficient technical knowledge of the new technology;
- the business possessed insufficient commercial expertise in the area where the technology was to be applied;
- the business had previously examined very similar technology;
- the technology did not fit with areas the business was currently trying to exploit;
- the technology did not complement the business's future plans.

The TTG had great difficulty in trying to get the businesses to articulate the technology that would be of interest to them. The typical response was:

> *'If we knew what we wanted we would go and get it!'* *(Ref: A9).*

The businesses were only able to define the <u>broad</u> area of interest. Specifying any further detail required input from other functions. For example the business teams all contained individuals from marketing, sales and R&T. It seemed that much of the criteria for identifying technology was held as tacit knowledge between members of the business teams and in relationships and understandings between departments.

It was clear that the businesses did not use a formal check-list of criteria and check the attributes of particular technology against this. Decisions were based on <u>tacit</u> knowledge of the business. Individuals within the business were aware of what type of technology was required, what type of technology would work and they were also aware of the needs of their customers. However, the relevance and importance of each of these issues were held within different parts of the business. Thus the detailed requirements of customers was held within the marketing function. The full technical capabilities of the business was held within the research and technology function. The full commercial capabilities of the business was held within the commercial functions. The detailed long term plans of the business were held by members of the senior management business team.

It was clear that the business did not have technology requirements that could be easily articulated in the form of a simple "shopping-list". Their technolgy-needs involved a variety of issues. Furthermore, the inward technology transfer process appeared to concern the ability to link technical opportunities with commercial opportunities and match these with internal technical and commercial capabilities. As if this was not enough, it also concerned developing "interest" and "enthusiasm" among people within the business to ensure the technology is applied effectively.

5.6.3 Inward technology transfer as an "osmosis" process

ICI C&P and R&T in particular absorb vast quantities of information every day. Every scientist/technologist/commercial employee collects and gathers information in a huge **osmosis process**. This is achieved via:
reading scientific and technical journals;
attending conferences;
discussions with colleagues;
academic links with university research departments;
company links,
ICI C&P's own information dept in particular the "Current Awareness Programme".

These preliminary discussions have revealed a great deal of new information and issues. Contra to initial thoughts R&T are not the only part of the organisation which is involved in scanning and absorbing technology from sources which are external to the organisation. People involved in the "business" are also actively scanning and searching for technologies. For example, within Watercare it was individuals operating within the "business", that identified a number of suitable technologies from external sources that eventually led to the purchase of licences for this technology. The company has repackaged the technology and is now selling it to its customers. The point here is that it is not the exclusive role of R&T to scan for technology.

1. ICI Coastguard ™ -(used to break down phosphates in waste water).

2. ICI Guardsman ™ -(used to break up solids in sewage).

In both of the examples above the technology in question required little if any further development. The "Business" has merely "rebadged" the technology and marketed it to their own customer base.

On the surface, the involvement of R&T in these two examples of inward technology transfer appeared to be limited. One might be tempted to argue that the "business" is able to search and scan for technology with little if any formal involvement from R&T. However, a closer examination of the actors involved in the process reveals that the key people involved in identifying the technology were former R&T personnel; now engaged in a commercial role! Furthermore, these people engaged in extensive informal communication with colleagues within R&T prior to purchasing the licence.

As was suggested earlier, the inward technology transfer process at ICI is a huge **osmosis process** whereby virtually every member of the organisation absorbs technology from outside. Furthermore, the opportunities for inward technology transfer far exceed the formal ITT process provided by the TTG.

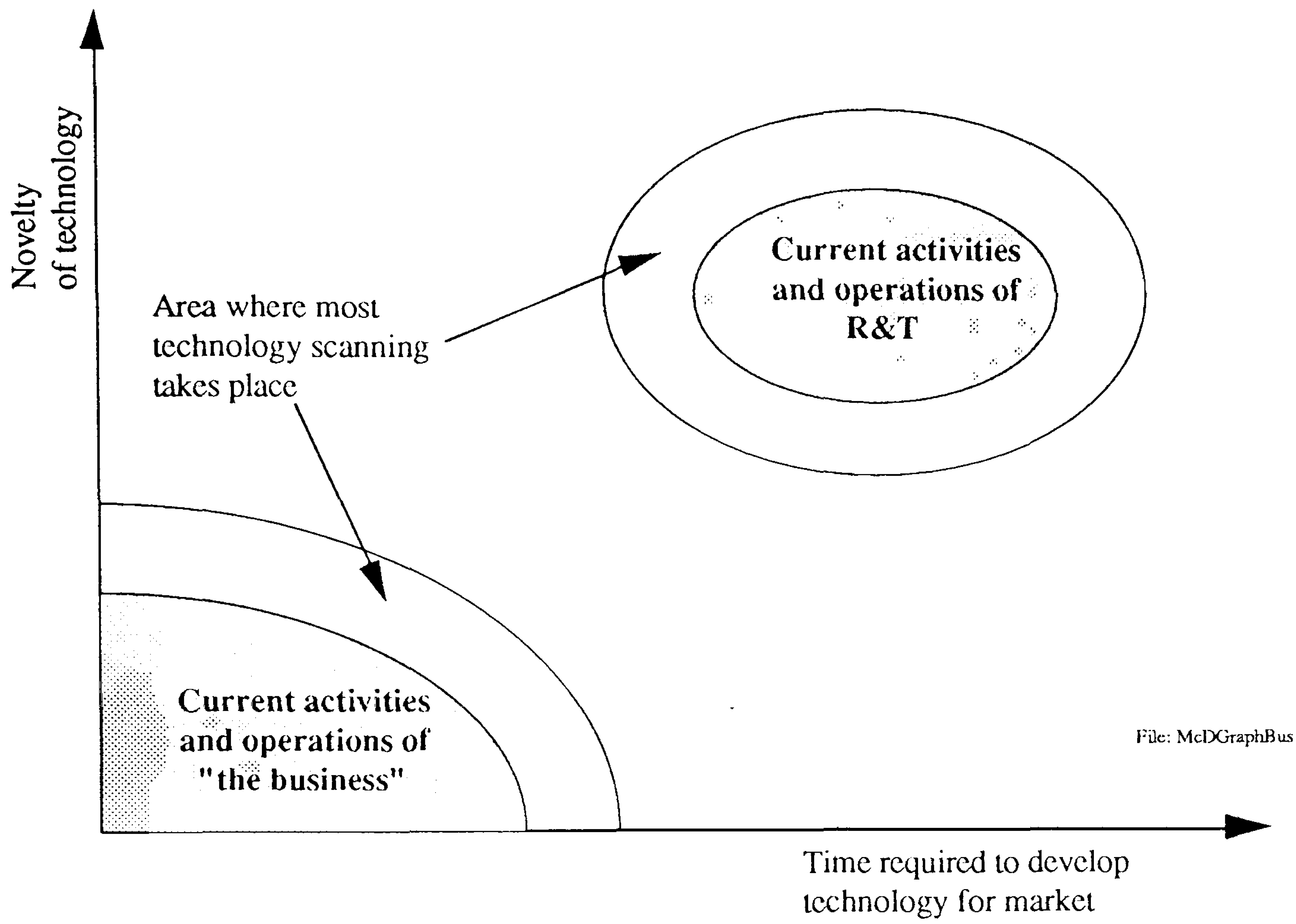
5.6.4 Technology-scanning

Once a technology has been identified by the organisation, discussions (informal and formal) between technical and commercial personnel appear to determine the decision of whether to obtain the technology.

It is worthy of note that technologies acquired through the "business" as opposed to technology acquired through R&T, tended to be technologies that are currently in use within similar or related industrial sectors. Thus, it would appear that there is an implicit difference in the type of scanning employed by R&T and those employed by the "business". The diagram in Figure 5.12 attempts to highlight how R&T and the "business" appear to differ in the areas in which they scan for technology.

Figure 5.12

Technology scanning by the business and R&T



5.7 Summary

The findings from this preliminary exploratory phase of research has suggested that the area of technology-scanning appeared to play a key part in the awareness and association stages of the inward technology transfer process. This initial phase has shown that technology-scanning was an interesting area that required further exploration. The study has also raised several questions, these include:

Who scans ?
To what extent do people scan ?
How do they scan ?
To what extent does the business scan ?
To what extent does R&T scan ?
What type of scanning is undertaken ?
etc.

These questions formed the basis of the second phase of the research which is explained in the next chapter.

Chapter 6

Design and application of the research techniques for Phase Two

This chapter explains the development and application of the comparative study of two businesses within ICI and is divided into three main sections. Section One discusses the development of the four propositions used in this study. Section Two explains the operationalisation of the propositions into questions, and discusses the design of the research instruments used in this second phase. The application of these instruments is discussed in Section Three.

6.1 Development of propositions

Part of the research framework (the "cube") developed in Chapter Five was used as a two dimensional matrix to capture and link all the issues and themes uncovered from the literature and from Phase One. This provided some initial order to what had previously been a jumble of issues (see Figure 6.1).

Figure 6.1

	Awareness	Association
Individual		

McD6.1

Adapted from Figure 5.10

Numerous themes were developed using the three areas of "individual", "Awareness" and "Association". This framework provided a focus for the development of relationships between these themes. This was the initial stage in the development of tentative propositions. Following careful analysis, many tautologies were revealed and eventually four distinct propositions emerged.

6.1.1 The recognition of the importance of scanning: Proposition One

Scanning is defined as *unstructured, formal and informal methods of information search.* It is an activity that requires high trust on the part of the organisation as it concerns the degree of freedom that individuals have within their organisation and the degree of freedom that they perceive to hold within their organisation. Consequently the level of scanning undertaken by individuals within an organisation will depend on the facilitative support provided by the organisation for scanning. This support may be present in a variety of forms:

Financial resources;
Accepted norms of behaviour;
Socialisation controls;
Social interaction.

These organisational factors evolve over many years and develop with the organisation. Such factors, are often bound together in the over used term 'company culture'. Indeed Pugh (1991) argues that any organisational factor that cannot be fully explained is often refered to as "company culture".

It is argued that organisations that recognise the value of scanning and networking will provide resources for their employees for these processes. Resources will be provided in the form of time and money. Financial support will be used for equipment to facilitate the scanning process. For example, the provision of databases to access world-wide bodies of information; the provision of libraries to hold regularly used literature and to make available new literature; the purchase and circulation of relevant journals; and resources to enable attendance at conferences and exhibitions. Hence the development of Proposition One:

Effective scanning depends on the explicit recognition by the organisation of the role of technical and commercial scanning.

6.1.2 The recognition of the importance of networking: Proposition Two

The activity of networking is closely linked to scanning. Indeed it could be argued that it is an aspect of scanning. Certainly the organisational factors affecting the extent of scanning also affect the extent of networking undertaken. However, for the purpose of this study networking will be considered separately from scanning and is specifically defined as: *The interaction of people resulting in the informal trading of know-how.*

This activity concerns the amount of freedom and autonomy the individual has within an organisation and whether the organisation provides support for the activity. It is argued that an individual who spends the vast majority of his/her time at their desk or laboratory bench will have a lower degree of "Awareness", for inward technology transfer than an individual who spends time interacting with others by attending conferences, exhibitions and visiting other companies and or universities etc.

A recent development at a large multinational chemical company in the North West of England has been to encourage research scientists to experience for themselves the external factors that influence the markets in which the business operates. This has been achieved by inviting groups of experts from a variety of areas within the industry to visit the organisation and talk to the research scientists about their thoughts and views on developments in the market. These experts included people from the fashion industry, the beautician industry, hair salons and hair dressers. The research scientists were able to experience for themselves developments that were occurring in the marketplace. One could argue, that in effect, the organisation is formalising the external scanning and networking activities in order to raise the awareness levels of their research scientists! Hence the development of Proposition Two:

Effective networking depends on the explicit recognition by the organisation of the role of networking

6.1.3 Understanding the activities and capabilities of the business: Proposition Three

Without extensive knowledge of the business' operations and activities including: the markets in which the business operates; the technical and commercial capabilities of the business; the types of customers who use the business's products and the future plans of the business, it is extremely difficult for an individual to scan effectively for useful information. Clearly, an individual will only know whether information uncovered is useful if that individual has **prior knowledge** of the business's operations and future intentions. Hence the development of Proposition Three:

A thorough understanding of the business's operations, markets capabilities and future business plans is essential for effective scanning and networking.

6.1.4 Effective scanning requires a series of linkages: Proposition Four

The inward technology transfer process appears to be dependent on the creation of an "Association" between an internal opportunity and an external opportunity. Furthermore, this "Association" appears to be made by an individual(s) within the organisation who is able to make a creative link in his/her mind between an internal situation and an external situation. This creation of an "Association", which previously did not exist, is by definition a creative process (Lewis, 1990; Burgleman, 1983). The argument here is that in order for an "Association" to be created a **series of linkages** have to be made. Hence the development of Proposition Four:

The coupling of internal and external, technical and commercial Scanning will produce business "Associations".

6.2 Design of the research instruments

Two research instruments were used for Phase Two, a simple "postal" questionnaire and a structured interview. Initial piloting of the questionnaire and the structured interview was conducted at Cranfield amongst the researcher's peers. Following the removal of the vast majority of structural errors, three pilot interviews were conducted at ICI and another large multinational chemical company, Redsoap, with the following people:
Consumer Research Scientist, Redsoap;
Information Manager, Redsoap;
New Business Development Manager, Chlor-Chemicals, ICI.

This activity shed light on some of the content of the questions and led to the removal of several questions that failed to produce the data required. In addition, several further questions were developed. Final piloting and development of the structured interview was conducted at ICI. A further three interviews were conducted with the following people:
Business Analyst, ICI C&P;
Strategic Planner, ICI C&P;
Business Development Manager, ICI C&P.

6.2.1 Design of questionnaire

In order to utilise time effectively a simple questionnaire was designed to obtain background information such as: age; education; career history; job title and role; etc. Appendix C shows the questionnaire used. This shows the conventional type of information sought. Nonetheless, this was necessary to compare the samples from the two ICI businesses, for example; to see if the age profile of the businesses varied significantly; to examine the range and level of qualifications for the two businesses; and to see whether the actual activities of the participants varied significantly.

6.2.2 Design of structured interview

The procedure for and the reasoning behind the structured interviews was outlined in Chapter Four. Suffice to say that the structured interview was seen as an appropriate method for uncovering, with some certainty, people's activities within the organisation.

The questions have been designed around the four propositions developed in Section 6.1. These propositions focus on the processes of "Awareness" and "Association". Hence, a wide range of questions were designed for individuals within the organisation, probing in a detailed way, into the nature of their actual activities pertaining to inward technology transfer. Each interview consisted of sixty five questions.

6.2.2.1 Questions for proposition One

The following questions attempt to uncover how much facilitative support the organisation gives its individuals for scanning. (Paradoxically organisational support will be provided in the form of low organisational control, that is, a high degree of freedom and autonomy.) Hence, the questions attempt to uncover whether, for example, the individual browses in the library and whether s/he perceives such informal information sources as useful. The questions also seek to find out whether individuals do not use informal sources because they don't value them or because the company does not support these activities. For example it may believe such activities are unimportant. The use of formal information sources, such as on-line services and the 'Current Awareness' programme, is also explored.

The questions developed were:

If there is a conference or exhibition that you wish attend what do you do?

To what extent are you able attend any conference or exhibition that you wish?

To what extent are you able to arrange visits for yourself to other companies and or universities?

Do you believe your business encourages people in your position to spend time outside the company?

In terms of improving the awareness of your business what new activities do you think you should be doing ?

What current activities do you think you should spend more time doing?

The following questions aim to discover what activities individuals undertake to obtain information.

How much of your time, in a week, at work do you spend scanning for useful information?
('scanning' here means unstructured, formal and informal methods of information search)

What technological information sources do you currently most frequently use in your work? (check against list)

What commercial information sources do you currently most frequently use in your work? (check against list)

Do you have any difficulties in gaining access to these sources?

Printed matter: journals, books etc.
Details of journals/literature most commonly used:

Where do you get these from?

How do you read these journals?

Do you ever get the opportunity to browse in the library?
If yes: How often?

How do you view browsing in the library?

What are your most useful sources of relevant information for your business?
(relevant here means to have a direct bearing on your business)

Do you know of any other sources of information that would be useful to you?

If yes: What are these?

Are you able to use these sources?
If no: Why?

Are there any additional activities which you personally feel are an important aspect of the job; but which others might not appreciate?

If yes: What are these?

Considering the things required of someone in your position— what additional facilities would enable you to fulfil all these requirements?

Of all your sources of information to which do you attach most credibility and validity ?

Are there any sources of information that you feel you would be more likely to act upon than others?
Reasons?

When you receive or uncover useful information, how do you rate the authenticity, validity and credibility of this information?

Would you have reacted differently to that information if, for example, you had come across it in a different way or if it had come from another source?
How?
Why?

6.2.2.2 Questions for proposition Two

It is not certain whether individuals perceive 'networking' as useful or not in the acquisition of technology or whether their actions depend on the support or lack of support for the activity by the organisation. That is, to what extent do individuals network because of the organisational environment or in spite of the organisational environment. The following questions attempt to address three areas: (1) whether individuals believe that networking can reveal useful information; (2) how individuals use networks; (3) the size and extent of individuals networks.

The questions developed were:

What technological information sources do you currently most frequently use in your work? (prompt list)

What commercial information sources do you currently most frequently use in your work? (prompt list)

Do you have any difficulties in gaining access to these sources?

What are your most useful sources of relevant information?
(relevant here means to have a direct bearing on your business)

Do you receive any other sorts of technical or commercial information from colleagues?

What sort of information is this?

Was this solicited on your part?
If no: Why do you receive this?
Is it useful?

In a normal week, what proportion of the people you speak to are:

within your department:................................%
within your business but not in your dept:..........%
within ICI but not in your business:.................%
Outside ICI:..%

Who most frequently provides you with information that is useful for your business?
('your business' here means either Watercare or Solvents)

What sort of information is this?

What interactions **within your business** produce the most useful information?

Excluding your business, what interactions **within Chlor-Chemicals** produce the most useful information?

Excluding Chlor-Chemicals, what interactions **within C&P** produce the most useful information?

Excluding C&P, what interactions **within ICI** produce the most useful information?

Do you gain any useful information from informal discussions and interactions with people from other companies, including competitors, operating in similar areas of business?

What are your thoughts about the type of information you acquire from informal discussions with others?

Do you have any important external sources of information?
('external' here means outside ICI)

What are these sources? or Why is this?

Do you know of any groups of people with whom you would like to discuss technological or commercial matters but for whatever reason are unable to do so?
If yes:
What are these sources?

What sort of things would you like to discuss?

In your current position, which form of communication do you find you use most often?

With regard to your position, which form of communication do you find to be most effective?

In your current position which form of communication would you say was vital to the effectiveness of your role?

Given the opportunity, would you alter current communication methods?

How do you pass on information that you believe is useful to the business?
(obtain details of people involved, methods, ie formal, informal, written report, verbal communication, presentation etc.)

Why do you choose this method?

Do you feel it is a successful method?

How much attention do you feel that your ideas receive?

Do you feel that your ideas are understood?
Why is this?

Do you feel that your ideas are taken seriously or not?
Why is this?

Given a choice which method would you prefer to use to put forward ideas?
(Reasons)

Do you think the decision to progress an idea is influenced by the source of the idea, the person proposing or presenting the idea, or what?

What influence does the person making a suggestion/ putting forward an idea, have on whether the idea is progressed?

6.2.2.3 Questions for proposition Three

This proposition relates to the notion of "tuned-scanning" developed in Chapter Three. Hence, the questions that were developed to test the proposition concern an individual's understanding of the commercial and technical needs and capabilities of their business. A number of direct questions are used together with a few more subtle ones.

The questions developed were:

In your current role, would you say you were familiar with the needs of your business?

How are you made aware of these needs? **or** Why is this?

Do you know what the business expects and requires from a (job title of interviewee) ?
How do you feel about this? **or** How do you know what the business expects and requires from a (job title of interviewee)

Do you know what your business manager expects and requires from (job title of interviewee)?

How do you feel about this? **or** How do you know what your business manager expects and requires from a (job title of interviewee)?

Are there any additional activities which you personally feel are an important aspect of the job; but which others might not appreciate?

If yes: What are these?

Considering the things required of someone in your position— what additional facilities would enable you to fulfil all these requirements?

What do you think are the main needs of the Watercare Business?

What do you think are the main needs of the Solvents Business?

What do you think are the main needs of Chlor-Chemicals?

What current external events are likely to affect your business's activities in the near future?

How **technologically** competent do you believe your business (either Watercare or Solvents) is compared with your main competitors?

How **commercially** competent do you believe your business (either Watercare or Solvents) is compared with your main competitors?

Would you say you were familiar with the internal workings of your business?

How are you made aware of these workings? **or** Why is this?

How do you try and ensure you are aware of information that might be important or relevant to your business?

How does the business ensure it is aware of technology that might be useful?

How does the business ensure it is aware of commercial opportunities that could be exploited?

6.2.2.4 Questions for proposition Four

The following questions attempt to assess the type of opportunities, if any, that are created through scanning and networking. The questions endeavour to uncover whether the opportunities that are most frequently generated are genuine business opportunities or technical or trading opportunities.

The questions developed were:

How do you view the levels of technical and commercial awareness of people within your business?

What are your initial thoughts when you come across possible opportunities for your business?

Do you feel your business encourages ideas and suggestions from people in your position?

Have you recently come across some information, either through reading or discussions with other people, in the last month that you thought might be useful for your business?

What was this information about? (obtain details)

Were you able to do anything with the information?

What happened? (obtain details)

Was there any feedback?
What was the nature of this feedback? **or** What happens now?

If yes: How often does this occur?

6.3 Application of the research instruments

6.3.1 Questionnaire

This was forwarded to the participants, via the organisation's internal post, a week before the interview, and collected on the day of the interview by the researcher immediately prior to conducting the interview. All the participants had been able to complete the questionnaire within 5 minutes.

6.3.2 Structured-interview

The two businesses used in this study, the Solvents business and the Watercare business, were selected by a senior manager at ICI as providing a useful contrast (see Chapter Four). In addition the sample selected from each business was checked by a senior ICI manager as representing a true and fair reflection of the actual population of each business. A total of twenty people were interviewed.

The interviews lasted between one and a half and two hours. The schedule for the interviews was arranged so that following each interview the researcher was able to visit the library (ICI, R&T Library) and review the interview to ensure that all the important points had been recorded. All the participants were extremely cooperative and very helpful. At the beginning of each interview a truthful but deliberately vague description of the area under study was given. This was to ensure responses were not "tailored" to suit the investigation. At the end of each interview a more detailed explanation was given of the area of research.

The interviews were conducted in private offices or in interview rooms, in an informal atmosphere and on a one-to-one basis. The responses to all the questions were recorded by the researcher directly onto the interview sheets. Handwritten transcripts were made of each interview, which were then content analysed. Mostyn (1985) suggests that 'content analysis is essentially just another term for a very ordinary everyday activity we all engage in when we communicate with one another. Content analysis occurs whenever the recipient of a message says to him/herself: "What they are actually saying is____"; What this means is ____"; "The speaker intended ____"; and so forth'.

The table shown in Figure 6.2 shows the list of participants in this study. Participant number 20 is a senior manager operating on behalf of ICI C&P and therefore does not belong to one particular business. He is used as a control in this study.

The next chapter will analyse the data collected from the application of these research techniques.

Figure 6.2

Participant	Role	Business
W1	New Product Development Manager	Watercare
W2	Technical Product Manager	Watercare
W3	Technical Development Manager	Watercare
W4	New Product Development Manager	Watercare
W5	Sales Manager	Watercare
W6	New Business Development Manager	Watercare
W7	Business Manager	Watercare
S8	New Business Manager	Solvents
S9	Product Manager	Solvents
S10	Marketing Manager	Solvents
S11	Technical Marketing Manager	Solvents
S12	Marketing Manager	Solvents
S13	Business Manager	Solvents
S14	Marketing Manager	Solvents
W15	Research Associate	Watercare
W16	Research Scientist	Watercare
W17	Business Technology Manager	Watercare
W18	Research Manager	Watercare
W19	Research Scientist	Watercare
N20	Business Development Manager ICI C&P	Control

Chapter Seven

Results and preliminary analysis of the study of the processes of "Awareness" and "Association" through a comparison of two businesses within ICI

This chapter analyses the data collected from the comparative study of two ICI businesses. Section One looks at the activities, and Section Two analyses the training and experience, of the individuals within the two businesses. The amount of scanning and networking undertaken is addressed in Sections Three and Four respectively. Section Five analyses the extent to which individuals are aware of the internal capabilities of the business. The type of scanning and networking undertaken is analysed in Sections Six and Seven respectively. To facilitate analysis and comparison of the data from this study, a series of Grids were devised. This provided a method of combining the large volume of data and making a comparative analysis a relatively simple process. Thus a summary of the results of the study is presented on three grids in Section Eight. The final section (Nine) discusses the preliminary findings of the study.

7.1 The main orientation of the activities of the participants

The results from the questionnaire and the structured-interview has enabled a picture to be constructed showing the main orientation of the activities undertaken by each respondent. The picture is assembled taking into account four factors, they are:

i. The location of the participant- the environment in which an individual operates on a daily basis will substantially influence the activities of that individual. The commercial operating environment of an organisation, like any operating environment, acquires a distinct set of procedures, unwritten rules, norms of behaviour and accepted activities. This is often unconstructively termed culture. A more accurate description would be "ways of doing things". Such "ways" are usually very different to those found in, for example, the operating environment of a research and technology department.

ii. Job role/function- to what extent the respondent is fulfilling a technical or commercial role.

iii. **Journals read-** this will reveal the type of information, whether technical or commercial, processed by the individual. Much of the evidence for this has been classified under "type of scanning undertaken" (see Section 7.6).

iv. **Networks-** the type of people, whether commercial or technical, with whom the individual interacts. As above, much of the evidence for this has been classified under "type of networking undertaken" (see Section 7.6).

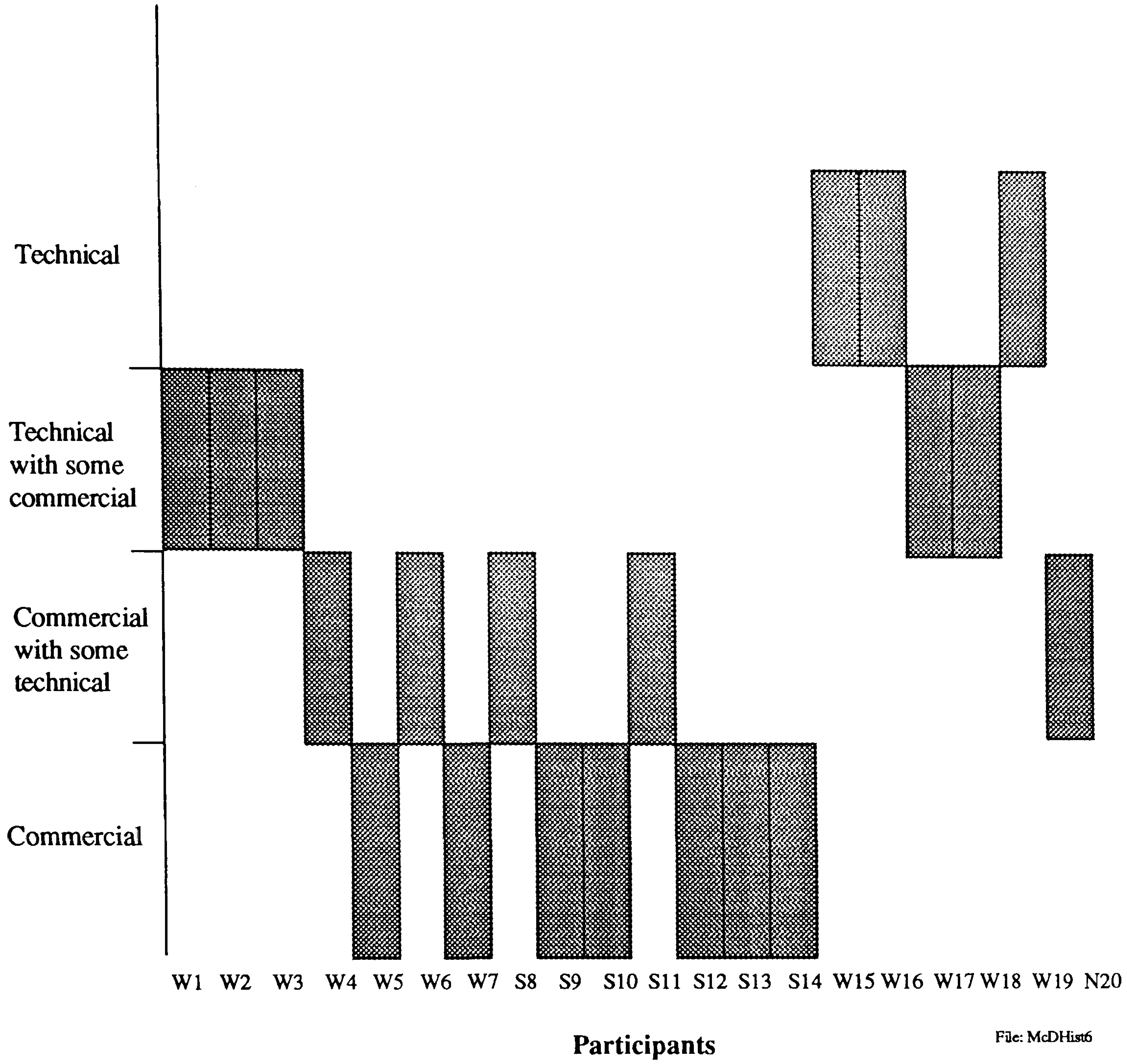
Together these four factors provide a rich picture of the main orientation, whether technical or commercial, of the current activities of the individuals (see Figure 7.1 below). Clearly at either end of the scale there will be technical and commercial activities. Inevitably there will be a large group that will be found in the centre who will be involved in both commercial and technical activities. However, the pictures that have been constructed from the data show several clear differences in the activities of the individuals in this group. The spatial histogram in Figure 7.2 clearly shows the distribution of activities amongst the participants.

Figure 7.1

Respondent	Function	Location	Journals	Networks	**Orientation of activities**
W1	T&c	T	T&c	T&c	T with some C
W2	T&c	T	T&c	T&c	T with some C
W3	T&c	C	T&c	T&c	T with some C
W4	C&t	C	C&t	C&t	C with some T
W5	C	C	C	C	Commercial
W6	C&t	C	C&t	C&t	C with some T
W7	C	C	C	C	Commercial
S8	C&t	C	C&t	C&t	C with some T
S9	C	C	C	C	Commercial
S10	C	C	C	C	Commercial
S11	C&t	C	T&c	T&c	C with some T
S12	C	C	C	C	Commercial
S13	C	C	C&t	C	Commercial
S14	C	C	C	C	Commercial
W15	T	T	T	T	Technical
W16	T	T	T	T	Technical
W17	T&c	T	T&c	T&c	T with some C
W18	T&c	T	T	T&c	T with some C
W19	T	T	T	T	Technical
N20	C&t	T	T&c	C&t	C with some T

Figure 7.2

Summary of orientation of activities



7.2 Training and experience of individual

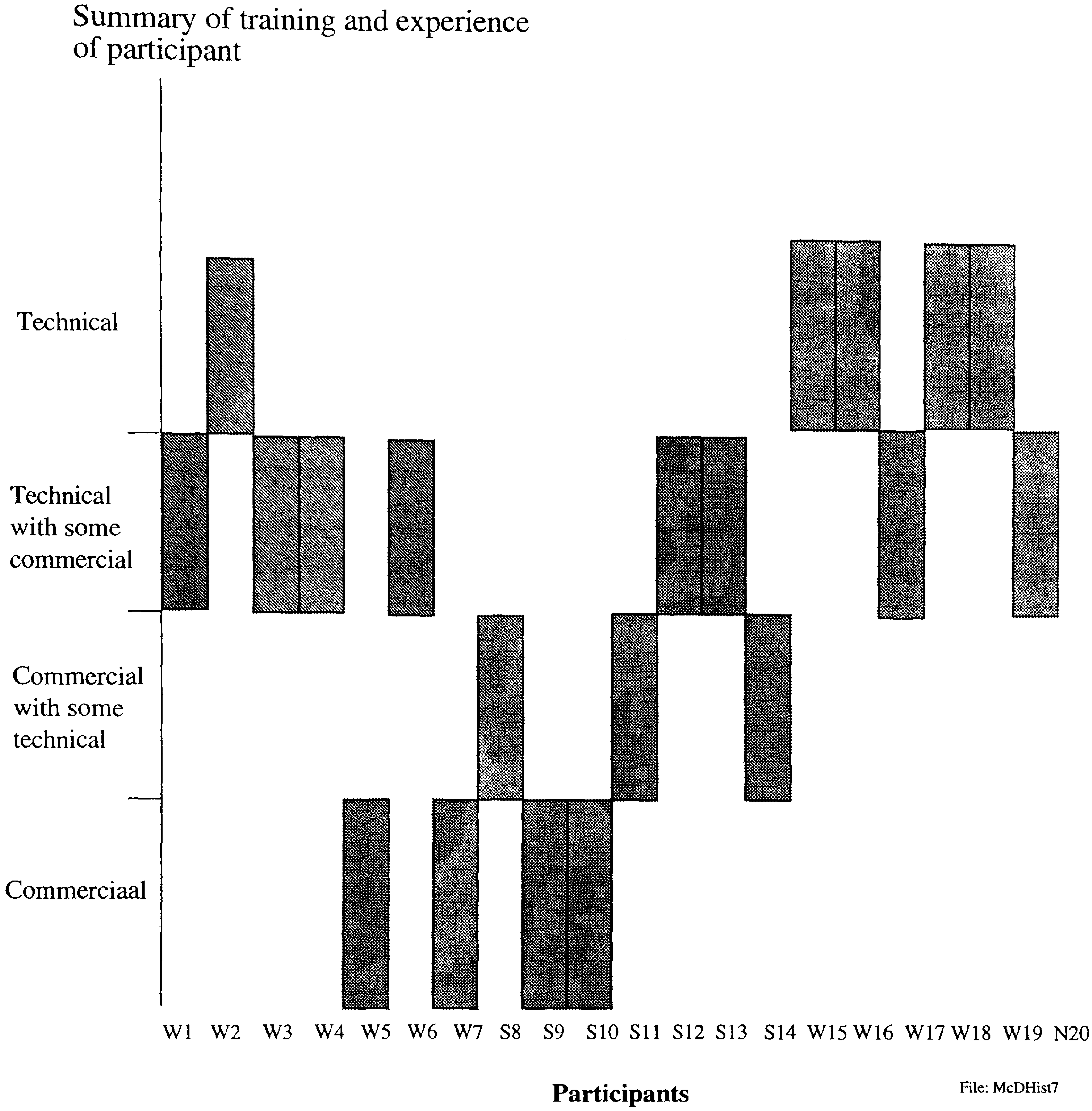
The questionnaire asked for details about: education; career background; number of years in a commercial role; and the number of years in a research/technology role. Participants who had a commercial education and training and fulfilled mainly commercial roles were placed in the commercial category. Similarly those who had technical education and training and fulfilled technical roles were placed in the technical category.

Clearly there was a large group who had both commercial and technical training and experience. Within this group it was possible to identify people who, while they had both technical and commercial skills, were weighted one way. For example: Respondents with three years training and experience within "R&T" and fifteen years in a commercial role were placed in the "commercial with some technical" section. Whereas someone with fifteen years training and experience in "R&T" and three years in a commercial role were placed in the "technical with some commercial" section (see Figure 7.3 below). The spatial histogram in Figure 7.4 clearly shows the distribution of training and experience amongst the participants.

Figure 7.3

Respondent	Years in Commercial	Years in Technical	Qualifications	**Training & experience**
W1	4	15	T	T with some C
W2	0	3	T	Technical
W3	1	12	T	T with some C
W4	6	3	T	T with some C
W5	26	0	C	Commercial
W6	7	5	T	T with some C
W7	15	0	C	Commercial
S8	11	3	T	C with some T
S9	0	13	C	Commercial
S10	5	0	C	Commercial
S11	25	5	T	C with some T
S12	6	24	T	T with some C
S13	5	15	T	T with some C
S14	15	0	T	C with some T
W15	0	17	T	Technical
W16	0	5	T	Technical
W17	7	10	T	T with some C
W18	0	10	T	Technical
W19	0	5	T	Technical
N20	5	25	T	T with some C

Figure 7.4

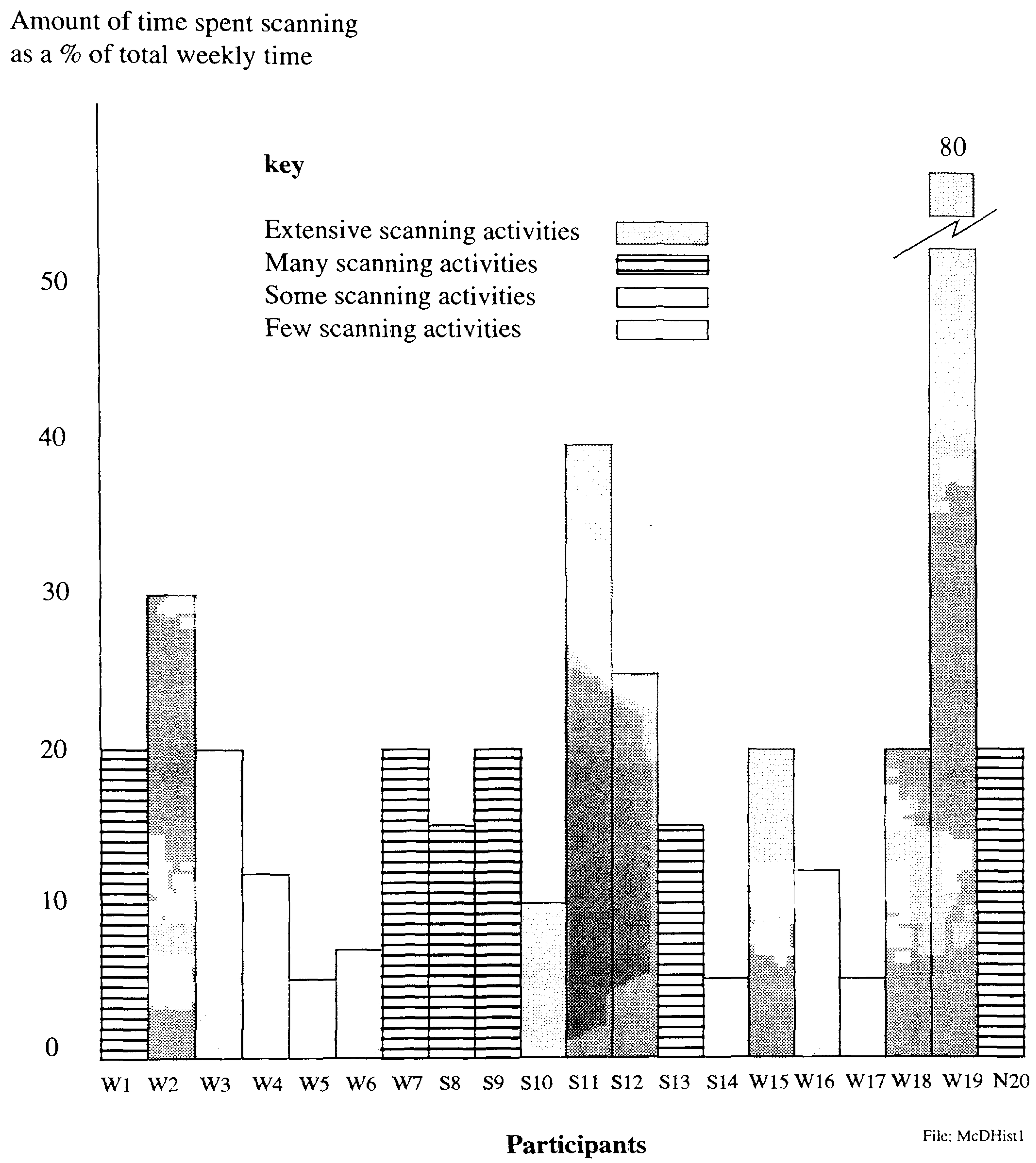


7.3 Amount of scanning undertaken

In order to gain a fair representation of the amount of scanning undertaken a combination of qualitative and quantitative questions were used (see Section 6.2.2.1). The quantitative and qualitative data were used together to establish and verify an accurate figure for the amount of "scanning" undertaken. In most cases the data from both the qualitative and quantitative questions concured; with a few exceptions.

As one would expect there was a wide range of responses. Some respondents undertook very little scanning while others spent many hours a week exploring various literature sources. Figure 7.5 displays the results in the form of a histogram. Similarly, some people viewed scanning as ineffective and a luxury while others viewed it as extremely important and a necessary part of their job.

Figure 7.5



7.3.1 Extensive scanning activities category

There were a number of people who spent a large part of their time scanning. When one considers that a figure of 20% represents one full day scanning any figure of 20% or more is a substantial amount of an individual's working week. This group tended to be within the "R&T" environment. For example, those respondents who were involved in research and technology exclusively were **all** extensive scanners. This may be because the scientific literature has a long history and consequently is well developed, unlike the commercial literature. There were, however, a few people fulfilling a commercial role who also spent a large part of their time scanning the literature (see Figure 7.6).

Figure 7.6

Respondent	Amount of scanning
W2	30 %
S11	40 %
S12	30 %
W15	20 %
W18	20 %
W19	80 %

"I keep up-to-date by reading: 'Nature', 'New Scientist', and 'Chemical Abstracts'. And I use specific polymer journals for my current work ... If you are doing a well defined job you will not need to use the library as much as someone who is investigating new areas" (W15).

"I spend most of my time scanning for useful information" (W19).

"The library only holds journals for the last ten years. I am always using the British Library ... I often go to the library after lunch for an hour" (W18).

"I spend half my time scanning for useful information ... I am still interested in my old PhD field; I browse the journals. Also I look at 'New Scientist', 'Water and Water Technology', 'American Waterworks Association Journal' and American Trade Association Magazines" (W2).

7.3.2 "Few" scanning activities category

There were few respondents in this category. This is because both businesses operate in an "information rich" environment (see Figure 7.7).

Figure 7.7

Respondent	Amount of scanning
W5	5 %
S14	5 %
W17	5 %

"I do very little undirected search" (W5).

"I never sit at my desk reading journals . . . I don't encourage my people to do it [browse in the library]" (S14)

"I get profiles [information sheets from information scientists] but I don't read them" (W17).

7.3.3 "Many" and "some" scanning activities categories

The vast majority of respondents fell somewhere between "extensive" and "few" scanning activities. It would have been possible to put the remainder into a single central group, but within this group there was a noticeable difference in the level of scanning undertaken. Hence, this group was divided in two, giving a total of four separate groups:

1. Few scanning activities undertaken
2. Some scanning activities undertaken
3. Many scanning activities undertaken
4. Extensive scanning activities undertaken

7.3.3.1 Examples of "many" scanning activities:

Figure 7.8 shows the participants in the "many" scanning activities category.

Figure 7.8

Respondent	Amount of scanning
W1	20 %
W7	20 %
S8	15 %
S9	20 %
S13	10-20 %
N20	20 %

"Scanning is an active part of my job ... Colleagues constantly drop things on my desk" (W1).

"I spend one hour a week consciously scanning plus two or three hours reading colleagues' reports, conference papers, rep's reports" (S8).

"I use 'European Chemical News', 'Chemical Marketing News', 'Japanese Chemical Reporter' ... I always read one article" (S13).

"Scanning is largely my job ... 'New Scientist', 'Economist', 'FT', I subscribe to industry news letters on TT ... I use the information scientists" (N20).

7.3.3.2 Examples of "some" scanning activities:

Figure 7.9 shows the participants in the "some" scanning activities category.

Figure 7.9

Respondent	Amount of scanning
W3	50 %
W4	12 %
W6	7 %
S10	10 %
W16	12 %

"We are encouraged to send electronic mail. Most people have a terminal in research and everyone has a terminal in commercial. We are linked to Watercare, Australia and all other ICI sites" (W3).

"Mostly targeted search" (W6).

"I only visit the library when I am in R&T, only in R&T four or five times a year ... I am an addict of the 'Economist' I read it all" (S10).

7.3.4 The variety of information sources available

The variety of information sources available to both businesses is staggering. There were no noticeable differences in the variety of sources used by people in either "Watercare" or "Solvents". An interesting feature, that seems worthy of note and is possibly a particular trait of ICI, was the extent to which internal colleagues were used as sources of information. Almost every respondent mentioned internal colleagues as the most valuable and "reliable source" of information.

The following is a list of sources made available by the organisation and cited by respondents as useful:

i. Journals

An enormous variety of journals, both specific and general, technical and commercial were available. Journals that are published all over the world were made available for example: 'Japanese Chemical Reporter', 'European Chemical News', 'American Waterworks Association Journal'. The Economist, New Scientist, Nature and The FT were commonly cited as journals frequently used to gather general news. Circulation lists were the most commonly used methods for accessing these journals.

ii. Information scientists

The Current Awareness Service provided key word searches on virtually any subject and maintained regular monthly updates on selected areas of interest.

iii. On-line external databases

These are either used by individuals in the library or through the information scientists

iv. Browsing in the library

An extensive library situated in the R&T department stocks a variety of commercial journals as well as a comprehensive selection of technical, mainly chemical journals. In addition the library offers all the standard services of an academic library.

(While the majority of respondents believed browsing in the library was a useful activity and often "sparked ideas" (Ref: W16); few people in a commercial role used the library. This could be mainly because of its location in relation to the commercial department offices. The library is located within R&T in a different building from the commercial departments).

v. Conferences & Exhibitions

People within ICI regularly attend conferences. For conferences in the UK there were few resource restrictions. For conferences in other parts of the world, financial restrictions existed but these appeared to be limited. For example one manager replied:

> *"I am just back from a conference in Australia and I'm going to another one in Florida next week!"* (Ref: W2)

The common procedure was:

i. Does it [the conference] look interesting?

ii. Is anyone else from ICI going?

iii. If not, book ticket and go (Ref: S10).

The information department also operates a Conference Bulletin service that provides people with information about forthcoming conferences.

vi. Company accounts

ICI operate a Company Reports Service at Winnington. This service is available to all ICI businesses.

vii. Other chemical companies

People frequently visited or had visits from other chemical companies normally in the capacity of supplier or customer.

viii. Internal meetings

Monthly business meetings and fortnightly team meetings were continually cited as a valuable source for information.

ix. Internal business reports

ICI operate a Documentation Centre which holds and files all internal documentation including:

Correspondence registry

Company reports: Sales rep visit reports, conference reports, business team meeting minutes, C&P reports, etc.

Laboratory notebooks

x. Social friends

Respondents cited old friends from university, former department/business colleagues and friends they had met at conferences as useful sources for information.

xi. Customers

The sales people and marketing people continually visit existing and potential customers.

xii. Academic contacts

Many projects within R&T have strong links with a senior academic in a university in the UK.

xiii. Trade Associations/Competitors

European, Japanese and US Chemical Trade Associations are three examples of organisations that provide opportunities for chemical companies to discuss general matters of interest to the industry.

xiv. Competitor analysis

The Publicity department provides copies of press releases relating to selected companies. This information provides the bulk of information for the Competitor Analysis Team who provide regular reports for the business teams within ICI.

xv. Suppliers

The marketing people and buyers, as well as people from R&T, regularly meet with suppliers to discuss technical and commercial issues.

xvi. Consultants/Consultants' Reports

Consultants, both commercial and technical , were used extensively especially when operating in U.S. markets. In addition, consultant reports were frequently purchased. These ranged in price from a few hundred to several thousand pounds!

xvii. ICI Patent department

This C&P department services all the C&P businesses. It provides many services including the search for patents in an area of interest; the ordering and the filing of patents. It has access to the "Derwent" database and supplies information on patents to all ICI C&P businesses.

xviii. Government departments

ICI provides substantial amounts of information to various government departments including the Dept of Environment and the Dept of Trade and Industry. In addition ICI managers also give papers at government meetings. For example one of the respondents recently gave a paper at a House of Lords Select Committee Meeting (Ref: W4). Reports of these meetings are then fed back into ICI.

xix. IT Awareness

ICI C&P operate a technology awareness office that aims to keep the businesses informed of developments in information technology that may be useful.

This enormous variety of information sources made available to the businesses of ICI and the people within ICI, is clear evidence, in itself, of the commitment the company has to ensuring its businesses and its people are aware of useful and potentially valuable information. Moreover, while it would not be true to say that **everyone** utilised **all** these sources, **all** the respondents were **aware** of the extensive variety of sources of information available to them. If further evidence was needed, no-one cited a problem with a lack of information. This was confirmed by the large number of respondents who were unable to identify any other sources of information that would be useful to them! (Ref: Q12). A few respondents identified additional sources, but many of these concerned the business plans of competitors!

7.4 Amount of external networking undertaken

In order to gain a fair representation of the amount of external[1] networking undertaken a combination of qualitative and quantitative questions were used (see Section 6.2.2.2). The quantitative and qualitative data were used together to establish and verify an accurate figure for the amount of networking undertaken. In most cases the data from both the qualitative and quantitative questions concured.

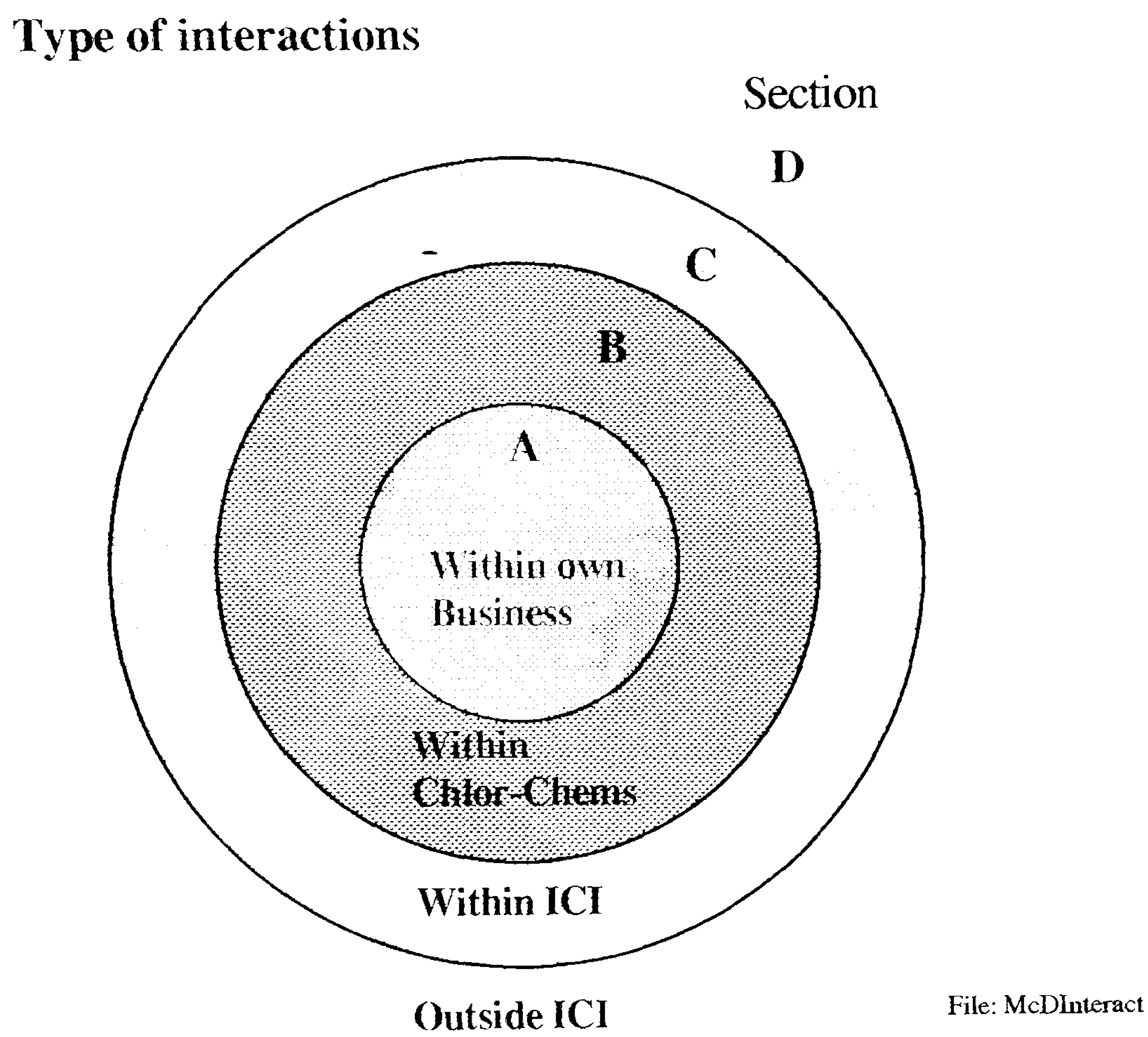
---

1 External here means outside ICI C&P.

As one would expect there was a wide range of responses. Some respondents undertook very little external networking while others spent much of their time outside the business consciously interacting with others. Similarly, some people viewed networking as ineffective and a waste of time, while others saw it as extremely important and a vital part of their job.

Figure 7.10 shows how the variety of possible interactions have been classified into four sections.

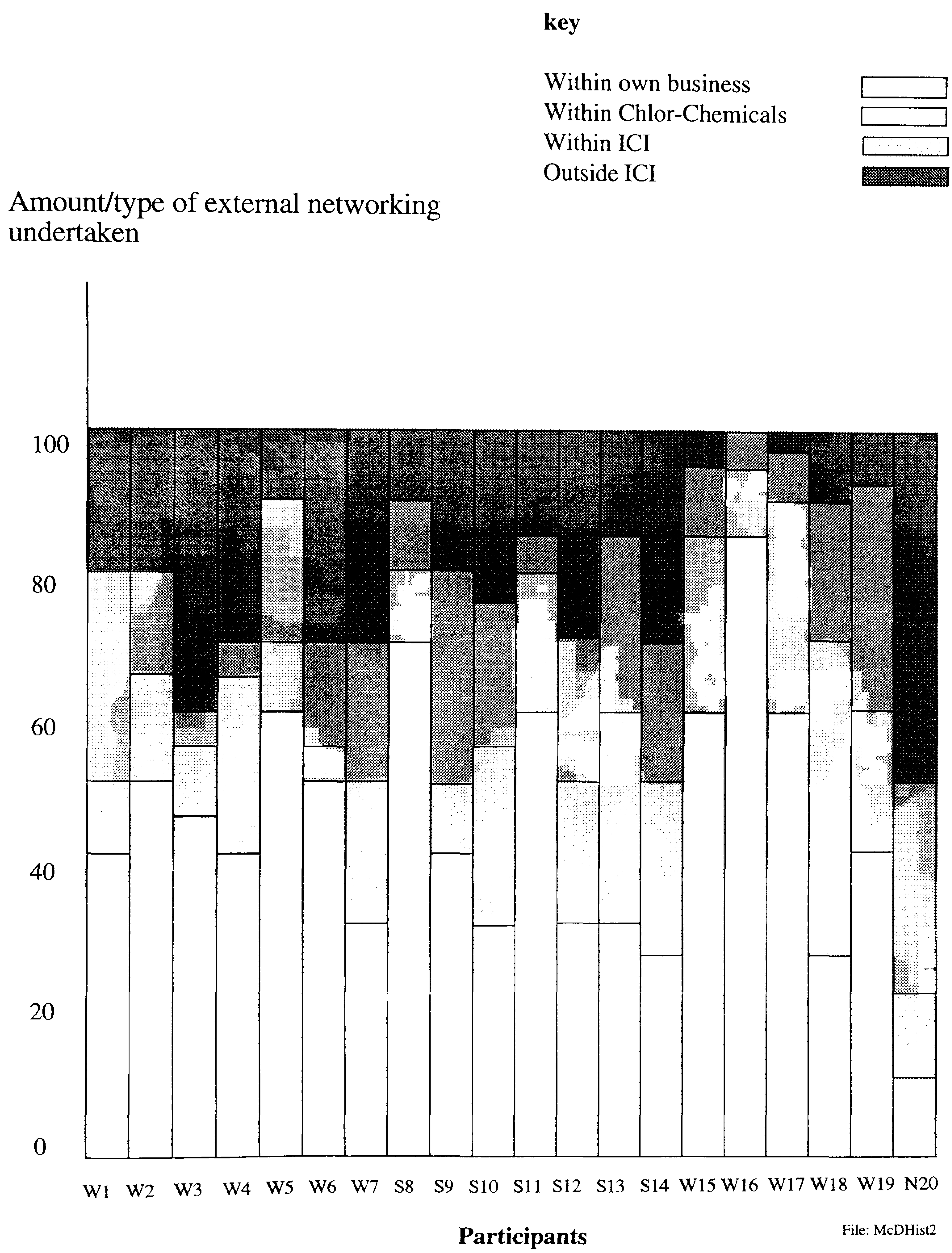
Figure 7.10



Respondents were asked to indicate the distribution of their interactions with people for a normal week (interactions here includes telephone and face to face communications). The results are shown in Figure 7.11.

Figure 7.11

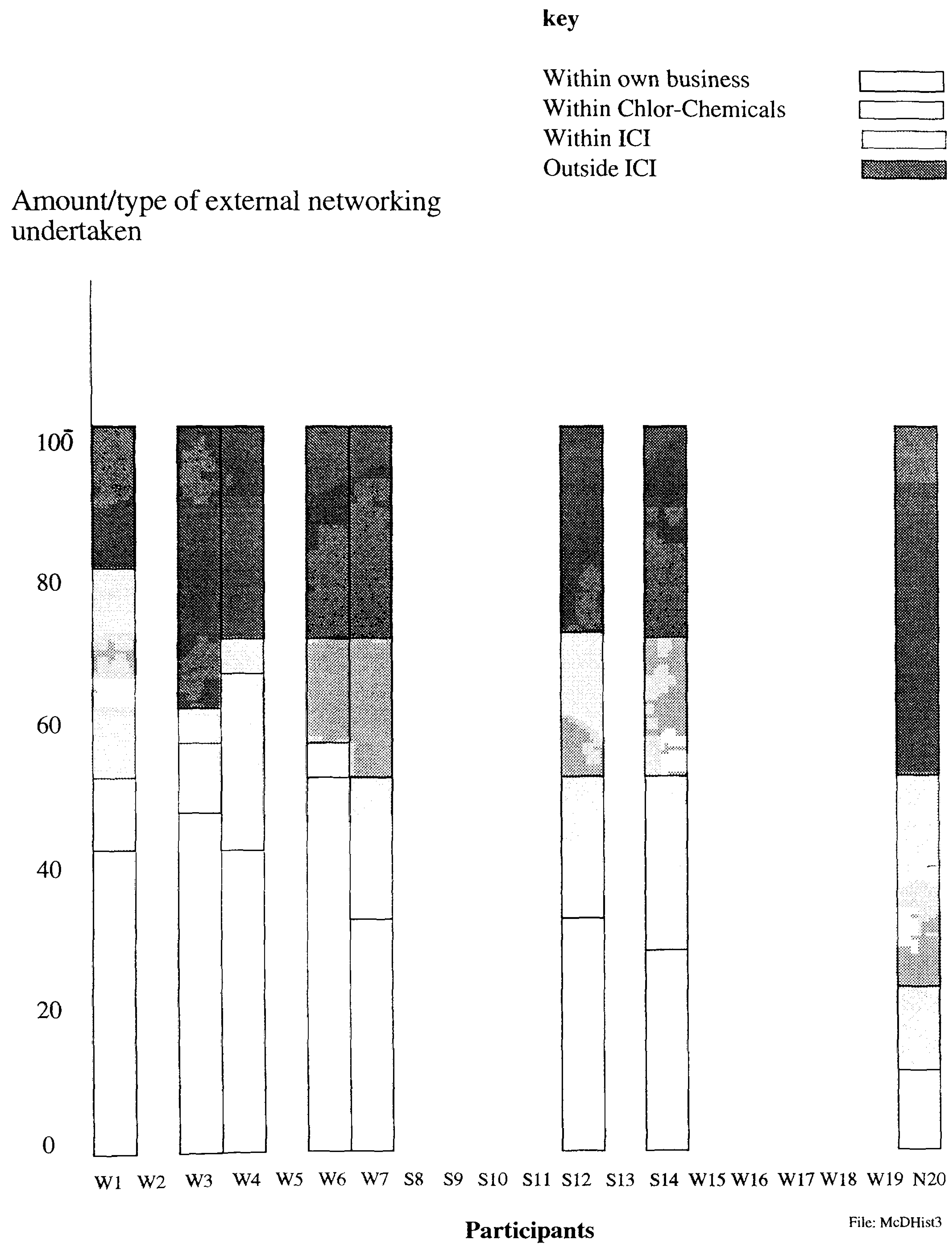
Histogram showing amount and type of external networking undertaken



7.4.1 "Extensive" external networking category

Figure 7.12 shows the participants in the "extensive" networking category.

Figure 7.12



There were a number of individuals who believed networking was an extremely valuable and a necessary part of their function. The following comments are typical from this group:

"The most useful sources of information are personal contacts ... awareness comes from interactions" (W1).

"Most useful source of information are external laboratories ... I go round chatting to people to find out what's going on" (W3).

"I try and interact with as many people as I can externally ... I only see customers once or twice a year" (S14).

"Outside business contacts [provide useful commercial information] ... I visit six customers a month" (S12).

"Customers are the most useful sources of information; I have a long list of customer contacts" (W4).

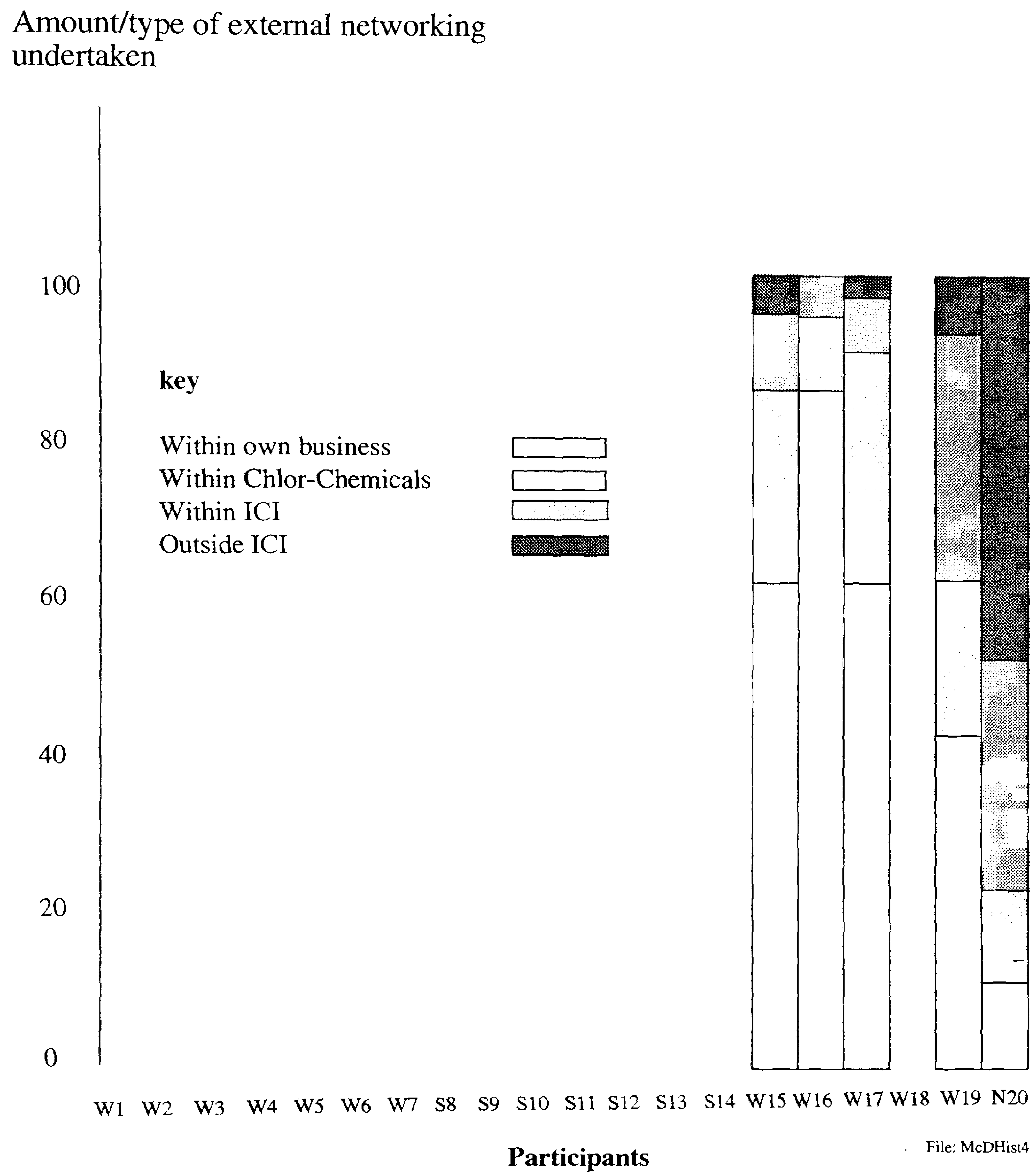
"We are more externally focussed [than other C&P businesses] ... I would like to spend more time outside the company, ideally 50%" (W7).

"I value very highly information from informal discussions with other companies; by not directly talking about a subject you can acquire useful information about that subject" (W6).

7.4.2 "Few" networking activities category

Figure 7.13 shows the participants in the "few" networking activities category.

Figure 7.13



At the other extreme there were a number of individuals who spent very little time interacting with others outside the organisation. The following comments are typical from this group:

"My manager (Watercare) says get yourself out; speak to people. People here wonder why I don't go outside!" (W19).

"I don't speak to anyone outside ICI [in a normal week]" (W16).

"Unlikely to be of any value if they are fulfilling their contracts [thoughts about informal discussions with people from other companies]" (W15).

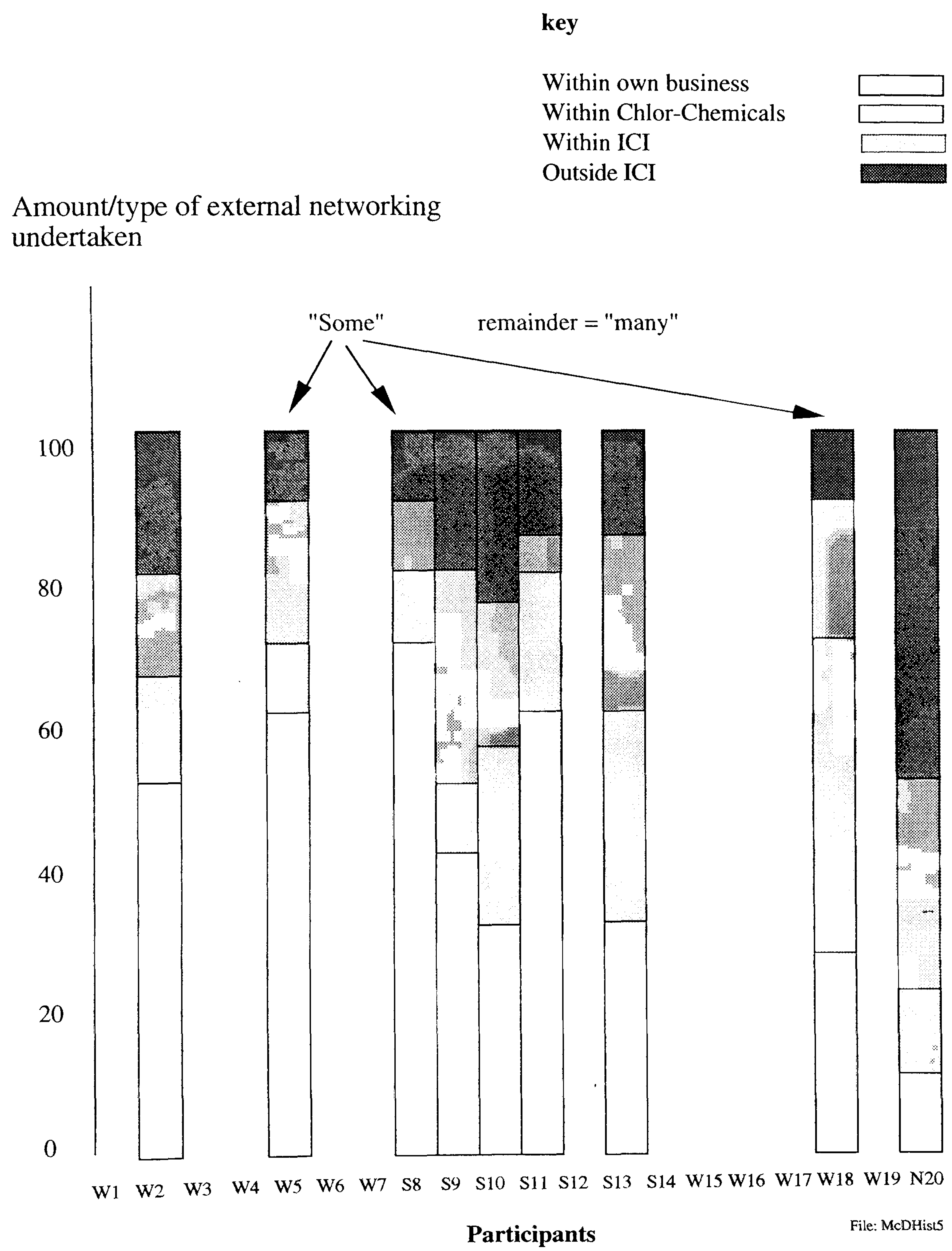
7.4.3 "Some" and "many" networking activities category

A large number of respondents fell somewhere between "extensive" and "few" networking activities. It would have been possible to put the remainder in one centre group, but within this group there were several distinct differences. Hence, this group was divided in two, giving four separate groups in total:

1. Few networking activities undertaken
2. Some networking activities undertaken
3. Many networking activities undertaken
4. Extensive networking activities undertaken

Figure 7.14 shows a histogram of the two categories: "some networking", and "many networking" activities.

Figure 7.14



7.4.3.1 Examples of "some" external networking activities:

"I gain useful information from informal contacts with suppliers and competitors" (W18).

"I gain useful information from informal discussions with other companies ... They can be as good as if not better than formal discussions" (W5).

"Competitors are a useful source of commercial information" (S8).

7.4.3.2 Examples of "many" external networking activities:

"Most people can go to any conference they wish. ICI rely on responsible people" (S11).

"The business objectives force you to go outside, but individual objectives have to be met" (S13).

7.4.4 The recognition of the importance of networking

The listing in 7.3.4 contains six different external informal linkages:
Conferences/Exhibitions;
Other chemical companies;
Social friends;
Academic contacts;
Technical and commercial consultants;
Customers;
Suppliers.

This signifies the importance, placed by individuals within both businesses, on informal networks as a means of remaining vigilant of external developments. This result is supported in a recent study by Steward and Conway (1993) on the origins of successful innovations. They identified five different types of informal networks that organisations had refered to as influential in developing the innovation. These were:
Kindred-spirit networks;
Professional networks;
User networks;
Scientific networks;
Friendship networks.

It is evident from the results from the first study in Chapter Five that ICI provides support, for informal interaction (networking) both in terms of its liberal attitude to socialisation

socialisation controls, norms of behaviour and organisational structure. For example, the organisation provides large travel budgets for personnel to attend conferences and exhibitions. This implies that this activity is recognised as **valuable** by senior management within ICI. In addition the matrix organisational structure and the use of business teams facilitates and encourages extensive internal interaction. Moreover, the study in phase two revealed that **interactions with people** were identified, by both businesses, as the most useful source of information above all other sources (Ref: Q10). There was a slight bias amongst the Solvents business towards using more internal interactions. The following extracts highlight the importance placed on the activity of networking:

> *'By keeping contact with as many people as I can. This is where you get information from' (Ref:W4).*

> *'I go round and interact, it doesn't come to you' (Ref: W7).*

> *'By opening up as many contacts as possible and encouraging people to keep me informed' (Ref: W6).*

Participants from both businesses appeared to pass information freely around the business and the extensive internal reporting infrastructure that existed further ensured that important and useful information was recorded. People appeared to use a combination of formal and informal procedures to ensure they were informed of current developments.

In addition the respondents from the Watercare business believed there was strong encouragement within the ethos of the business to spend time outside the company (Q 17). The respondents from the Solvents business believed, however, that there was little, if any, encouragement to spend time outside the business, as the following extracts show:

> *"The culture* [of the Solvents business] *is inward looking, we have to spend time sorting out our own problems, therefore not enough time is spent looking at competitors and markets" (Ref S9).*

> *"A market survey two years ago said that we [Solvents business] don't spend enough time with customers but nothing changed" (Ref S11).*

> Spending time outside the company *"is not seen as important by the business managers [Solvents business] and even the technical people don't think its worth going to universities". (Ref: S15).*

7.5 The importance of being aware of the technical and commercial capabilities of the business and the future direction of the business

Participants from both businesses displayed a thorough and comprehensive understanding of the needs of their business. The respondents were satisfied that they knew what the business required of them. Moreover, regular discussions both informal and formal, with the senior management of the business appeared to ensure that people were familiar with the needs of the business. Monthly business meetings and weekly business team meetings provided the formal opportunity for discussions. Informal daily discussions, encouraged through "open door" style management, further ensured members of the organisation were aware of developments. This finding supports the theory put forward by Marsh (1989), that ICI operates a "fuzzy" management style that enables continuous interaction and aids the flow of ideas. There are numerous communication systems available to people within the businesses: -

Internal Mail system
Internal telephone system
Electronic voice box: an elaborate answer phone system.
Electronic Mail system (IBM: STRATOS)
Internal weekly and monthly meetings

7.5.1 Technical Product Managers

In addition to a "commercial" Product manager, the Watercare Business, ūse "Technical Product Managers" (TPM). The role of a Technical Product Manager involves interacting with customers; listening to their problems, understanding their needs and attempting to develop technological solutions. TPM's often accompany sales representatives on their customer visits.

An examination of the Technical Product Managers within Watercare reveals that the TPM's have an R&D background and many have a PhD in chemistry. They also have many years of experience and training within a commercial environment, normally in project management and or product management.

The Solvents business use Technical Sales personnel who appear to fulfil a similar role. But it would appear that the Solvents business does not facilitate or encourage "technologists" to interact with users. The Technical Marketing Manager explained that:

"only sales representatives or sometimes marketing visit customers"(S11).

7.5.2 ICI Personal Review Process

A finding worthy of note is that every respondent identified the Personal Review Process (PRP), that has recently been introduced throughout ICI C&P, as the main channel through which they discuss personal objectives and performance. This relatively new PRP incorporates a performance related pay scheme and consists of four quarterly reviews and an annual review. The following extracts are answers to the question on whether the respondent is familiar with the needs of the business:

'My job remit is agreed at my personal review and updated quarterly' (Ref:W4).

'My job description is very detailed and very explicit. Also my "Personal Performance Review" is reviewed quarterly ' (Ref: S14).

7.5.3 Training

As part of the quality drive within ICI, each business has developed a set of manuals that detail a full job description of every position within the business. Included in this job description is a comprehensive training programme. Everyone in the business is expected to complete a minimum number of training courses each year, and this is reviewed at each Personal Review. (The Business Manager of Watercare explained that 5% of an individual's working time should be spent in training). This view was supported by several respondents:

"Training is a big part of ICI culture" (Ref: W6).

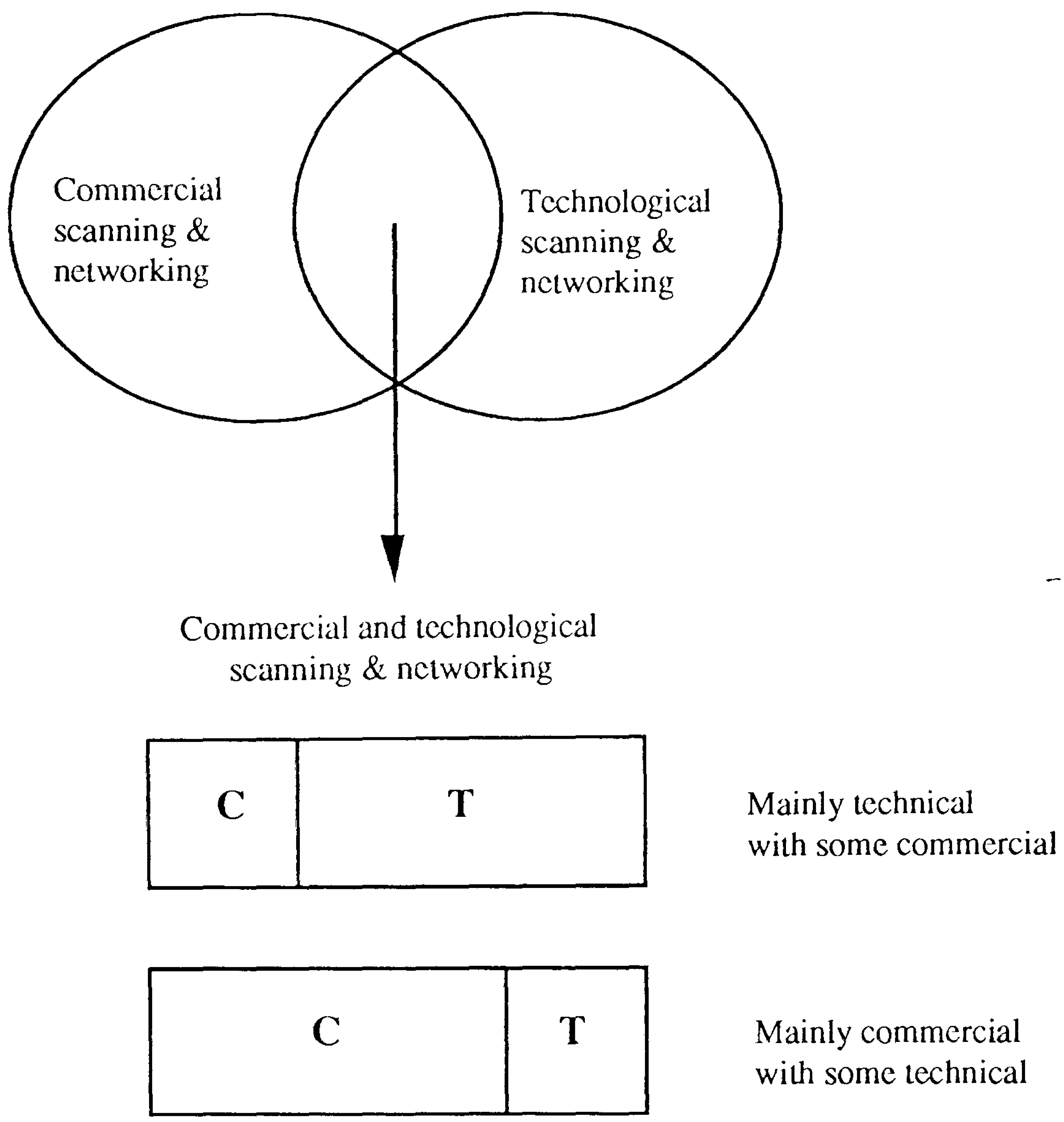
These courses include: various computer skills, management skills, technical training and other forms of personal development. The Watercare business has recently established an on-going short course at Cranfield Institute of Technology to provide their commercial people with technical training.

7.6 Type of scanning and networking undertaken

A series of qualitative questions were used in the structured-interview to uncover the type of scanning and networking undertaken by each individual (see Section 6.2.2.4). This enabled the researcher to construct a picture concerning the extent of commercial and technical scanning and networking. Inevitably there was a large group in the centre who performed both commercial and technical scanning and networking activities. Nonetheless, it was possible from the data to identify notable differences within this centre group and establish two distinct groups (see Figure 7.15).

Figure 7.15

Type of scanning & networking



File: McDC&Ts&n

7.6.1 Examples of technical scanning:

"I use 'Chemical Abstracts' and various water treatment journals; I don't read any commercial journals" (W19).

"I use chemistry handbooks ... I'm not concerned with commercial side at all" (W16).

"I keep up-to-date by reading: 'Nature', 'New Scientist', and 'Chemical Abstracts'. And I use specific polymer journals for my current work" (W15).

"I use 'Chem Abs', 'Nature', 'Membrane Science Journal' and "profiles" from information scientists ... I use 'Nature' [for commercial information]" (W18).

7.6.2 Examples of commercial scanning:

"I rely on the chaps in R&T for technical information ... I don't see the chemical press [ie technical]" (S12).

"We have technical experts for technical information ... We rely on them" (W5).

"Other people in R&T [provide me with technical information] and business team meetings" (S14).

7.6.3 Examples of mainly technical with some commercial scanning:

"I use general journals, consultants reports ... very specific journals to the industry we are involved in" (W17).

"I use 'Aqualine', 'Chemical Abstracts', 'New Scientist', 'Nature' and other water journals ... subordinates pass me a great deal of commercial information" (W1).

"I go to technical seminars and conferences [also] use sales rep reports and trade journals [for commercial information]" (S11).

"I am still interested in my old PhD field; I browse the journals. Also I use 'New Scientist', 'Water and Water Technology', 'American Waterworks Association Journal' ... [for commercial information] I use American trade association magazines and other trade magazines" (W2).

7.6.4 Examples of mainly commercial with some technical scanning:

"I read very few technical sources ... I use 'European Chemical News', 'Chemical Marketing News', 'Japanese Chemical Reporter' ... I always read one article" (S13).

"Market reports done by the 'Economist' and 'Japanese Association of Hydrocarbons' [would be useful to us]" (S10).

"The 'Water Bulletin' is essential [also] 'Water & Waste Treatment' ... The journals in the library are too academic" (W4).

"I use reports from R&T and journals [for technical information] ... Sales rep visit reports are by far the most important [source of relevant information]" (W6).

7.6.5 Examples of "technical" external networking:

There were no qualitative examples of people networking externally for mainly technical information. External technical networking seemed to involve a certain amount of commercial networking; hence the large grouping of respondents in that section.

7.6.6 Examples of "commercial" external networking:

"Outside business contacts [provide useful commercial information] ... I visit six customers a month" (S12).

"Competitors most frequently provide me with useful information for my business ... market positioning, overall views on trends, strategies, assets etc" (S9).

"I use external customers for commercial information ... The Chief Executives of the Regional Water-boards are important external sources of information for me" (W7).

"I rely on chaps in the labs for technological information ... I use outside business contacts for commercial information ... We rely on R&T to keep us aware of technology ... the business doesn't do it [ensure it is aware of technology] as well as it use to" (S14).

"I use very few technological information sources ... The European Chlorinated Trade Association is very useful for competitor analysis ... I have regular meetings with the Department of the Environment" (S13).

7.6.7 Examples of "mainly technical with some commercial" external networking:

"Most useful source of information are external laboratories ... I go round chatting to people to find out what's going on" (W3).

"Suppliers, a number of technical consultants and two particular customers are important external sources of information ... I use customers for commercial information" (W2).

"I use seminars, exhibitions and conferences for technical information ... The most useful source of information for me is market intelligence from talking to people in the industry" (S11).

7.6.8 Examples of "mainly commercial with some technical" external networking:

"Competitors are a useful source of commercial information" (S8).

"I most frequently use customer contacts for commercial information ... I visit at least one customer a week ... Close customer contact ensures the business is aware of technology that has been developed" (W4).

7.7 The type of positive outcomes generated through scanning and networking

Proposition Four suggested that: the coupling of internal and external, technical and commercial scanning will increase the likelihood of genuine business associations being made (that is associations with a technical and commercial content). This proposition was tested by analysing some of the positive outcomes produced through scanning and networking by the two businesses. The complete analysis is shown in a table in Appendix E. The data shown within this table, and summarised in Figure 7.16, is however, not sufficiently robust to draw any firm conclusions either way about the opportunities generated by the businesses. Nonetheless it does indicate that there is some support for the proposition that combining the four scanning activities (internal and external, commercial and technical) may increase the likelihood of genuine business associations being created. On the other hand the evidence is more compelling regarding the type of opportunities generated by the participants in this study. The participants from the Solvents business produced only one technical opportunity and one "genuine business opportunity". Whereas the participants from the Watercare business produced relatively more technical and "genuine business opportunities". Thus suggesting that the absence of technical scanning clearly affects the type of opportunities generated. Clearly a more detailed study of this area is required.

Figure 7.16

A summary of the positive outcomes produced through Scanning

	Commercial opportunities	Technical opportunities	Genuine business opportunities	Other or N/A	Total
Solvents	4	1	1	1	7
Watercare	1	4	4	3	12

7.7.1 Introduction to the grids

The quantitative and qualitative analysis of the data revealed few discernible differences in the extent of scanning and networking undertaken by the two businesses. There was, however, a noticeable contrast in the type of scanning and networking activities. This can be clearly seen in the following grids, developed to facilitate a comparison of the data from the two businesses.

The comparative qualitative analysis of the survey results are presented in the form of three grids which also represent a summary of the results. These grids show the activities of individuals within the two businesses of Watercare and Solvents. Each grid has two axes, displaying two different variables. Each variable is quantified into four categories. The variables and grids are:

List of Grids:

Grid 1: Training & experience	V	Main orientation of activities.
Grid 2: Amount of scanning	V	Type of scanning.
Grid 3: Amount of networking	V	Type of networking.

The letters 'W' and 'S' represent the Watercare business and the Solvents business respectively. The numbers, 1-20, represent the twenty participants. Participant N20 was asked to position himself on a blank grid this placement corroborated the researcher's position for N20.

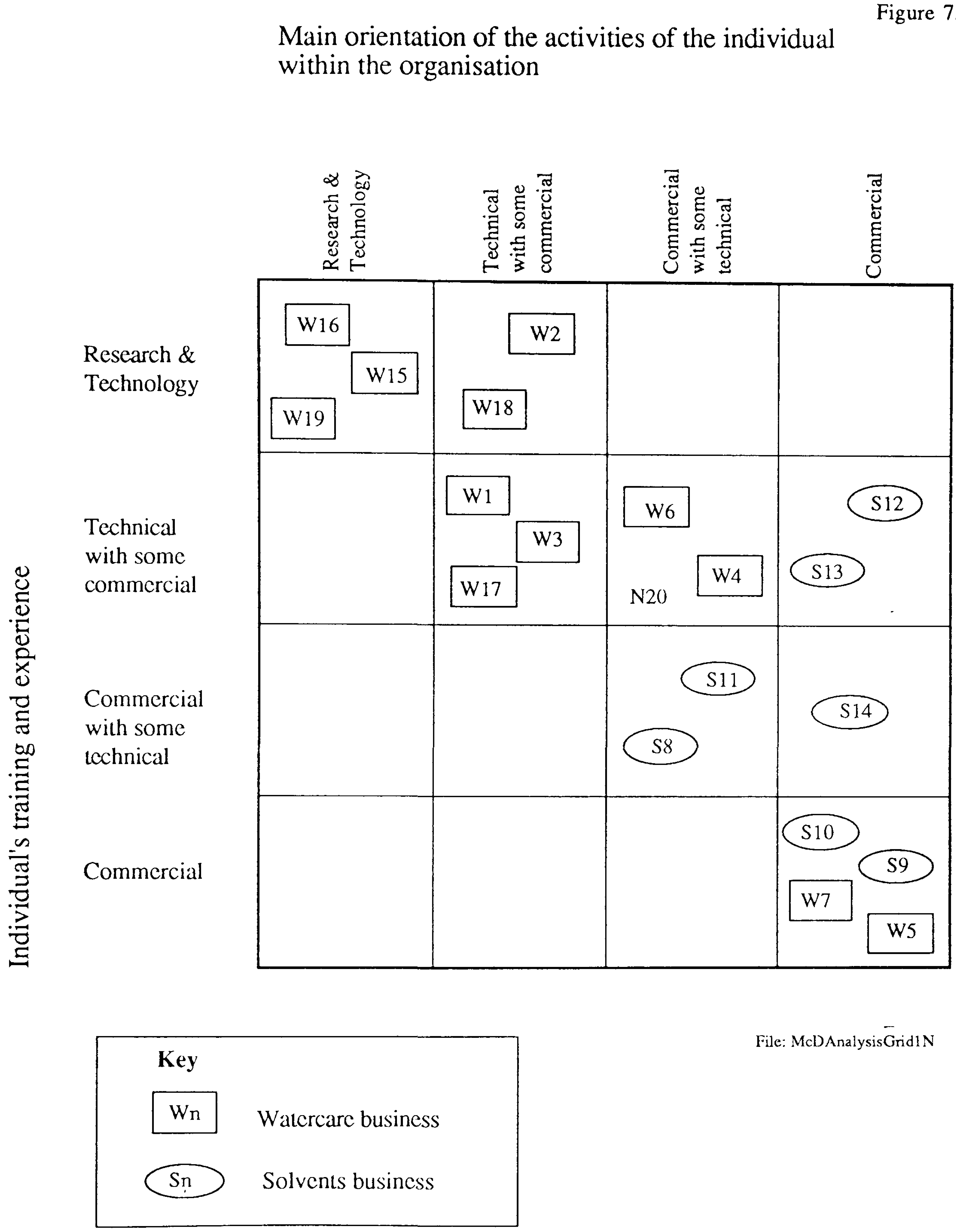
The most obvious and striking observation from all three grids is the cluster of Solvents personnel fulfilling commercial activities, whereas the Watercare business has a more even distribution, with possibly a slight bias towards research and technology activities. This reflects the earlier evidence (Chapter Five and Appendix B) that showed a substantially larger R&T expenditure by the Watercare business compared with the Solvents business.

7.7.2 Grid 1: Current activities v training and experience

Grid 1 (Figure 7.17) shows individuals' training and experience against current activities. As expected it shows that there is a correlation between individual's training and experience and their current activities. For example, individuals trained in the field of research tend to be involved in research and technical activities and people trained in commercial skills tend to be involved in commercial activities.

Grid 1- Current activities v training and experience

Figure 7.17



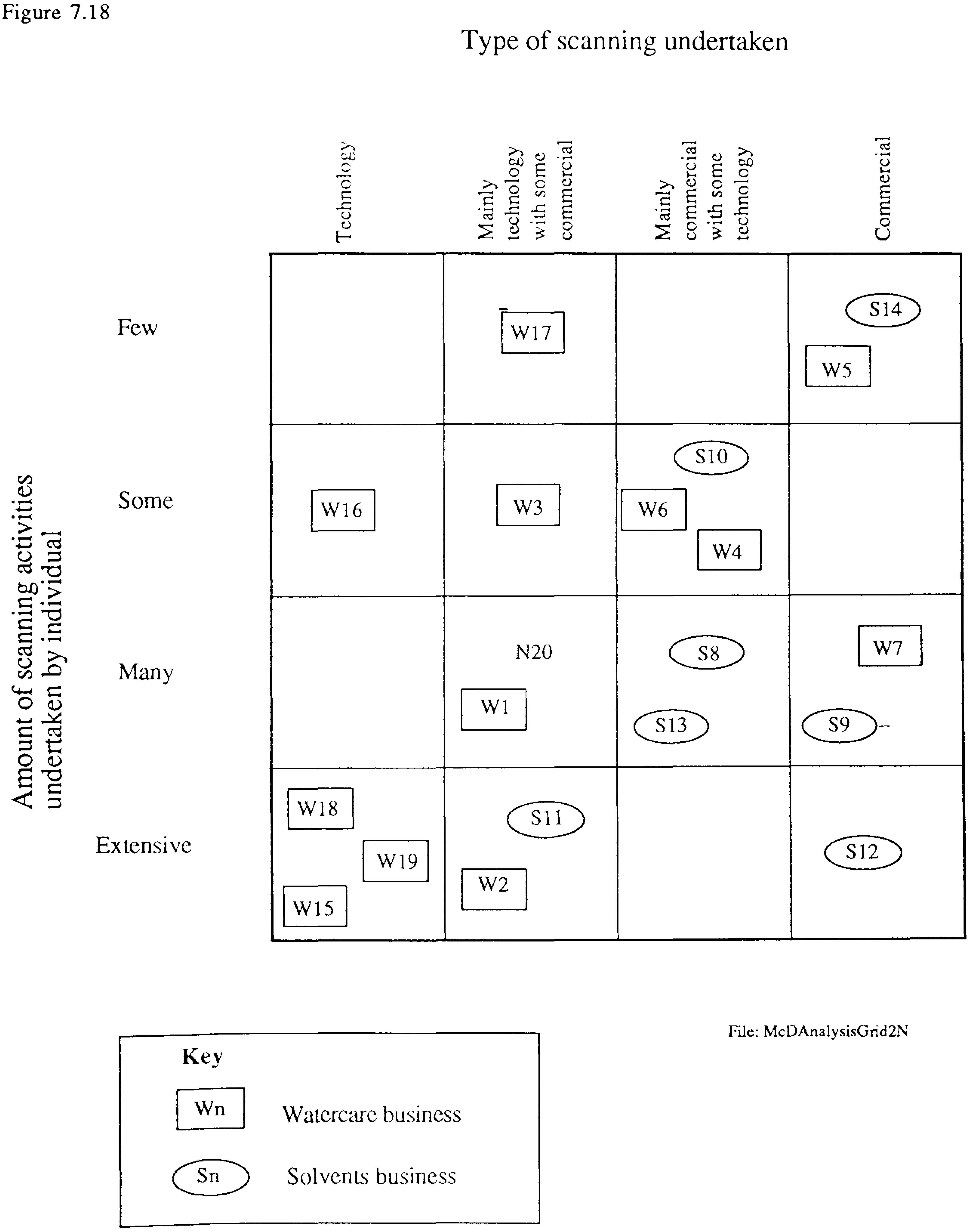
File: McDAnalysisGrid1N

7.7.3 Grid 2: Amount of scanning and type of scanning

Grid 2 (Figure 7.18) shows the amount of scanning undertaken by individuals and the type of scanning undertaken. The grid shows the Solvents business clustered towards commercial scanning, whereas the Watercare business has a more diverse distribution.

Grid 2- Amount of scanning v type of scanning

Figure 7.18



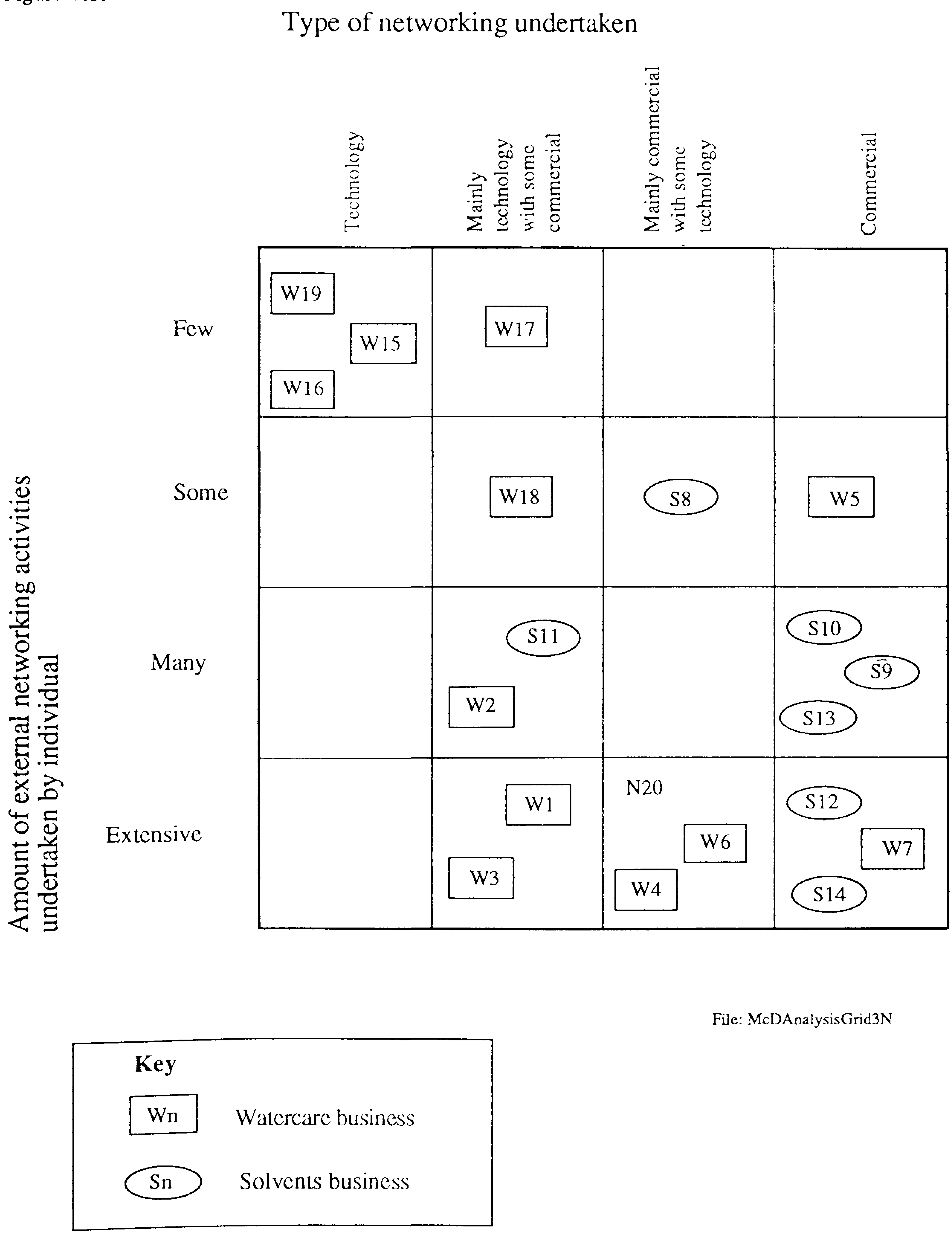
File: McDAnalysisGrid2N

7.7.4 Grid 3: Amount of networking and type of networking

Grid 3 (Figure 7.19) shows the amount of networking undertaken by individuals and the type of networking undertaken. As with the previous grid, the Solvents business is clustered towards commercial networking, whereas the Watercare business has a diverse distribution.

Grid 3- Amount of networking v type of networking

Figure 7.19



This grid highlights some significant differences between the activities of scanning and networking. Grid 3 shows a cluster of research scientists that undertake few networking activities. Whereas the same research scientists undertake extensive scanning activities. Thus suggesting that research scientists tend to engage in more inanimate scanning than interpersonal interaction (networking).

Broadly speaking Watercare has extensive networking activities with techno-commercial people. Whereas the scanning activities of Watercare appear to be more involved in the technical area.

7.8 Conclusions

7.8.1 The recognition of external scanning and networking

It is possible to conclude from the findings in Section 7.2 that ICI, as a corporate organisation, appears to recognise the role of scanning and networking and thus provides extensive resources for its employees in terms of in-house information resources and financial resources that fund visits to conferences, exhibitions, companies and academic institutions all over the world. Thus there is support for proposition One. Both businesses under study recognised the importance of scanning and the results showed that there was little difference in the amount of scanning undertaken by each.

Therefore, one might expect there to be little difference in the extent of networking undertaken by the two ICI businesses. However, while the respondents from the Watercare business believed there was strong encouragement within the ethos of the business to spend time outside the company the respondents from the Solvents business believed that there was little, if any, encouragement to spend time outside the business. This important distinction between the ethos of the two businesses was noticeable in the extent of external networking undertaken; individuals within the Watercare business tended to spend more time outside of the business than their counterparts from the Solvents business. These differences occur in spite of the fact that the two businesses operate within the same corporate structure and within the same corporate culture. These findings indicate that there is support for Proposition Two; that is, effective networking is dependent on the recognition by the organisation of the importance of networking.

7.8.2 Understanding the capabilities and needs of the business

Individuals within both businesses displayed a thorough and comprehensive understanding of the needs of their business. There were no discernible differences between the responses from individuals within the two businesses. This is probably more a reflection of the strong "ICI culture" than any peculiarities of the two businesses being studied. Their strong awareness may also be due to the importance given to training within the overall ICI ethos. One might reasonably expect people to understand the needs of their business if 5% of their working time is spent in training!

In addition the use of a matrix organisational structure and its impact of on encouraging additional lines of communication within the organisation would also appear to enhance internal awareness. There is evidence within the literature that matrix organisational forms are particularly suited to science based or technical organisations.

> *Improved information processing facilitates the sharing of technical information by those who need it and assists in the communication and consideration of critical, technical information for a project. Greater flexibility allows an organisation to quickly make appropriate technical decisions and adapt to changing technical conditions . . . The multidisciplinary approach to a project allows the maintaining of functional discipline expertise not possible in other organisational forms.*
>
> Ford and Randolph (1992).

The findings in Section 7.4 suggest that ICI recognises the role played by internal informal interaction (networking). The organisation supports the activity through the provision of the following:

- the operation of an "open" and informal style of management.
- a matrix organisational form.
- the use of business teams.

The respondents in both the Watercare business and the Solvents business emphasised the importance and value of interacting with people (ie networking) internally, within ICI, and externally, outside ICI, in order to maintain a high level of awareness. They believed networking was a necessary activity in order to remain aware of developments within their business (internal networking) and within the industry in general (external networking). Hence, there is support for Proposition Three and the overall theory on networking.

When one considers the wealth of formal information sources available (see Section 7.3.4) and then adds to this the many informal sources in the form of internal and external networks. One could reasonably conclude that the organisation recognises the importance of individuals possessing a high degree of awareness, further suggesting that with this support people within ICI are able to scan effectively for technology for their business.

7.8.3 The importance of a range of scanning activities

The grids in Section 7.7 identify several differences between the activities of individuals within the two businesses. The differences are not in the amount of scanning or networking undertaken per se, but with the type of scanning and networking undertaken. The activities of the Solvents business are commercially orientated with limited technology-scanning. Whereas the Watercare business has a range of commercial and technological activities.

The Solvents business has a limited number of activities in research and technology. It is a mature business involved in the management of established products in established markets. Hence, the focus of attention has been centred around the commercial activities of delivering products to customers. Emphasis has been on minimising costs and meeting the needs of new and existing customers. Consequently "associations" are generated from these commercial activities and in particular the commercial scanning activities. These tend to be in the form of "trading associations" such as: opportunities to enter new markets in terms of geography and/or business sector; opportunities to reduce costs by introducing new operating procedures; opportunities to increase sales through establishing a new trading partner. There are few technological "associations" because there is very little technological scanning. Consequently as shown in Figure 7.16 there are few genuine "business associations" created.

The Watercare business, on the other hand, is a new business with newly acquired products operating in new markets. It does not have to maintain a large, existing customer base or maintain existing plant or production facilities. This allows for greater flexibility and provides individuals with a high degree of autonomy in activities undertaken. With a clear business strategy to introduce new products and few existing operations to cause distractions, the business is able to concentrate its efforts on the search for new technology and new products.

This strategy is consistent with the ethos of the Watercare business; the business's only assets are its "people". While ICI recognises, more than most companies, that their people are an important asset, for the Watercare business this factor appears to be even more pertinent.

7.8.4 The creation of linkages and "Associations" for the business

The role of Technical Product Managers by the Watercare business is an example of the different strategies being followed by the businesses. The use of TPM's by the Watercare business facilitates the interaction of technical staff with customers. TPM's often accompany sales representatives on visits to customers. At first glance this appears to be a significant structural difference between the two businesses. A closer qualitative examination reveals that the Solvents business use Technical Sales (TS) personnel who perform a similar role to that of the TPM. Both roles involve technical personnel interacting with customers, listening to their problems, understanding their problems and attempting to solve these needs. There is, however, a subtle difference between these two roles. The role of the TPM is to develop new products, whereas the role of TS is to service existing customers' technical needs. The distinction here is on the emphasis of activity. One is on technical development while the other is on technical service. (See Chapter Five for a full explanation of the difference in these activities).

The deployment of "technologists" into the market place to meet, discuss and interact with customers, suppliers and competitors, enables a wealth of "hard" and tacit knowledge to be acquired first hand. This provides the technologist with not only an appreciation of the technological problem, (technical problems are often presented, second hand, in the form of a technological project), but also with a richer and fuller understanding of the needs and problems of users and potential users. Interaction is instrumental in the acquisition of tacit knowledge because it is deeply rooted in action and is context specific. It consists partly of technical skills that are informal and hard to pin down. In a study of the development of the Honda City in Japan, Nonaka (1988) emphasises the importance of tacit knowledge:

> *"An engineer comments, I think it's pretty difficult to articulate really meaningful know-how in text, figures, or other measurable forms. The knowledge is alive because ... it changes continuously ... The best way to transfer it is through human interaction."*

This type of knowledge is often termed "know-how". Furthermore, interaction allows the technologist to enter into context specific dialogue with customers enabling them to assimilate and interpret for themselves the actual technological needs and opportunities that exist. This activity, which may be described as a form of technology assessment, further provides the opportunity for **"associations"** to be made and new ideas to be developed. A similar concept is being introduced at a major consumer goods chemical company in the North West of England. In this particular case the products under development are personal care products such as shampoos. The company has taken the unusual step of bringing the market place, in the form of a range of practioners to the laboratory to meet, discuss and interact with the research scientists. For example, hair dressers, beauticeans and fashion experts. This provides the opportunity for novel associations and linkages to be generated.

The role played by TPM's in the Watercare business highlights another distinguishing feature between the two businesses. The Watercare business unlike the Solvents Business, use a greater number of techno-commercial people within all areas of the business. This is can be seen on Grid 1 (Section 7.7) which shows a large number of personnel from the Watercare business that have both technical and commercial training and experience. This type of individual possess both technical and commercial experience rather than specialist knowledge in a particular field. The Solvents business, on the other hand tend to use specialists. This provides the Watercare business with **diversity** in a variety of functions.

All these factors mentioned above provides a business with personnel that are "tuned" into the technical and commercial capabilities of the business and are aware of the future direction of the business. These conditions are necessary to enable the workforce to scan effectively for associations and business opportunities. The absence of one or more of these factors will increase the likelihood of introducing noise into the scanning process. Thereby reducing the effectiveness of technology-scanning.

The "tuned-scanning process" developed in Chapter Three highlights a number of interesting points. The solvents business have limited activities in one of the four part scanning process, namely external technical-scanning. Whereas the Watercare business have extensive activities in all four areas. This would explain why scanning undertaken by the Solvents business tended to produce more opportunities with only a commercial content. Whereas the Watercare business tended to produce opportunities with a commercial and technical content. While the evidence from this study, and in particular the data in Figure 7.15, is not conclusive it does suggest that there is some evidence to support the scanning model and the importance of coupling technical and commercial scanning in order to generate business opportunities and thus improve a business's receptivity to externally developed technology.

The next chapter will examine how these business opportunities are "Assimilated" by the organisation and transformed into genuine business opportunities that the business has an intention to exploit.

Chapter Eight

Uncovering the process of "assimilation": Phase three of the research

This chapter explores the notion of "Assimilation" through a study of three businesses. The chapter is divided into six sections. Section One discusses the notion of "Assimilation" and presents the researchers understanding of it in the form of a conceptual model of "Assimilation" that has been derived from the literature and the findings from the previous two phases of research. Section Two discusses the aims of the fieldwork and the suitability of cognitive mapping as a modelling technique. The application of the research technique is discussed in Section Three. Section Four presents the findings of the study and includes the cognitive maps of the participants. The analysis of these maps is presented in Section Five, with the conclusions presented in Section Six.

8.1 The third element in the 4A model of inward technology transfer: "Assimilation"

The process of "Assimilation" within the context of the four stage model of inward technology transfer, presented earlier in Chapter Three, is narrowly defined as:

The internal organisational process of transforming technical or commercial ideas into genuine business opportunities.

A *Genuine Business Opportunity* is defined as an opportunity that the business has an intention to exploit. It follows that in order for an organisation to move from a position of interest in a business opportunity to a position where it intends to exploit the business opportunity, the organisation will have gone through a process of learning and understanding the details and facts associated with it. Hence, it is proposed, that the organisation will have "assimilated" a body of knowledge specific to that business opportunity. Whether the organisation utilises this genuine business opportunity involves an analysis of further organisational decision making processes. The question of an organisation's capacity to exploit a business opportunity is beyond the scope of this research.

The concept of "Assimilation" will now be explored a little further. In a rapidly changing environment successful companies may be characterised by those who are consistently able to create new knowledge; disseminate this throughout the organisation and then "Assimilate" it into new technology and products and supply this successfully in the market place (Nonaka, 1991). "Assimilation" then, concerns how an individual's knowledge is transformed into organisational knowledge valuable to the company as a whole. The knowledge base of an organisation may be described as an accumulation of the knowledge bases of all the individuals within an organisation and the social knowledge embedded in relationships between those individuals. These relationships are often recognised as organisational processes and procedures (Kogut & Zander, 1992; Nonaka, 1991, Senker, 1993). The relationships between individuals represent a form of "glue" that joins the smaller parts and transforms it into a larger and more capable part. Hence, the "glue" may be said to convert individual knowledge into organisational knowledge.

This interaction is fuelled by the thirst for additional information. Some of this information may have been previously acquired, but it is the process of interaction with other members of the organisation that will continue to "add to" and "build on" the existing technical and commercial knowledge associated with the opportunity. This may be described as a cumulative learning process that builds on **prior knowledge**.

In order for an organisation to evaluate business opportunities it has to learn and understand (assimilate) a variety of commercial and technical details and facts associated with the business opportunity. The argument presented in Chapter Three suggested that these "Business Associations" are developed and presented to the organisation, that is other people in the organisation, by individuals from within the organisation. Hence, the organisation has to learn and understand a body of knowledge related with the "Business Associations". It is proposed that the process of "Assimilation" is an iteritive one, whereby the organisation constantly filters potential opportunities. In some cases the business opportunity will require additional information; in others the commercial or technological knowledge base of the organisation may be insufficient to support the opportunity; some may not fit with the strategy of the business, etc. This overall process is defined as "Assimilation". Figure 8.1 represents the researcher's theoretical interpretation of inward technology transfer and includes the process of "Assimilation". This is derived from the literature and the findings from the two previous phases of research. This leads to the development of a working proposition:

> To what extent is this conceptual model of "Assimilation" [Figure 8.1] supported by the evidence from the fieldwork.

The aim of this third and final phase of the research aims to address this point and uncover the actual content and nature of this process as described by three different businesses: two from ICI and one from Redsoap[1].

8.1.1 A theoretical model of inward technology transfer

The model in Figure 8.1 shows the four elements of the inward technology transfer process down the left hand side of the model. These are awareness-association-assimilation-application. It begins with the activity of scanning and suggests that new information not related to existing activities will be less easily absorbed. Whereas new extramural information, that is related to a current technical project, for example, will be readily absorbed. The model lacks detail on exactly how this new information is transformed and used but it posits that following internal experimentation and discussion this information builds on the existing knowledge base of the organisation. During these internal experimentations and discussions it is suggested that new technical and commercial linkages and "Associations" will emerge and that these will be discussed with the business management team. The result of which may produce genuine business opportunities that the business has an intention to exploit.

8.2 Factors influencing the choice of research method

Preserving the form as well as the content of recorded utterances is vital to richness and to allow emergence of attitudes and values. This is best achieved by verbatim reporting; it is better to abbreviate words than to precis or translate. As Brown (1992) points out, 'users of cognitive mapping for this research process need to be vigilant during the later, boring, data hammering stages of the project'.

Respondents were to be those involved in the internal organisational activities of generating and managing new business opportunities. This would include Research Scientists, Senior Research Scientists, Research Managers, Marketers, Sales Managers, Marketing Managers and Business Managers. The latter of which are responsible for the overall performance of the business. Clearly these potential clients would have limited time to give us, so any technique chosen had to be operable without the need for previous training or detailed

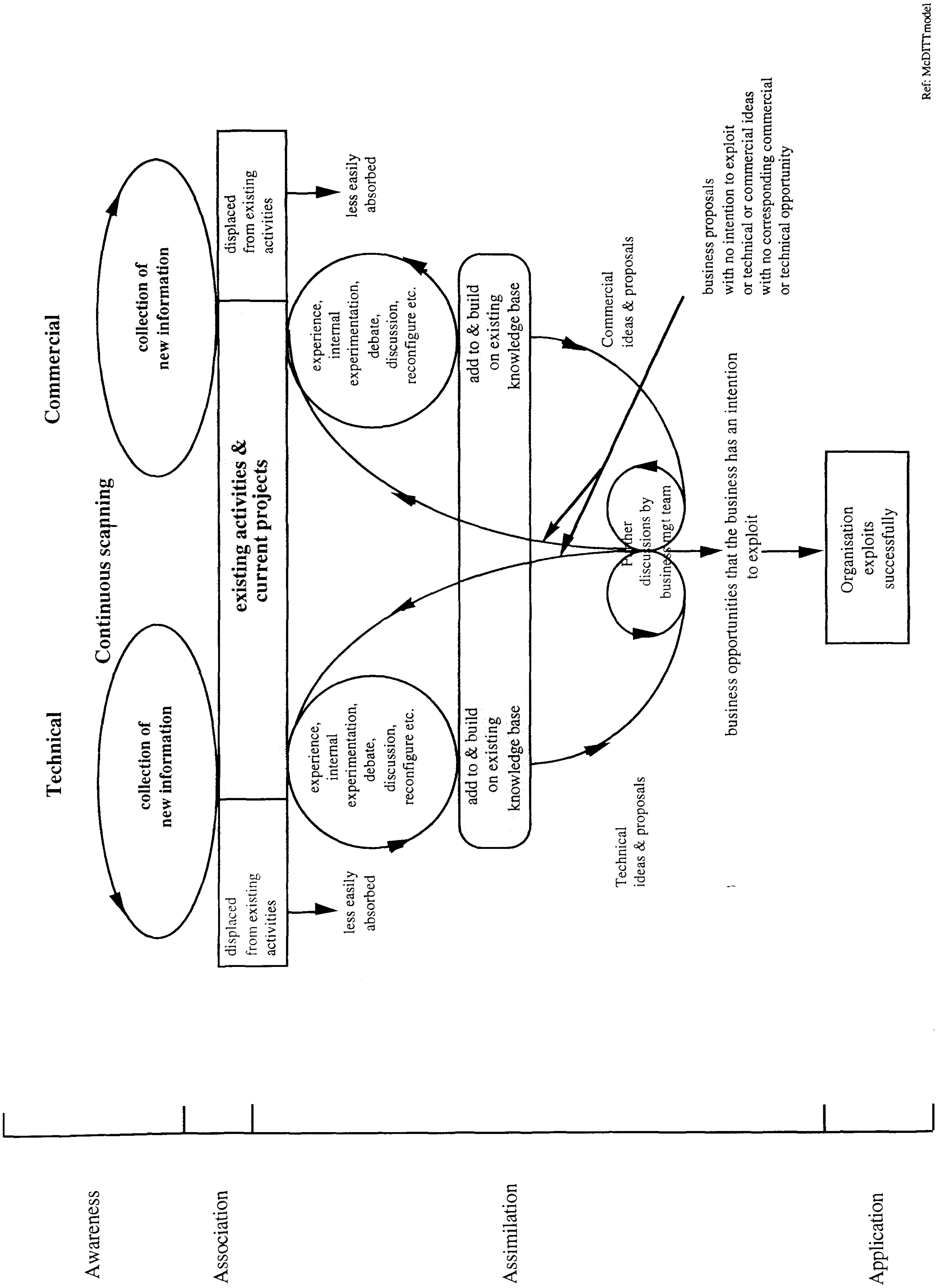
[1]The study of "Assimilation" within the Redsoap business is contained within Appendix G. This information will be used as a comparative reference point at the final analysis stage.

explanation. Also as the majority of the respondents were likely to be highly intelligent and thus become bored easily, so the methods needed to be interesting to them.

The previous section (8.1) suggested that the process of "assimilation" would appear to be made up of informal procedures and routines which are used subconsciously by the individuals within an organisation. These informal procedures and routines represent the shared understandings people have of a particular process, which are acquired through socialisation and the interaction of people within a collective. Cognition is defined as the mental act or process by which knowledge is acquired, including perception intuition and reasoning. If we wish to explore individuals' mental models of an organisation's "assimilation" process as they perceive and understand it, we have to access their own cognitive model which will have been acquired through experience of working within the organisation. Cognitive mapping is a technique that allows the participant to talk freely about an area (ramble) and where the emphasis is on spontaneous debate. It is an open style of interview/discussion where the interviewer encourages and prompts discussion. Moreover, it requires respondents to explore the ramifications of their situation. The investigator facilitates this by prompting the respondent with open questions, quizzical looks, etc. The interviewer does what the persistently curious child does and asks, 'Why?', or, 'What makes it like that?' Having recorded the answer, the researcher then persists, 'And why is that the way you describe ?' (see Eden et al., 1979).

Figure 8.1

PT's Proposed model of the complex inward technology transfer process



8.2.1 Aggregate cognitive maps

Langfield-Smith (1992) argues that in studying organisational processes while it is useful to examine individual belief systems, it is essential to examine also the extent to which these beliefs are shared by members within an organisation, and the subsequent strengths or weaknesses that this sharing lends to organisational functioning. Thus a study of this kind should include a number of people from the same organisation. In a study for the Agricultural and Food Research Council [AFRC] and the Economic and Social Research Council [ESRC], on the availability and take-up of technology in the agricultural industry, Brown (1992) found that cognitive mapping was a suitable method. The technique will maintain the richness and variety of qualitative data which is necessary if the factors that affect the process of "Assimilation" are to be uncovered.

The cognitive maps produced in this study will be aggregated at the end to produce a single cognitive map which will represent a summary of the process of "Assimilation" within one organisation.

8.2.2 Cognitive Mapping as a modelling technique

Before moving on to the analysis it is necessary to explain some of the important features of cognitive mapping and to review some of the relevant literature on the topic. Cropper, Eden and Ackerman (1990) describes cognitive mapping as a modelling technique which intends to portray ideas, beliefs, values and attitudes and their relationship to one another in a form which is amenable to study and analysis. In order to uncover an individual's mental map the researcher has to develop a good relationship with the client under study. This will help to ensure his client discusses openly and freely the area under study and will enable the client to access theories and perceptions which have been developed through experience.[2]

Essentially then cognitive mapping is a graphic technique which provides a visual language for setting down an individual's system of beliefs about a situation (Bryant, 1989). It is based upon Kelly's work on personal constructs. Kelly (1955, 1963) argues that individuals attempt to make sense of the world through a process of hypotheses building and testing. The hypotheses derive from the system of constructs an individual develops to make sense of his experience. Eden C, Ackerman F and Cropper (1992) notes:

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[2] Wittgenstein (1953) suggested that "the aspects of things that are more important for us are hidden because of their simplicity and familiarity".

'A personal construct system is the result of our past experience: the constructs and the anticipatory propositions we build with them will be supported or modified as a result of the testing against new experiences.'

Hence, cognitive mapping may be viewed as a practical development of the implications of Personal Construct Theory. However, Eden (1992) believes that the term cognitive mapping is often misleading for it implies that the map is a model of cognition (thinking). He argues that few mapping methods can reasonably make, let alone substantiate this claim. He suggests that 'cognitive maps should be viewed as a picture or visual aid in comprehending the mappers' understanding of particular, and selective, elements of the thoughts (rather than thinking) of an individual, group or organisation'. Eden C, Ackerman F and Cropper (1992) argue the technique is <u>flexible</u> and aims to capture and work with individuals' theories of their situation and ways of dealing with it. In the same vain, Ackerman et al (1991) suggest that models of an account will differ according to the interpretation of the data made by each individual user. They suggest that 'mapping is in this sense an inexact science, nevertheless it provides a powerful way of thinking about, representing and asking questions of an account.'

The term 'cognitive map' has been used to describe several forms of diagrammatic representation of an individual's cognitions. 'Causal maps' are one such form, and these are essentially networks, consisting of elements and directional (cause and effect) relationships between those elements. Within a causal cognitive map the beliefs that an individual has concerning a domain can be modelled as causal relationships Langfield-Smith (1992). The result is a network diagram (map) of expressed ideas and beliefs (nodes) which an individual has about a problem or situation. These nodes are linked by arrows to show a relationship of causality between the ideas and beliefs. The map is derived from a subject's account which is broken down into its elements to form the nodes of the network. Importantly, the resulting map can then be shared or discussed with others, as well as providing revealing insights in its own right. The technique works by applying the following disciplines (Ackerman et al, 1991).[3]

an account of a problem is broken down into its constitute elements— usually distinct phrases of 10-12 words which retain the language of the person providing the account. These are treated as distinct concepts which are then reconnected to

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3 Ackerman et al (1991) offers a detailed set of guide-lines to help new and existing users of the technique.

represent the account in a graphical format. This reveals the pattern of reasoning about a problem in a way that linear text cannot.

8.2.3 Cognitive Mapping: Reliability and validity

Brown (1992) argues that 'recording needs to be as close to verbatim as possible. This means using exact words and phrases, whether or not these are technically or grammatically correct and, even more importantly, recording links just as the respondent wished them, logical gaps and all'. Hence, the interviews were recorded onto tape.

Turning, now to validity. The data collected and produced from cognitive mapping was validated in two ways. Firstly, by returning the maps to the participants for comment. This served as a check that the map was a true and fair representation of their understanding of the process of "assimilation". None of the participants made any major changes to the maps redrawing neither part of or the whole map. Half of the participants altered one or two nodes and added or deleted a few arrows. The other half returned the maps unchanged with comments such as: "It is interesting to see the process displayed in this way" (Map 5; see Appendix F).

The second validity test involved presenting the maps to senior managers from each of the two organisations. In the case of the two ICI businesses, two senior managers with over sixty [sic] years of experience between them at various levels within ICI reviewed all twelve ICI maps. They immediately recognised the organisation and believed that the maps captured the activities and processes that exist within the organisation.

8.3 Development of the cognitive maps

The complete development of a cognitive map consisted of three stages: individual interview; construction of cognitive map; feedback from the participants on the constructed cognitive map. This procedure was used in the construction of all cognitive maps in this study. It is important to note that an elementary version of cognitive mapping was used in this study.

8.3.1 Individual interview

The purpose of this interview was to allow the participant to talk about the internal assimilation of ideas with minimal direction from the researcher. The interview, which would more accurately be described as a discussion, consisted of ten open questions (see Figure 8.2). These were designed to encourage the participant to talk about and describe how technical and commercial ideas are transformed into genuine business opportunities; hence question 1. This area was explored in further detail by focusing on the internal factors that affect the transfer of knowledge and ideas, hence questions: 2,3,5,7,8. They were also encouraged to talk about the internal issues that affect acceptance of technical or commercial ideas, hence questions 4 and 6. In addition question 9 invites participants to talk through a recent example of knowledge transfer. Finally, question 10 checks whether the participant's responses can be applied generally across other transfer processes, or whether there are some unique incidents that require special attention.

The time of the interviews varied between one and one and a half hours. Each interview was recorded onto audio cassette and in addition notes were transcribed during the discussion. The interview was designed to encourage participants to talk widely, even to ramble, about the issues involved in the process. The complete interview schedule is shown below in Figure 8.2.

Questions used for interview

Figure 8.2

1. What is your overall perception of how technical and or commercial ideas are transformed into genuine business opportunities and or proposals.
(Responses to be followed up in a critical incident way; checking on constructs used where appropriate.)

2. What is your overall perception of how knowledge and ideas are transferred between people and across departments within the organisation?
(Check constructs used.)

3. From what has just been said, what in your view facilitates transfer of ideas and knowledge more than anything else?
(Check constructs used.)

4. What facilitates acceptance of ideas and knowledge more than anything else?
(Check constructs used.)

5. What in your view hinders transfer of knowledge and ideas more than anything else?
(Check constructs used.)

6. What in your view hinders acceptance/assimilation of ideas and knowledge more than anything else?
(Check constructs used.)

7. Can you recognise any weaknesses in the transfer process that we have been discussing?
(Check constructs used.)

8. Can you recognise any strengths?
(Check constructs used.)

9. Will you talk me through the process of a particular transfer of knowledge or idea. It may help to focus on one particular incident that you are familiar with.
(Check constructs used.)

10. Can the principles of what you have described be applied generally across other transfer processes, or are there some unique incidents that require special attention?
(Follow up particular incidents.)

8.3.2 Construction of cognitive maps

With regards to construction of the maps from the recorded data, Brown (1992) found that manual mapping on large sheets of paper gave better data than direct entry to the software. Hence, the boundaries of the process under investigation were placed onto a large 6ft x 3ft "wipe-board". These boundaries are defined as "generation of technical or commercial idea" and "generation of genuine business opportunity". This loose framework was used for each construction. The salient points, which had been transcribed during the interview, provided the "skeleton" shape for each map, into which "colour" and "texture" could be added later. The richness (details) for each map came from careful listening and analysis of the audio cassettes. The recording of the interview enabled the researcher to capture and place all elements of the discussion onto the large "wipe-board". The result was a detailed picture of the interview. This was transfered verbatim onto a computer software drawing package, 'Claris Draw' and assembled in the form of a cognitive map. See Figure 8.5-8.13 for details of all constructed cognitive maps. The time taken to produce the final cognitive map, that is from audio cassette to computer print-out was 6-8 hours. This is line with the findings from Lemon (1992) who suggests that one hour of audio tape represents six hours of transcript.

8.3.3 Feedback on cognitive maps produced

The fully constructed cognitive map was returned to the participant with a pre-paid, addressed envelope. The participant was asked to analyse the cognitive map and firstly, verify that it was a true and fair representation of the interview. Secondly, they were asked to make any alterations that they thought necessary including the addition of any other details that were part of the "assimilation" process.

It is worthy of note that all the maps were returned within a few days of receipt. Further evidence of support that the technique was easily understood and "user friendly". The amount of modification was limited.

8.3.4 Aggregation of cognitive maps

The method used for aggregation will essentially involve identifying the common themes from each map. However, these common themes will be divided into core and non-core themes. This will be based on the number of times a node is accessed, either input or output. Having established both the core and non-core common themes these will be reassembled using the same criteria as was used initially to identify the core and non-core themes. This procedure is explained in greater detail in Section Five.

8.3.5 The assimilation process as seen from one senior manager within ICI

Prior to the studies within ICI and Redsoap the researcher conducted a preliminary experiment (which took the form of a pilot study) of the research method selected. This was necessary to check that: [a] the modelling method chosen would uncover the processes involved in the area under study; [b] that the data collected would be in a usable form; [c] that the technique would meet all the necessary organisational requirements mentioned in 8.2. The output from this initial study was to be in the form of a model showing the key elements in the process and was to provide a framework for future analysis of the ICI and Redsoap businesses. This model is shown in Figure 8.3.

The aim was to access the mental map of a senior manager from within ICI and to produce a rational and well understood model of how technical and commercial ideas are transformed into genuine business opportunities (assimilation). To ensure the model elicited was an accurate representation, feedback from the respondent was to be sought. This would serve as a validation procedure for both the model and the research technique. In this particular case the senior manager selected was known to the author and had worked with the author on the research project. Thus, in order to ensure objectivity an independent observer was required to conduct the interview. An intermediary consultant was used to administer the technique. The use of an independent intermediary also provided an additional method of validation.

The intermediary selected for this activity was Dr M Craig, an experienced consultant with many years training in the field of interviewing and interviewing skills. He is also a senior tutor at the Open University in the area of Systems Methodology, and is familiar with the technique of cognitive mapping. Before the interview/meeting could take place two detailed briefing sessions were arranged to inform Dr Craig of the objectives of the research, the objectives of the interview and the broad form of data required in order that the researcher could model the assimilation process. This was necessary because while there are a number of advantages in using an intermediary, it also presents a different set of problems. For example, it is necessary to ensure that:

a) the intermediary and the participant are focussing on the same issue. Hence, the intermediary needs to be objectively informed of the specific area under analysis without revealing the researcher's own beliefs and hypothesis about the area.

b) the vocabulary used needs to checked to ensure interpretation and semantics are understood. For example, the terms "innovation" and "culture" can have very different definitions; especially within an organisational setting. Constructs used have to be checked.

c) level of analysis needs to be specified, to ensure the level of inward technology transfer received is consistent with that of the interviewer's view.

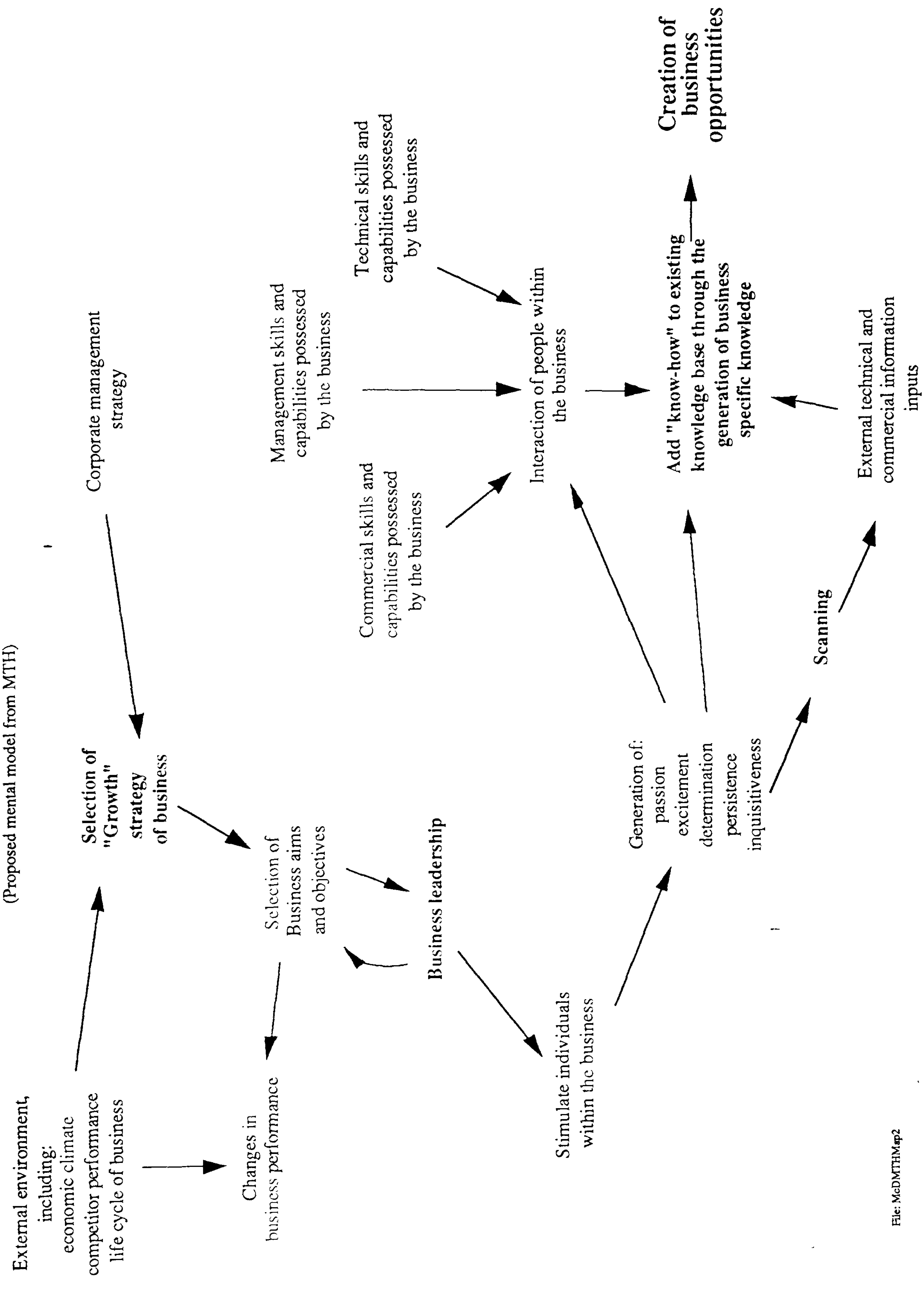
d) prior statement from the interviewer to establish the boundaries of the discussion ie up to commitment to exploit.

8.3.6 Analysis of pilot cognitive map

This map, shown in Figure 8.3, emphasises the important influence of the external operating environment. Influences that have been highlighted concern strategic decision making and business leadership. This view reflects the corporate role played by the individual who operates at a senior management level and is probably frequently dealing with policy issues. Evidence of this is further provided by the lack of detail concerning the internal organisational activities involved in the "Assimilation" process. Despite this several important influences are mentioned. The generation of a positive internal environment is stressed with particular reference to "passion" and excitement. Furthermore the existence of a competent knowledge base of commercial, technical and managerial capabilities is also stressed. Indeed it is the interaction of people within the business who possess these capabilities that will lead to the creation of business opportunities.

Figure 8.3

Causal map of the inward technology transfer process.
(Proposed mental model from MTH)



8.4 Presentation of results from study within two ICI businesses

A series of eight interviews were conducted within two different businesses, the details of the participants are listed below in Figure 8.4:

Figure 8.4

Number	Business	Participant	Age	Time with: particular business & organisation in general
1	ICI Watercare	New Product Dev. Mgr	32	2yrs & 8 yrs
2	ICI Watercare	Business Manager	42	3yrs & 20 yrs
3	ICI Watercare	New Product Dev. Mgr	45	2yrs & 20 yrs
4	ICI Watercare	Research Scientist	26	2yrs & 2yrs
5	ICI Solvents	Marketing Manager	50	30 yrs & 30 yrs
5	ICI Solvents	Product Mgr	31	5yrs & 5yrs
7	ICI Solvents	New Business Dev. Mgr	44	10yrs & 15yrs
8	ICI Solvents	Sales Mgr	45	25 yrs & 25 yrs
9	ICI C&P (pilot)	New Business Dev. Mgr.	50	30 yrs

8.4.1 Selection of participants

A senior Manager at ICI selected two samples of people representative of the population within the two businesses. From each of these samples the researcher selected four participants.

8.4.2 Analysis of individual maps

This section will present all the cognitive maps and briefly discuss the content of each, providing where necessary useful background information concerning the participant's role.

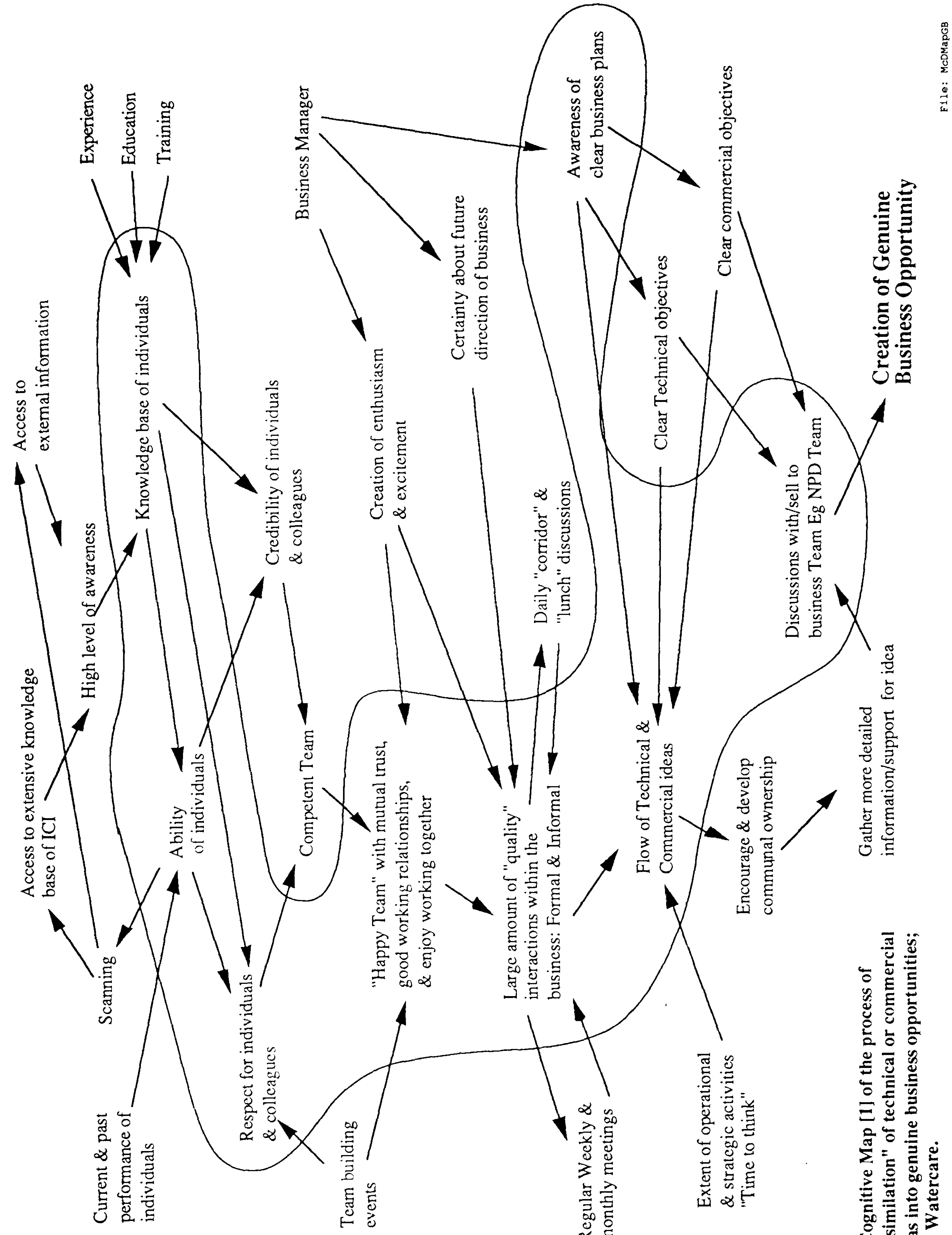
8.4.2.1 Participant No 1: New Product Development Manager, ICI Watercare

The subject whose data are shown in Figure 8.5 is one of two New Product Development Managers within ICI Watercare. Formerly a PhD research chemist in the Research &Technology department, he has spent the last five years fulfilling a mainly commercial role within various ICI businesses before joining Watercare two years ago. With substantial technical training and several years of experience in marketing he is able to fulfil a "techno-commercial" role. This map contains 28 nodes or influences. It offers a detailed insight into the many internal organisational influences on the assimilation process. The importance of a good working environment is emphasised as is the importance of interaction, both formal and informal. However, this interaction is far from random; the map shows the importance placed on the knowledge base, respect and credibility of colleagues within the organisation. The role of the Business manager is recognised as significant and this role is shown to impact upon the awareness of clear business plans and the internal operating environment.

8 4.2.2 Participant No 2— Business Manager, ICI Watercare

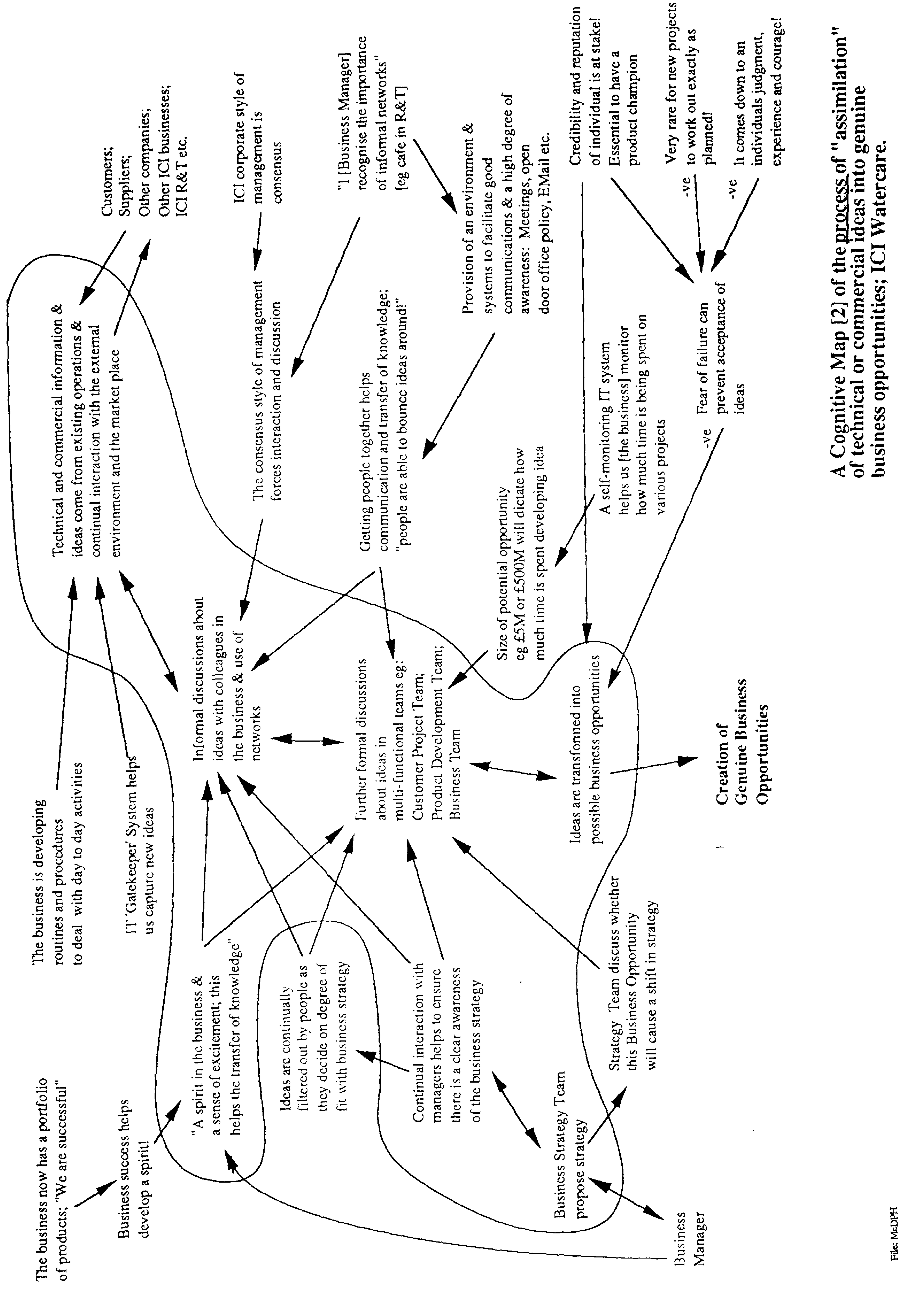
The subject whose data are shown in Figure 8.6 is the Business Manager of ICI Watercare. This individual has fought hard to promote the cause of the Watercare business within ICI in general and within ICI Chemicals and Polymers in particular. He has substantial commercial training and experience within a variety of functions within other ICI businesses. This map shows 27 nodes many of which concern the business and how and why it performs various activities, for example: "The business now has ..."; "The business is ..."; "The strategy team ...". This may be indicative of a manager who has responsibility for the business. The influence of existing technical and commercial operations are identified as generating information and ideas. In addition, the importance of a "spirit" within the business is again stressed as is the importance of informal and formal interaction. Particular emphasis is placed on the decision-making procedure at the individual level. Indeed several individual characteristics are cited as influential: credibility and reputation of individual; individual judgement experience and courage of individual.

Figure 8.5 Cognitive map [1]



A Cognitive Map [1] of the process of "assimilation" of technical or commercial ideas into genuine business opportunities; ICI Watercare.

Figure 8.6 Cognitive map [2]



8.4.2.3 Participant No 3—New Product Development Manager, ICI Watercare

The subject whose data are shown in Figure 8.7 is the second of the New Product Development Managers in ICI Watercare. This individual also started his career at ICI as a research chemist within the Research and Technology department. This was followed with several years experience in product management. Hence he is also able to fulfil a "techno-commercial" role. The need for diversity of knowledge is emphasised in this model with numerous sources of information detailed; including colleagues within the business whose knowledge base, it is suggested, can be accessed by "walking around" and interacting. Once again informal and formal discussions are highlighted as necessary for developing ideas and the importance of "enthusiasm in the business" is also underlined. Understanding the strategy of the business is cited as influential in filtering ideas and generating a range of options and opportunities.

8.4.2.4 Participant No 4—Research Scientist, ICI Watercare

The data shown in Figure 8.8 represents a research scientist from ICI Watercare. The message that is stressed within this map is the importance of interaction. Of the 24 nodes, over half deal with issues of communication: "regular discussions with colleagues ..."; "meetings help ensure we all understand ..."; "Honest and open communications help develop good relations ...".This may reflect the individual's role as a research scientist who may spend large amounts of time working alone in the laboratory and for whom interactions may be viewed as particularly valuable. However as is stressed in the map, this interaction must be coupled with "mutual respect and credibility of colleagues".

Figure 8.7 Cognitive map [3]

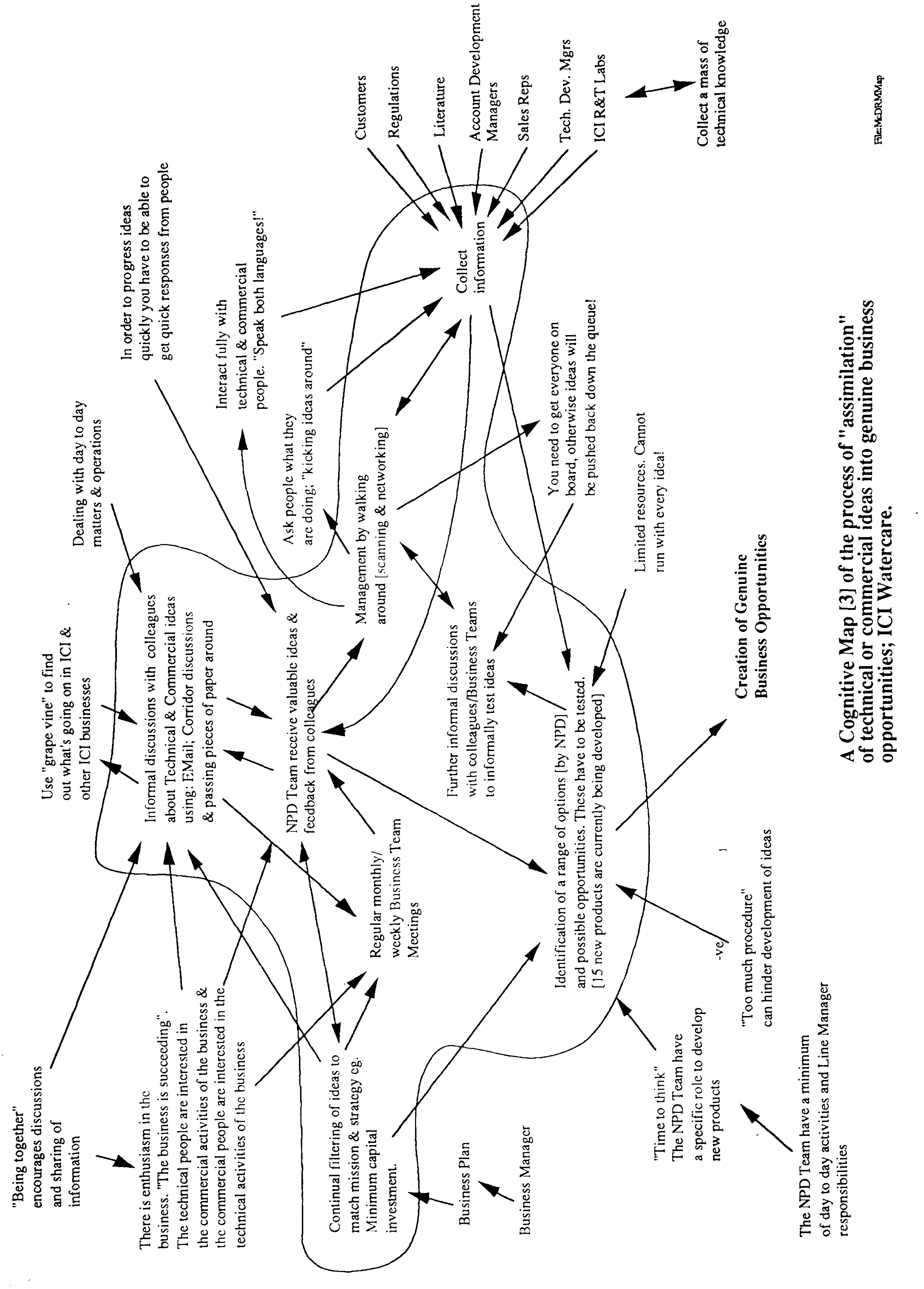
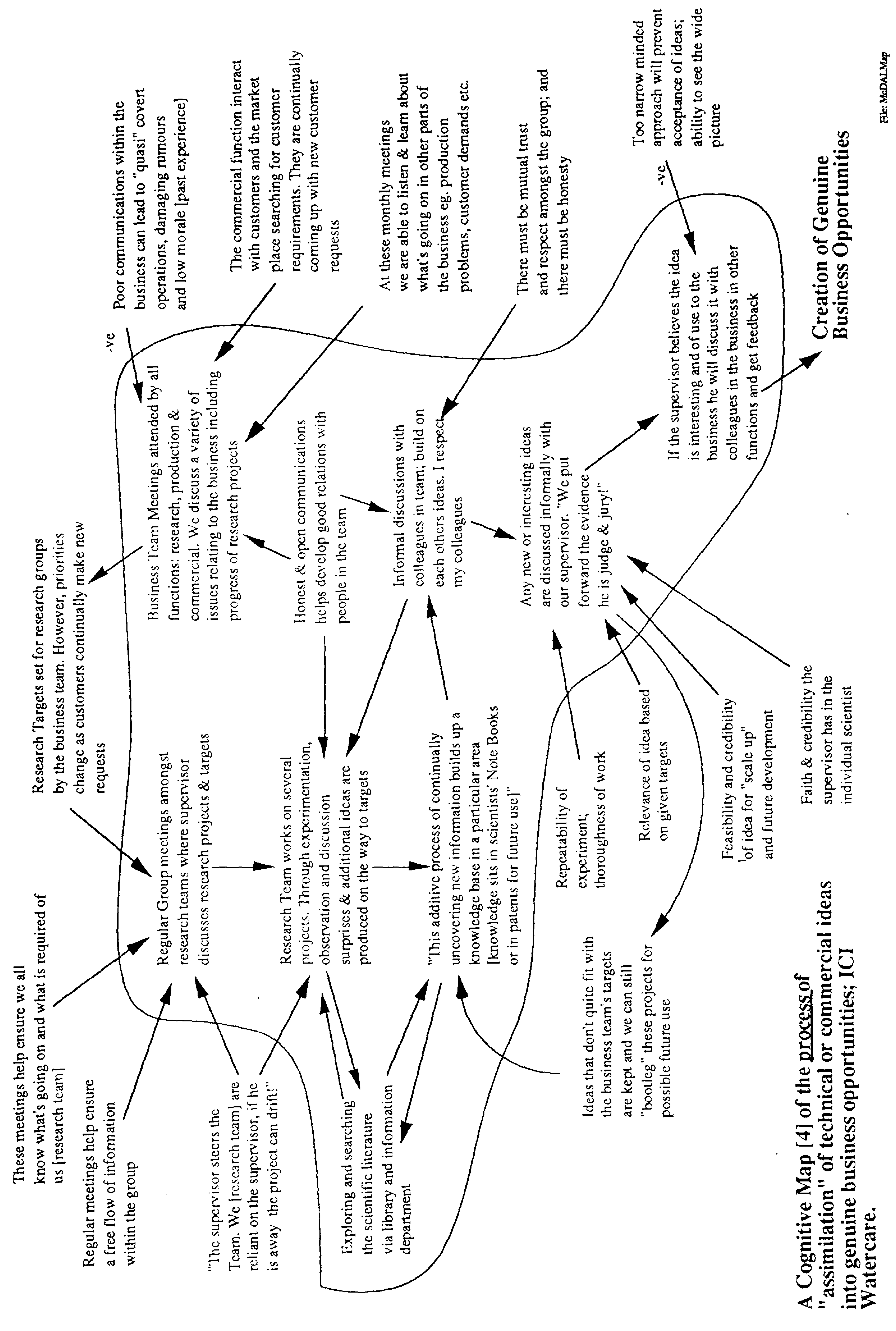


Figure 8.8 Cognitive map [4]



8.4.2.5 Participant No 5—Marketing Manager, ICI Solvents

The data contained in Figure 8.9 represents the Marketing Manager of ICI Solvents. Unlike the cognitive map of the research scientist, this map stresses the external operating business environment and corporate decision making within ICI. This clearly reflects this manager's concerns as he is involved in setting and planning a strategy for the business. This particular manager has been with ICI for over thirty years and has fulfilled a variety of roles within research and the commercial sections. His knowledge of the past is revealed through examples of how things are now different and how things have changed. For example: "In the past R&T projects were not well defined ..." and "R&T is now more focussed ...". As with all the previous maps a number of common themes are present. The importance of meetings and informal discussions is identified, as is an awareness of the business's plans: "Awareness of a clear way forward". The mutual respect for colleagues is also refered to: "A lot of ideas come from discussions; we rely on our colleagues". The operating environment is also mentioned as influencing the creation of genuine business opportunities. In addition this manager recognises the constraints that this business has to manage. He discusses the issue of the management of existing plants and explains how, to a large extent, the operation of these multimillion pound chemical plants can confine strategic decision making.

8.4.2.6 Participant No 6—Product Manager, ICI Solvents

Figure 8.10 shows the data collected from a Product Manager from ICI Solvents. This individual operates within a commercial environment and has a commercial background. He has only been with ICI for 4 years but there is no clear evidence within the map that reveals this fact. Consistent with the previous map the asset-intensive nature of the business is highlighted. Additional emphasis is directed at the value of colleagues within ICI. He states the importance of "testing ideas out on other people in ICI and other businesses in ICI. People here are very knowledgeable, there is always an expert somewhere in ICI". There can be few organisations who are able to offer such a diversity of business interests, and therefore, access to such a diverse knowledge base.

Figure 8.9 Cognitive map [5]

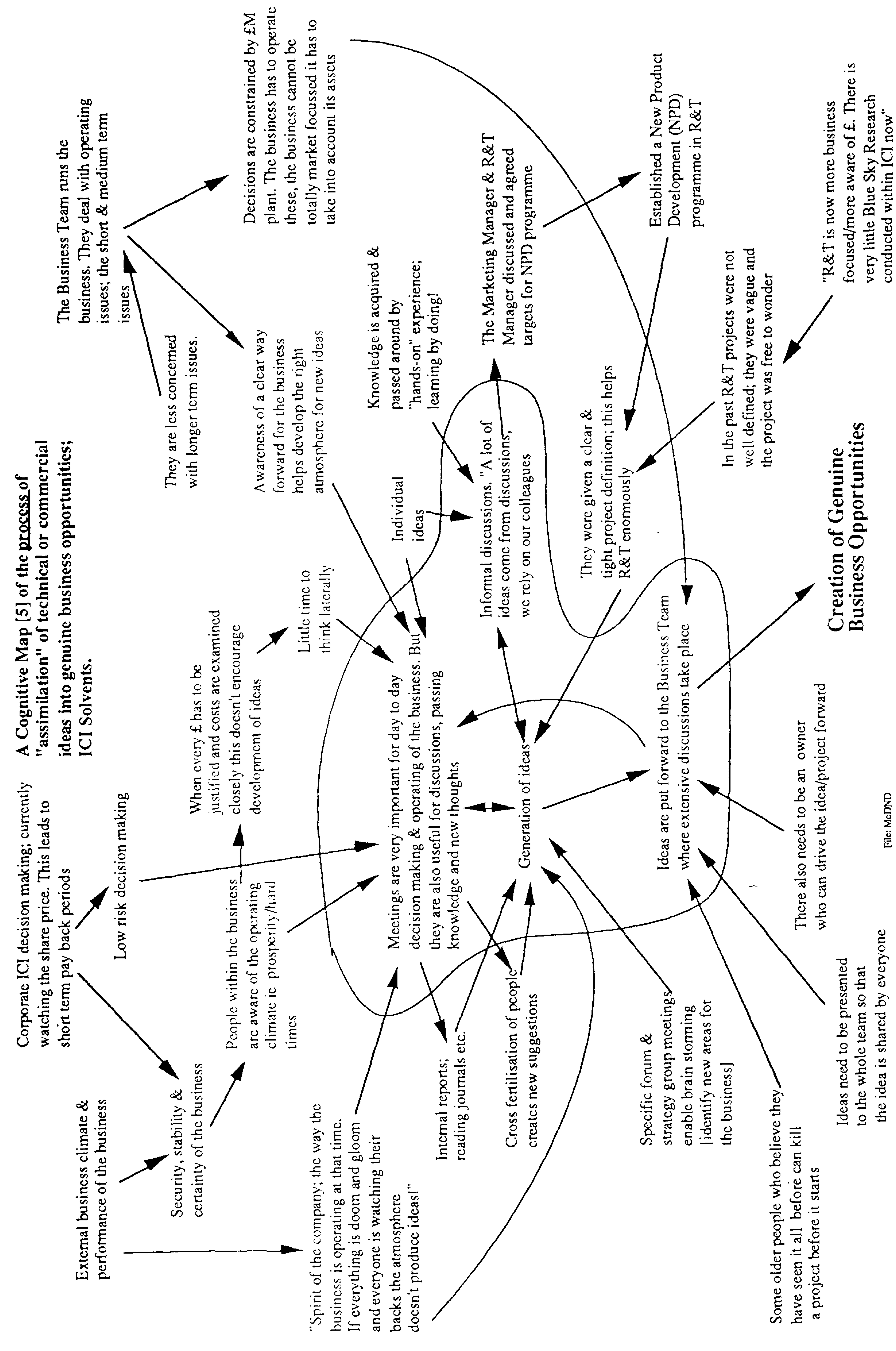
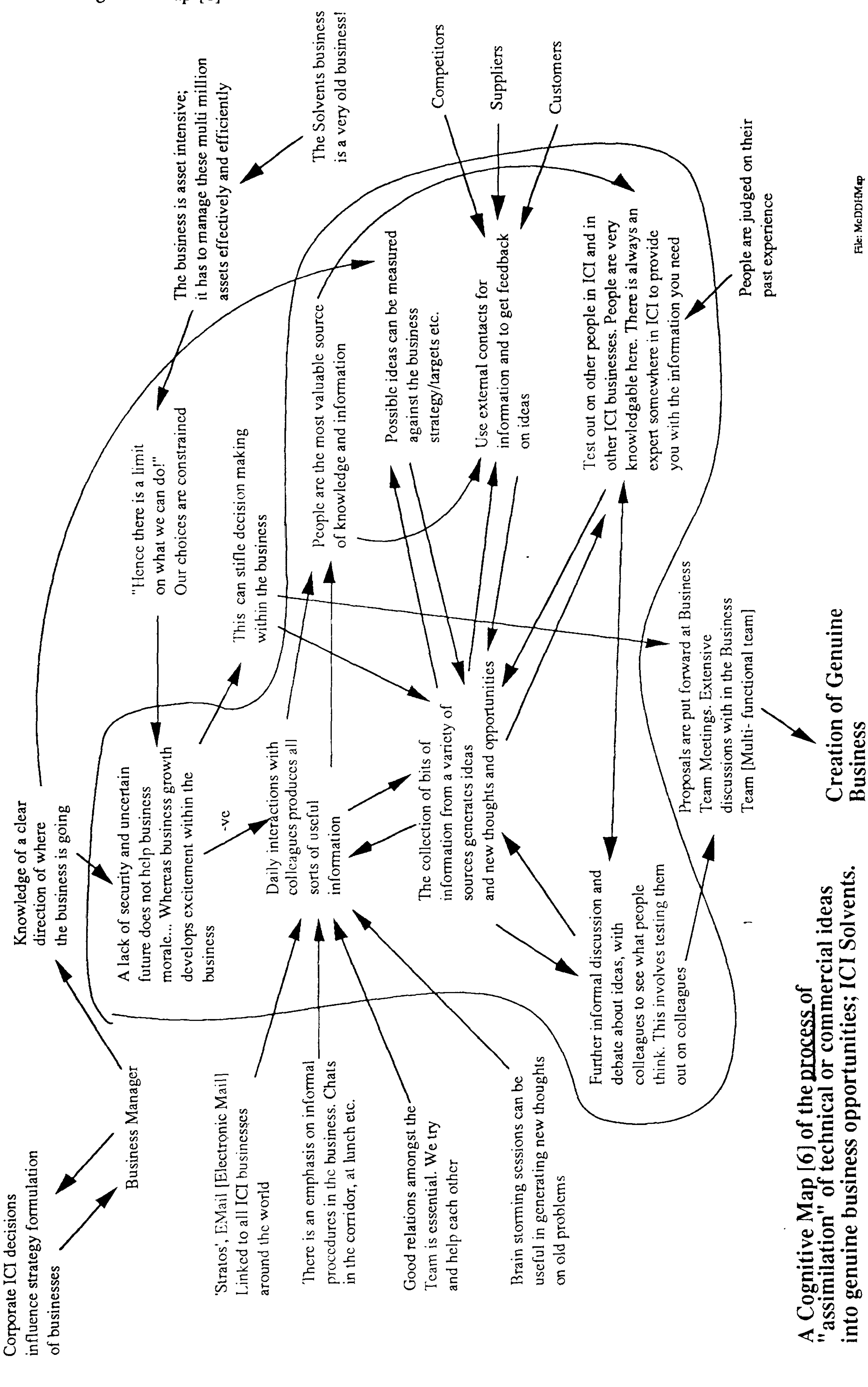


Figure 8.10 Cognitive map [6]



8.4.2.7 Participant No 7—Business Development Manager, ICI Solvents

The subject whose data are shown in Figure 8.11 is the Business Development Manager for ICI Solvents. This individual also began his career as a research scientist but not with ICI. This fact is worthy of note as the vast majority of those interviewed have only worked for ICI. However the map in Figure 8.11 does not show any idiosyncrasy. This may reflect that his last five years have been spent with ICI. What appears to be stressed in this map is the importance of both technical and commercial knowledge. For example "obtaining feedback from the technical and sales representatives" facilitates "understanding of customer needs "helping the "development of R&T projects". The credibility and respect of colleagues are once again seen to be important factors in deciding which sources generate "valuable information". This clearly is an important input into the creation of technical and commercial opportunities.

A range of common themes are now beginning to emerge from the maps. Hence it would appear that each person construes the world in which they operate and the important influences on the process of "Assimilation" in the same way as one another. In particular an awareness of the business strategy; regular formal and informal interactions; respect and credibility for colleagues; the external business operating climate; and enthusiasm within the business have all emerged from the richness of the subjective world of each individual.

8.2.4.8 Participant No 8—Sales Manager, ICI Solvents

The data contained in Figure 8.12 represents the Sales Manager, ICI Solvents. This map portrays many similarities with the previous seven maps, with many common themes present such as: formal interactions; the role of the business manager; a clear business strategy; and a positive internal environment. However, there is a distinguishing feature in this map: the role of this individual is entirely commercially orientated, reflected in the absence of any mention of the technical functions or technical information. Yet there is substantial reference to generating new ideas and discussing these thoughts with colleagues "to test the idea". This supports the findings of Phase Two of the research that suggested that there was a lack of technical information inputs into the Solvents business leading to the development of commercially orientated business opportunities.

Figure 8.11 Cognitive map [7]

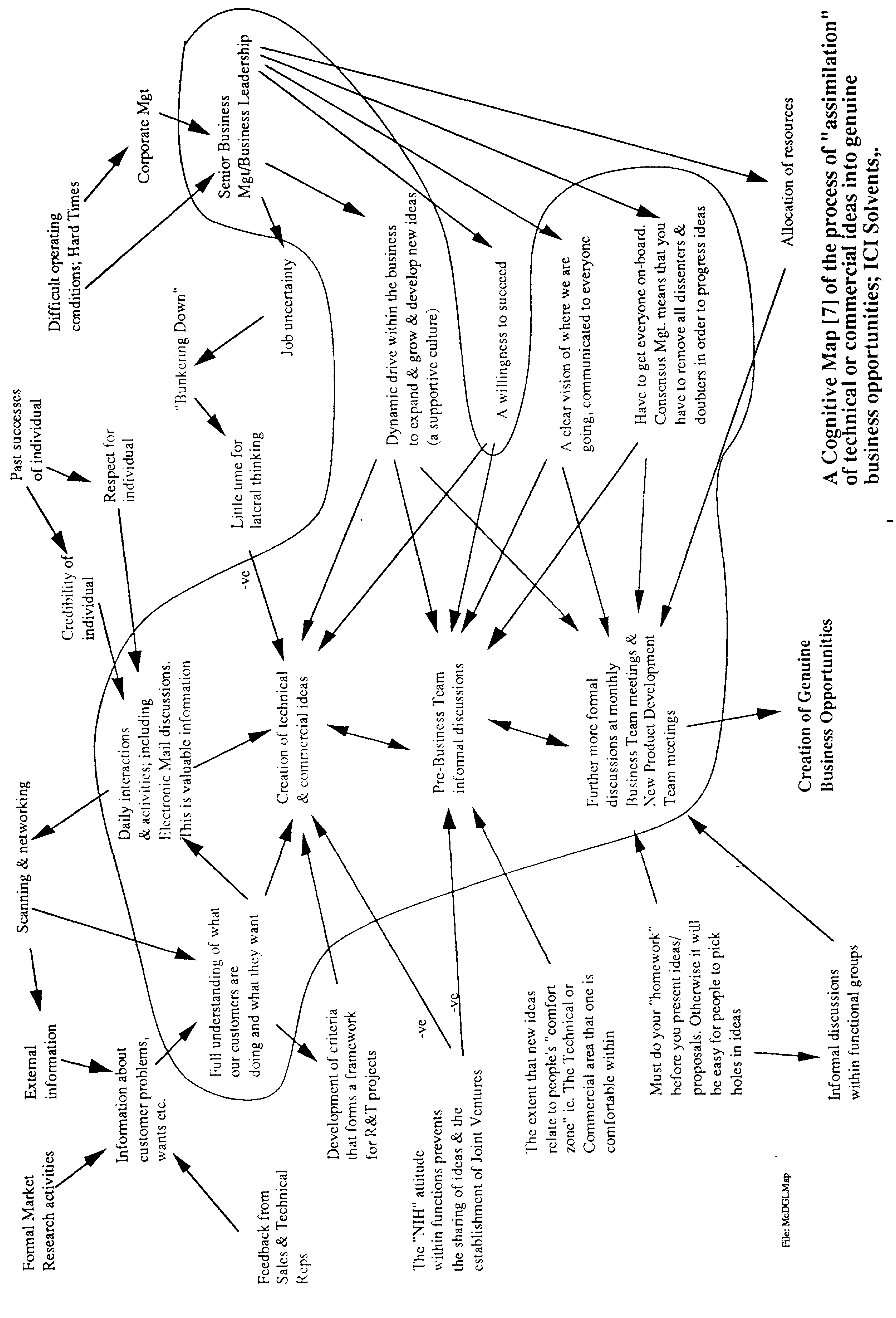
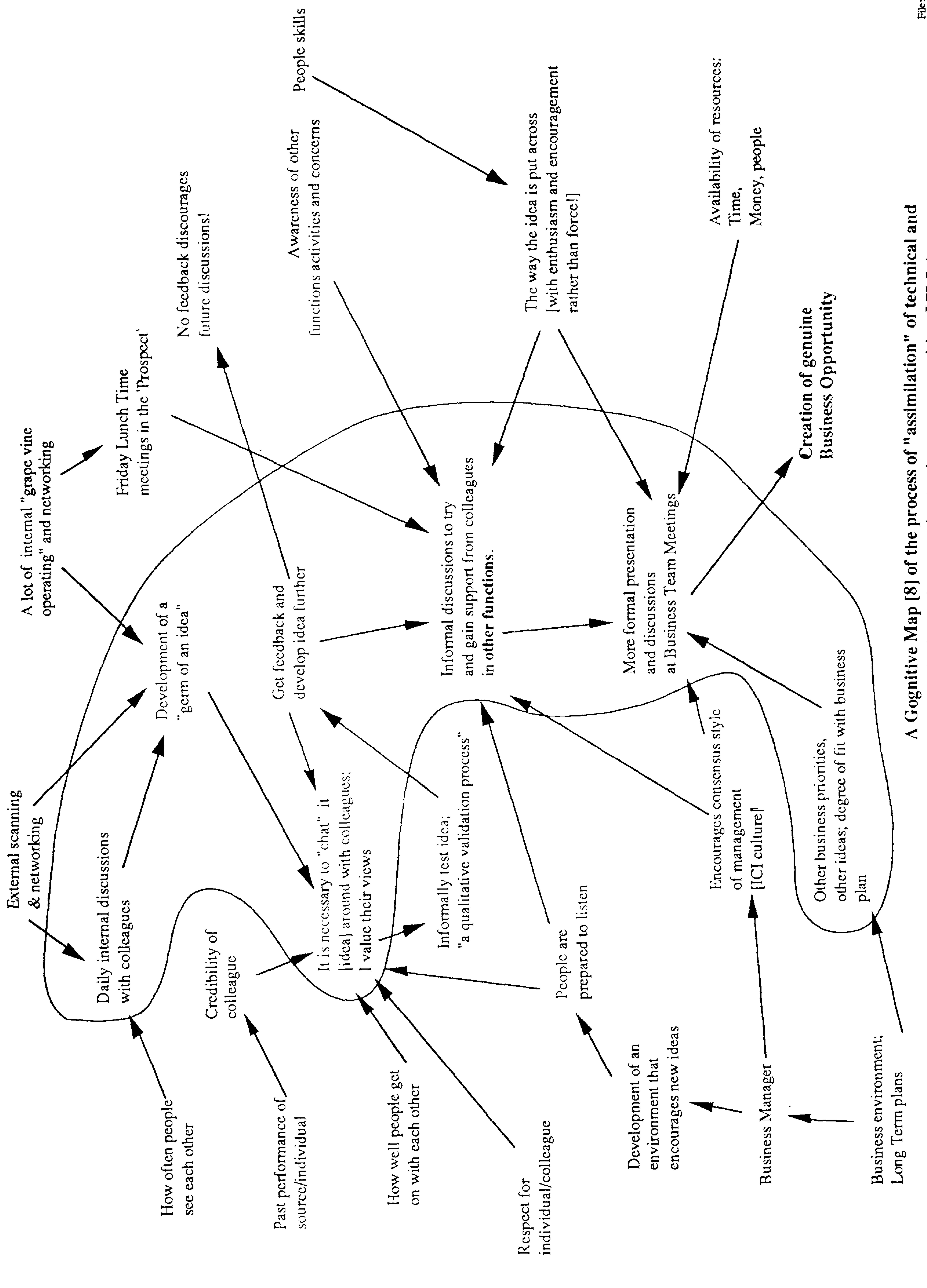


Figure 8.12 Cognitive map [8]



A Gognitive Map [8] of the process of "assimilation" of technical and commercial ideas into genuine business opportunities; ICI Solvents.

8.5 Preliminary analysis of Cognitive maps

The output from each interview was a cognitive map which represented the unique way in which each of the individuals viewed the important features of the "Assimilation" process. Each map consisted of elements expressed in the individual's own language, with causal linkages between those elements. All eight cognitive maps are shown in Figures 8.5-8.12. In addition the maps from the Redsoap business are contained in Appendix G.

Each of the cognitive maps contained between 24 and 30 nodes. Of these, some nodes were "sources" and some were "sinks", that is, some nodes only produced an output and some nodes only received an input. A node had a minimum number of one and had a maximum of ten inputs/outputs. Each map contained a number of nodes that were far more highly interconnected, ie a large number of inputs/outputs, than other nodes on the map. Figure 8.4 shows a breakdown of the total number of nodes and the number of highly interconnected nodes on each map. It would appear that nodes that are highly interconnected would be far more influential in the assimilation process than nodes that provided one source. Thus, drawing a boundary around the highly interconnected items may help to reveal the <u>core</u> activities in the assimilation process. This raises a further question regarding the point at which a node is defined as highly interconnected (that is 3, 4 or 5 inputs/outputs). This will clearly influence the size of the boundary on every map. Needless to say the objective is to capture a clear 'signal' without too much unnecessary 'noise'.

<u>8.5.1 Sensitivity Analysis</u>

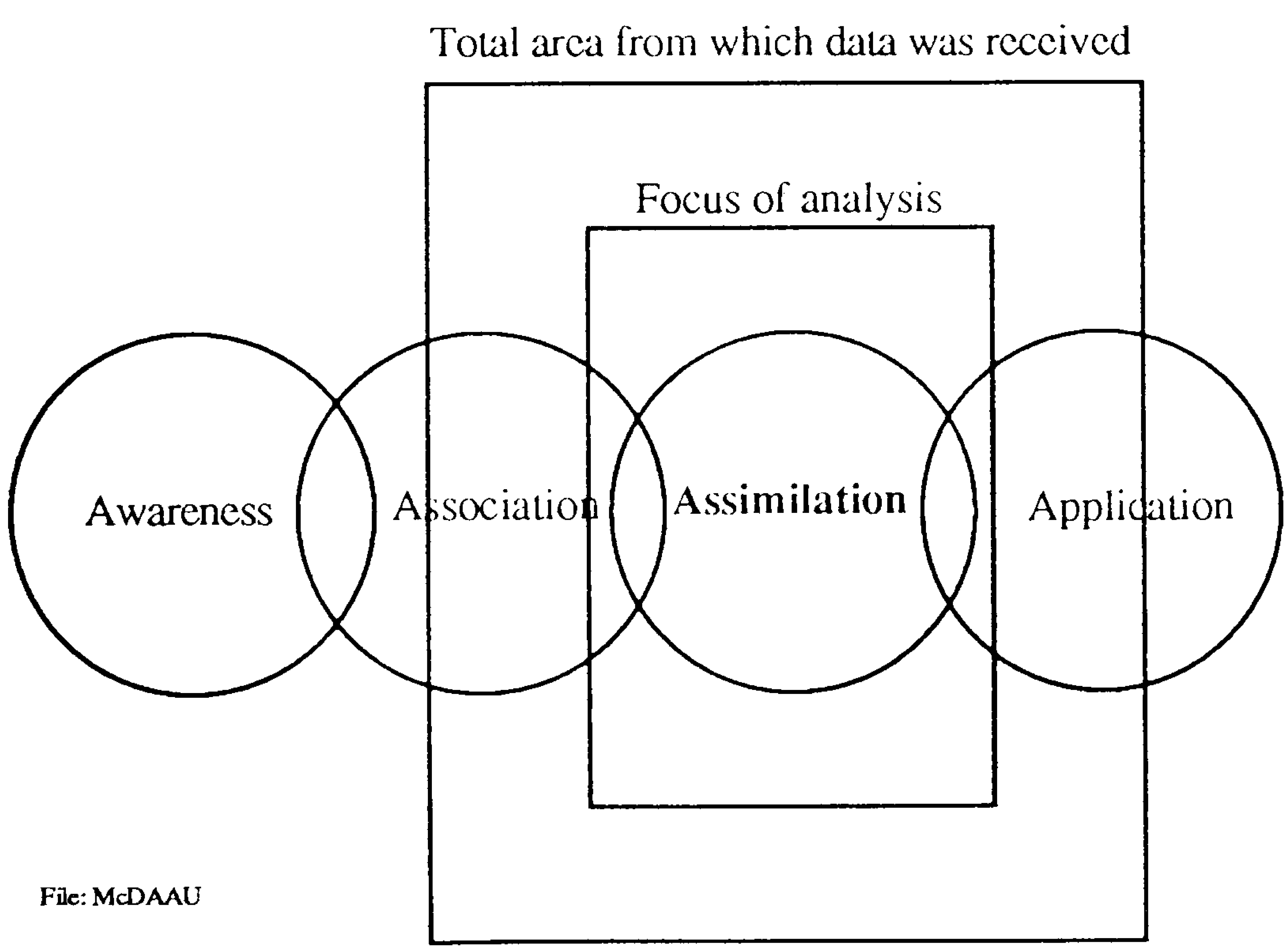
Figure 8.13

Map No	Total No of Nodes	No of nodes accessed ≥2	No of nodes accessed ≥3	No of nodes accessed ≥4	No of nodes accessed ≥5	No of nodes accessed ≥6
1	28	21	12	8	3	2
2	27	19	10	7	6	2
3	31	17	10	8	6	6
4	24	12	9	9	5	2
5	30	21	9	4	4	3
6	24	15	12	8	3	2
7	30	26	11	9	6	4
8	27	19	10	7	5	4
9	16	9	7	3	3	2

8.5.2 Bounding the core activities of the process of assimilation

It appears that during the interview some of the participants discussed activities and processes regarding earlier stages of the Inward Technology Transfer (ITT) process, for example many of the maps refer to scanning and networking as a source for ideas. Similarly the maps contain influences that refer to later stages in the ITT process, that is, "application" of the Technology/Knowledge. For example, map 2 refers to '... whether the business opportunity will cause a shift in strategy'. While this is relevant to the overall process of ITT the business opportunity has already been created and thus this issue is mainly concerned with the application of the technology. Hence, the maps actually capture a wider view of the "assimilation" process and in fact contain parts of the complete four stage model of ITT. Figure 8.14 shows how the cognitive maps contain other parts of the Inward technology Transfer model.

Figure 8.14



Bearing the above diagram in mind it seems that it may be possible to draw a boundary around the core activities of the area under investigation. This begs the question: Where should the boundary be drawn?

The table contained in Figure 8.14 represents a sensitivity analysis. At one end is the total number of nodes on each map. At the other end are the total number of nodes with 6 or more inputs/outputs. The selection of "≥6" as a boundary is clearly too coarse a filter as this would produce only two nodes in six of the twelve maps. In a similar way the selection of "≥2" as a boundary would produce six maps with around twenty nodes. Clearly the ideal boundary lies somewhere in between.

A highly interconnected node was defined as a node that has 4 or more inputs and or outputs. These highly interconnected noded items represent between 50% and 70% of the total number of influences on each map (see Figure 8.13). Influences here are represented by the arrows on the maps. The number of highly interconnected nodes on each map varied from 3 to 10. If a boundary is drawn around these nodes this area is defined as representing the core influences within the process of "Assimilation". The cognitive maps shown in Figures 8.5-8.12 show a boundary which contains the core activities of "Assimilation".

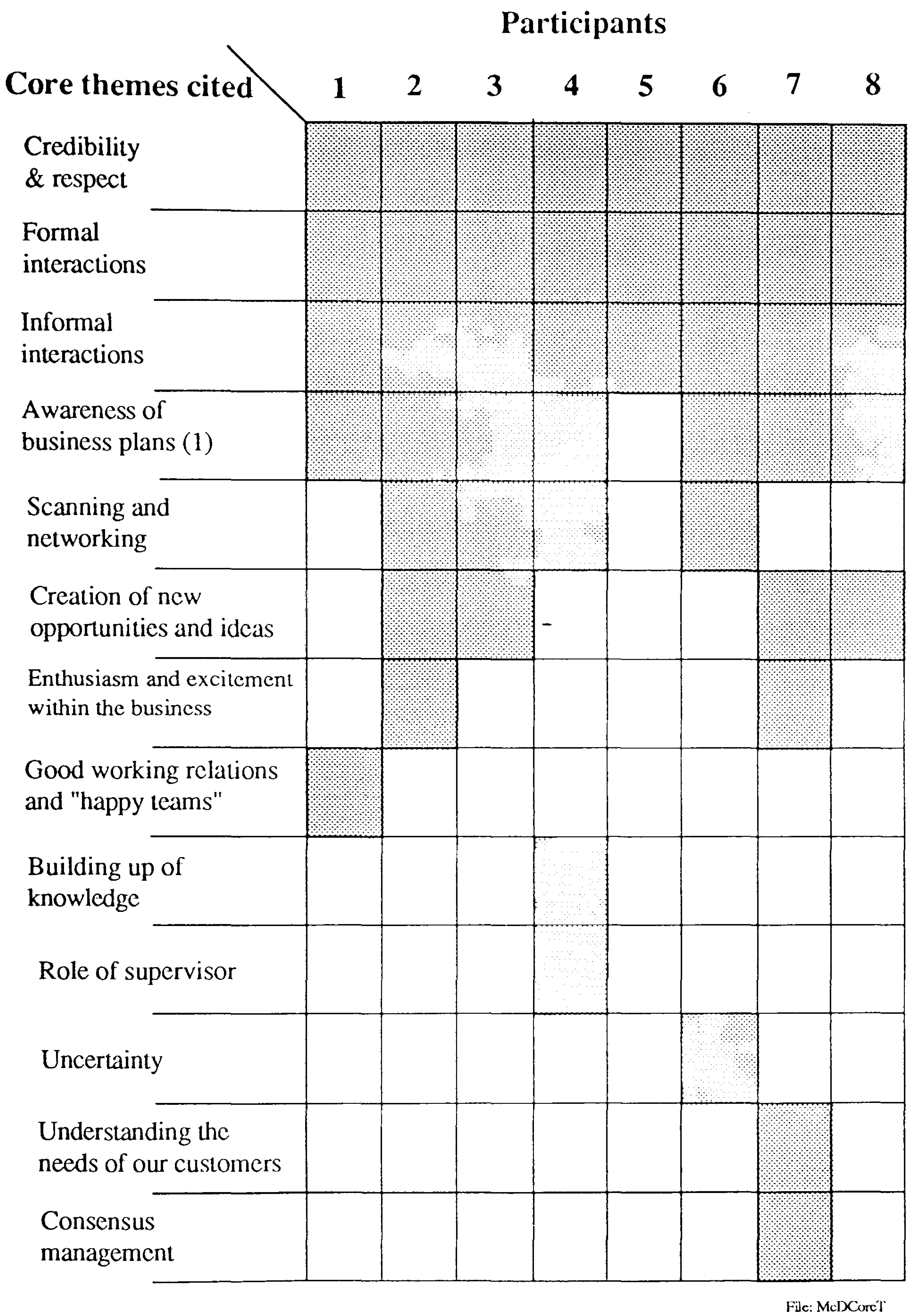
8.5.3 Core activities of the "Assimilation" process

A comparison of all the bounded influences from each map reveals extensive similarity regarding common activities. This can be clearly seen in Figure 8.15 which shows the all the core themes identified by the participants, and the four activities which are common to each map. The characteristics of the activities within these boundaries can be defined as: mutual respect for and a recognition that colleagues are a source of a wealth of knowledge. This leads to extensive quality interactions between people within the business underpined by a clear understanding of the main aims of the business and the future direction of the business. Hence, the core activities of assimilation are:

- recognition that colleagues are a source of a wealth of knowledge;
- extensive internal informal discussions with colleagues;
- regular informal discussions with colleagues from other functions but within the same business team;
- regular, more formal, discussions within meetings with business teams that represent a variety of business functions;
- a clear vision of the future direction of the business communicated to everyone.

Figure 8.15

The distribution of common core-themes



Note (1): Participant number 5 identified awareness of business plans but this was outside the core boundary.

8.5.4 Non-core themes facilitating the "Assimilation" process

Outside of the boundaries a comparison of all the non-bounded influences within each map also reveals a number of common themes. Whereas the core-themes represented the main components of the "Assimilation" process, these additional factors appear to facilitate the process. These are shown in Figure 8.16.

8.5.5 Aggregation of the cognitive maps

The cognitive map in Figure 8.17 represents an aggregation of all eight ICI cognitive maps. Each node is taken from one of the eight individual cognitive maps. This represents a summary of all the eight maps and highlights the common themes. The "core activities" are shown bounded and one can clearly see that the emphasis within this boundary is on prior knowledge and credibility and respect for colleagues coupled with interaction and the exchange of information in both a formal and informal environment. The four influences outside the bounded nodes represent the common factors that facilitate the assimilation process.

The next section will analyse the findings presented here in more detail and draw a number of conclusions concerning the "Assimilation" process.

Figure 8.16

Common non-core themes—ICI Maps

	External business operating climate	"Happy Teams"	"Spirit" within the business	Leadership
Map 1	Certainty about future direction of business	Happy Team with mutual trust, good working relationships, & enjoy working together	Creation of enthusiasm & excitement	Business Manager
Map 2	The business now has a portfolio of products; "We are successful"	Getting people together helps communication and transfer of knowledge; "people are able to bounce ideas around!"	"A spirit in the business & a sense of excitement; this helps the transfer of knowledge"	Business Manager
Map 3		"Being together" encourages discussions and sharing of information	There is enthusiasm in the business.	Business Manager
Map 4	At these monthly meetings we are able to listen & learn about what's going on in other parts of the business ...	Honest & open communications helps develop good relations with people in the team	Poor communications within the business can lead to "quasi" covert operations, damaging rumours and low morale ...	"The supervisor steers the Team. We [research team] are reliant on the supervisor, if he is ...
Map 5	People within the business are aware of the operating climate ie prosperity/hard times	If everything is doom and gloom and everyone is watching their backs the atmosphere doesn't produce ideas!"	"Spirit of the company; the way the business is operating at that time...	The Business Team runs the business. They deal with operating issues; the short & medium term issues
Map 6	A lack of security and uncertain future does not help business morale...	Good relations amongst the Team is essential. We try and help each other	...Whereas business growth develops excitement within the business	Business Manager
Map 7	Difficult operating conditions; Hard Times	Consensus Mgt. means that youhave to remove all dissenters & doubters in order to progress ideas	Dynamic drive within the business to expand & grow & develop new ideas (a supportive culture)	Senior Business Mgt/Business Leadership
Map 8	Business environment; Long Term plans	How well people get on with each other	Development of an environment that encourages new ideas	Business Manager
Map 9 (Pilot)	External environment, including: economic climate competitor performance life cycle of business	Stimulate individuals within the business	Generation of: passion excitement determination persistence inquisitiveness	Business leadership

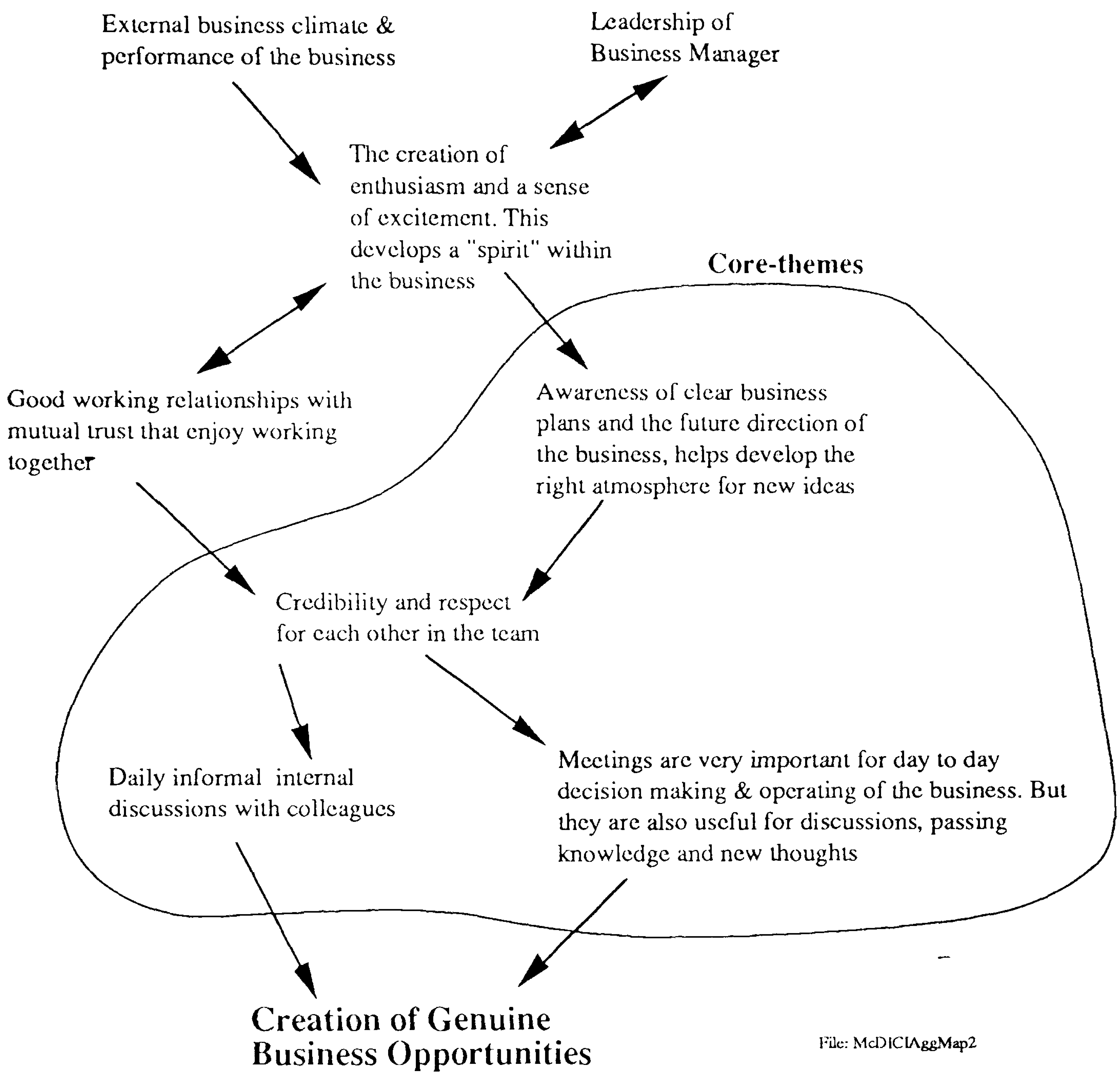
File: McDTable2

N.B. Activities taken directly from respective maps

Figure 8.17

An aggregate Cognitive Map from 8 individual maps of the process of "assimilation", ICI.

This illustrates the common core and non-core themes



8.6 Analysis of models of assimilation

The researcher's theoretical model presented at the beginning of the chapter attempted to map out the main components of the process of "Assimilation". This map was not intended to be a definitive model, rather it was to try and establish a way of looking at an area that was complex and diffuse. Indeed it provided a useful starting point facilitating the design of the research instrument. In addition it provided a "working" proposition: To what extent is this conceptual model of "Assimilation" [Figure 8.1] supported by the evidence from the fieldwork. The nine models of "Assimilation" presented in the form of cognitive maps in

Section 8.5 have added richness and detail to the author's theoretical model by uncovering a sequence of non-routine activities that together contribute to a process model of "Assimilation". These will now be discussed.

8.6.1 Analysis of core activities

The core activities are those which had a high level of influence within an individual's cognitive map. While four common themes were identified as: Credibility and respect for colleagues; Extensive informal interactions; Extensive formal interactions; and Awareness of main aims and future direction of business, these themes are integrated and should not be viewed in isolation. They were presented by individuals operating within the organisation, in the form of their model of the **process of "Assimilation"**. As such they are completely interelated, influencing and influenced by each other as can be seen from the cognitive maps in Section 8.5. They represent the key internal organisational mechanisms in the "Assimilation" of externally developed technology into genuine business opportunities; and will be discussed collectively.

8.6.1.1 The need for "prior related knowledge"

The notion of mutual credibility and respect for colleagues suggests a recognition of the value of the views and knowledge held by colleagues. Indeed a number of participants maintained that 'there is always an expert somewhere in ICI (ref: Map 6)' and 'a lot of ideas come from discussions; we rely on our colleagues (ref: Map: 5)'. Phase One of the research in Chapter Five has already shown that ICI has built a reputation for recruiting high quality staff. The findings here, from the cognitive maps, appear to support this. The credibility and respect for colleagues derives from a history of using knowledge effectively which is made up of a combination of elements. These are:
experience of individual (ref: Map 1);
level of awareness of individual (ref: Map 2);
education of individual (ref: Map 1);
past performance of individual (ref: Map 8).

This "prior knowledge" base (Cohen and Levinthal, 1990) of individuals represents an important input into the "Assimilation" process. Cohen and Levinthal (1990) argue that prior related knowledge at the individual level provides an ability to recognise the value of new information. This facilitates the creation of linkages and associations that have not been made before. At the organisational level the creation of novel linkages by the individuals is enhanced through communication amongst individuals with diverse and different knowledge structures. Thus prior related knowledge enables an organisation to recognise the value of new information, capture and apply it to commercial ends.

The implications of this ability to create linkages and associations assumes an understanding of the needs of the business. This introduces another core-theme. An understanding of the future direction of the business was cited as necessary for individuals to assess whether technical opportunities would be of interest to the business. Rather than a detailed breakdown of the aims and objectives of the business strategy, the participants within the two ICI businesses sought generalised business objectives. These provide them with sufficient scope to identify potentially useful technical linkages and associations. This finding is consistent with several recent pieces of research within Japanese companies by Imai K, Nonaka I and Takeuchi H, 1985; Nonaka 1990; 1991.

8.6.1.2 The need to share and exchange knowledge

Prior knowledge, however, that is wrapped up and inaccessible is of limited use to the organisation. Hence the importance placed on interaction (both formal and informal) within the cognitive maps. There is a great deal of support in the literature for the importance of informal interaction in the industrial innovation process see Roy (1960). Zaltman et al (1984) argue that interpersonal skills are important components of the innovation process because of their positive effect on openness, risk taking, and trust. More recently Nonaka & Kenney (1991) in a case study comparing 'Apple Computer' and 'Canon', have argued that: '... innovation is an information creation process that arises out of social interaction. In effect, the firm provides a structure within which the creative process is located'.

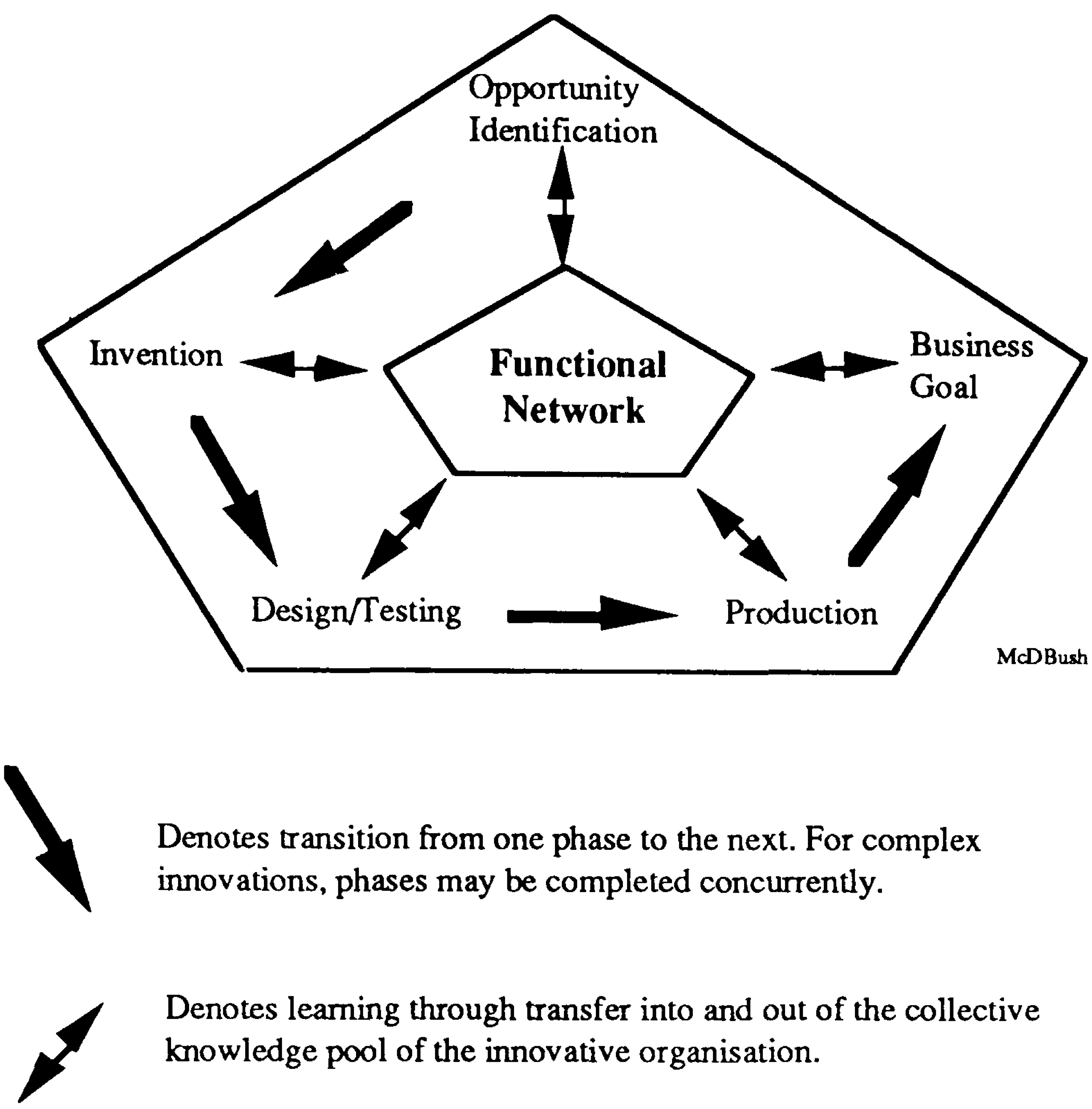
These interactions provide the opportunity for thoughts, potential ideas and views to be shared and exchanged. However, Polyani (1966) has argued that we are often unable to explain what we normally do; we can be competent without being able to offer a theoretical account of our actions. He refered to this as "tacit knowledge". A great deal of technical skill is "know-how" and much industrial innovation occurs through on the spot experiments, a kind of action orientated research with ad-hoc modifications during step-by-step processes, through which existing repertoires are extended. Such knowledge can only be learned through practice and experience. This view has recently found support from a study of Japanese firms; Nonaka (1991) has suggested that the creation of new knowledge within an organisation depends on tapping the tacit and often highly subjective insights, intuitions and hunches of individual employees and making those insights available for testing and use by the organisation as a whole. Hence, this implies that certain knowledge and skills, embodied in the term "know-how", are not easily understood, moreover are less able to be communicated. This would suggest that to gain access to such knowledge one may have to be practicing in this or related areas of knowledge. Cohen and Levinthal (1990) refer to this condition as "lockout" suggesting that failure to invest in research and technology will limit an organisation's ability to capture technological opportunities. 'Once off the technological escalator it's difficult to get back on' Cohen and Levinthal (1990.

In addition to informal interactions, the importance of formal interactions was also highlighted on the cognitive maps. There is a substantial amount of research stressing the need for a "shared language" within organisations to facilitate internal communication (Allen and Cohen, 1969; Allen, 1977; Tushman, 1978). The arguments are presented along the following lines: if all actors in the organisation share the same specialised language, they will be effective in their communication. Hence, there needs to be an overlap of knowledge in order for communication to occur. Such arguments have led to developments in cross-function interfaces, for example between R&D, design, manufacturing and marketing. Concurrent Engineering is an extension of this; in this particular case a small team consisting of a member from each of the various functional departments manage the design, development, manufacture and marketing of a product.

Such thinking is captured in a model of innovation by Bush and Frohman (1991). They argue that the "up-down" flow of communication in a traditional organisation hierarchy blocks innovation and change. They propose a networking structure that allows lateral communication, helping managers and their staff unleash creativity. This model, illustrated in Figure 8.18, emphasises the importance of informal networking, across all functions.

Figure 8.18

A concurrent model of technological innovation



Source: Bush and Frohman (1991)

This introduces a tension between the need for diversity, on the one hand, in order to generate novel linkages and associations, and the need for commonality on the other, to facilitate effective internal communication. Clearly there will be an organisational trade-off between diversity and commonality of knowledge across individuals. Chapter Seven highlighted the use by ICI of technical people in commercial roles, thereby enhancing the diversity of background of their personnel. Similarly a number of large Japanese companies have a practice of rotating their R&D personnel through marketing and manufacturing operations.

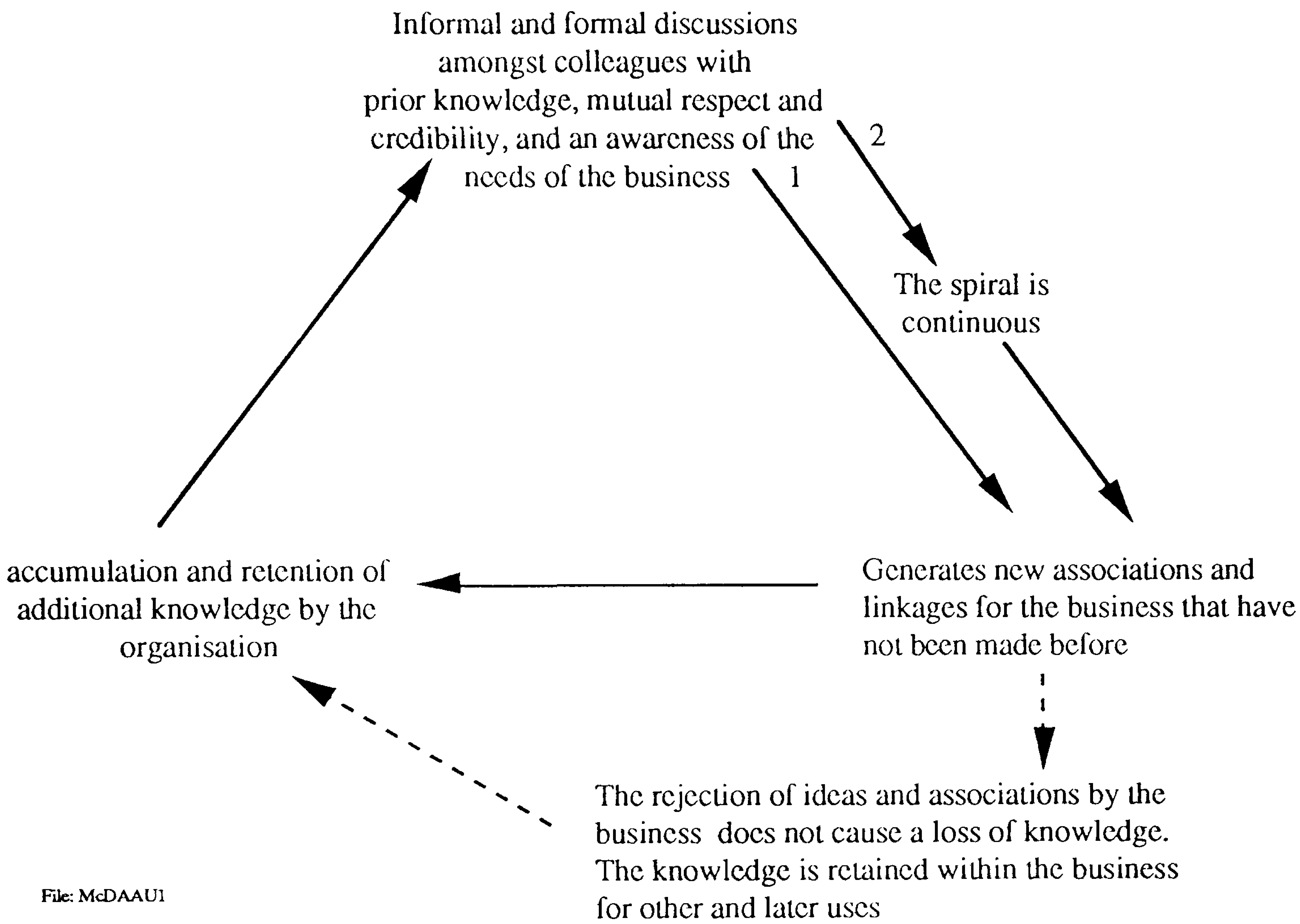
Specialist functional departments within large organisations usually possess a wealth of idiosyncratic knowledge and experience. One of their important, but unappreciated roles is to constantly impart specialist information (knowledge) to colleagues concerning technical or commercial ideas. This "informal internal consultancy" activity is often described by individuals within the organisation as "the informal testing of ideas on people in their functional capacity" (Map 8). For example, a technical idea will often be informally discussed with colleagues from marketing to get informed commercial advice. This valuable informal activity is often unrecognised. The process serves as a dual role: not only does it serve as an informal testing device whereby ideas can be presented to a variety of in-house specialists who are then able to assess the idea, it also serves as a support-gathering device. If the general feedback is positive and sufficient people are made aware of the idea this will increase the likelihood of it eventually receiving formal backing from the business team. If, on the other hand, the feedback is broadly negative this will alert individuals to the fact that the idea will probably not receive formal support from the business. Individuals will either develop the idea further by gaining additional information or decide that the idea is not suitable, for whatever reasons, as an opportunity for the business.

8.6.1.3 The development of an internal knowledge accumulation process

The non-routine activities, discussed above, characterise an internal knowledge accumulation process. This is represented diagrammatically in Figure 8.19. There are arguably already enough models of learning in existence, for example "critical reflection" (Mezirow, 1985); "learning conversation" (Brookfield, 1987); "Double loop learning" (Argyris and Schon, 1974); "Reflection in action" (Schon, 1983); "Action learning" (Revans, 1980). However, within these models learning is presented as an elusive concept that is difficult to delineate. The process illustrated in Figure 8.19 highlights the individual activities, as identified by managers in the practical world of organisational life, that characterise knowledge accumulation.

Figure 8.19

The internal knowledge accumulation process



8.6.2 Analysis of non-core themes-ICI

Outside the core boundaries four common themes were found to be present on the cognitive maps. These factors were identified as necessary ingredients in facilitating the "Assimilation" of technical linkages and associations into genuine business opportunities. They are as follows:

8.6.2.1 External operating climate and performance of the business

It is inevitable that if a business is operating within an expanding and growing market the operating conditions for that business are clearly going to be more favourable than if a business is operating in a declining market. Within the businesses studied, individuals recognised that the current performance of the business had a significant influence on the internal "climate". Falling sales immediately led to questions about future security and health of the business, whereas rising sales tend to induce a sense of optimism and even excitement at the prospect of new research projects being undertaken. In other words the prospect of cuts within the business and even redundancy does not foster team spirit or "happy teams".

The Solvents business was operating in a declining business environment. Many of its products were being phased out due to various environmental legislatures, for example the Montreal Protocol (see Chapter Five for a more detailed explanation). In addition the corporate ICI strategy for the whole Chemicals & Polymers Group (of which the Solvents business is a part (see Figure 5.4)) was under review. Hence, there was a great deal of uncertainty regarding the future direction of the business. By contrast the Watercare business was operating in a growing business environment. The same strict environmental legislation that was threatening the markets of the Solvents business was forcing increasing numbers of companies to clean up their manufacturing operations. Ironically this was creating a large and growing market for the Watercare business.

The presence of such influences clearly has an impact on other factors such as the leadership of the business and morale amongst the business teams. These factors are discussed below.

8.6.2.2 "Happy Teams"

The previous section emphasised how the assimilation of technical linkages and associations is characterised by extensive regular informal and formal daily interactions. Hence, it is essential that people develop good working relationships. The notion of "Happy Teams" (ref: Map 1) tends to induce good team work. For example:

> "Good relations amongst the team is important; we try and help each other (ref: Map 6").

This emphasises how individuals are dependent on the performance of their colleagues and a competent team. Good working relationships help to foster mutual respect and credibility; a key component of the core themes.

8.6.2.3 Business Leadership

The leadership and managerial style of the Business Manager was also identified as a significant influence on the way in which the business operates and the style in which it operates. This influence dictated whether there was an emphasis on formal or informal activities and dictated the future direction of the business especially regarding markets to enter/ pull out from. In addition, the type and style of relationship the business manager has with other corporate ICI managers and indeed with the C&P board also play a part in determining the "drive" and "spirit" within the business.

8.6.2.4 A "spirit" and a sense of excitement within the business

This particular factor proved to be difficult to delineate and define. When questioned in more detail about it, participants had difficulty in articulating what they understood by "spirit", they found it easier to provide examples:

> ... a buzz in the office that is not present in other businesses I have worked (ref:Map 1);
>
> ... everyone is enthusiastic and everyone seems to work late (ref: Map 3);
>
> ... we seem to have new ideas to discuss every day, (ref: Map 2) etc.

It concerns enthusiasm and excitement and appears to be closely related to company culture. Furthermore, it appears to be an effect of the presence of the other three factors: positive operating environment; business leadership; and "happy teams".

In this context "Spirit" is defined as *dynamism and enterprise, leading to a willingness to explore and a willingness to learn.*. It was noticeable that these features were stressed and clearly evident within the Watercare business but not in the Solvents business. This may reflect the current difficult operating climate of the Solvents business and subsequent performance of the business.

8.7 Conclusions

A similar comparative study was conducted within another large chemical company, in the North West of England. The results of this study are presented in Appendix G. This parallel study was undertaken to ascertain whether the findings from the study within ICI were particular only to ICI. However, the findings in Appendix G show a number of similarities with the findings from the two ICI businesses. The common-core themes identified are consistent with those from the ICI businesses. There are, however, a number of differences in the non-core themes identified. This may be due to the very different markets in which the businesses operate. In contrast to the two ICI businesses the Redsoap Detergents business operates as a duopoly within a relatively stable market. Demand for household consumer goods, for example soap powder, remains fairly constant. Hence, the business does not experience the peaks and troughs in overall demand so familiar in many other markets, and especially in the industrial materials markets in which ICI Solvents operate. Relatively stable demand is also reinforced as a result of having only one other competitor in the market. This may help to explain why there was little emphasis on "spirit" within the Redsoap business. A further explanation is the structure of the Redsoap businesses. Redsoap operate a central laboratory which serves all their businesses. Hence, individuals working within the laboratory have less of a sense of affiliation with an individual business. In contrast the research groups within ICI tend to be more strongly linked to particular businesses.

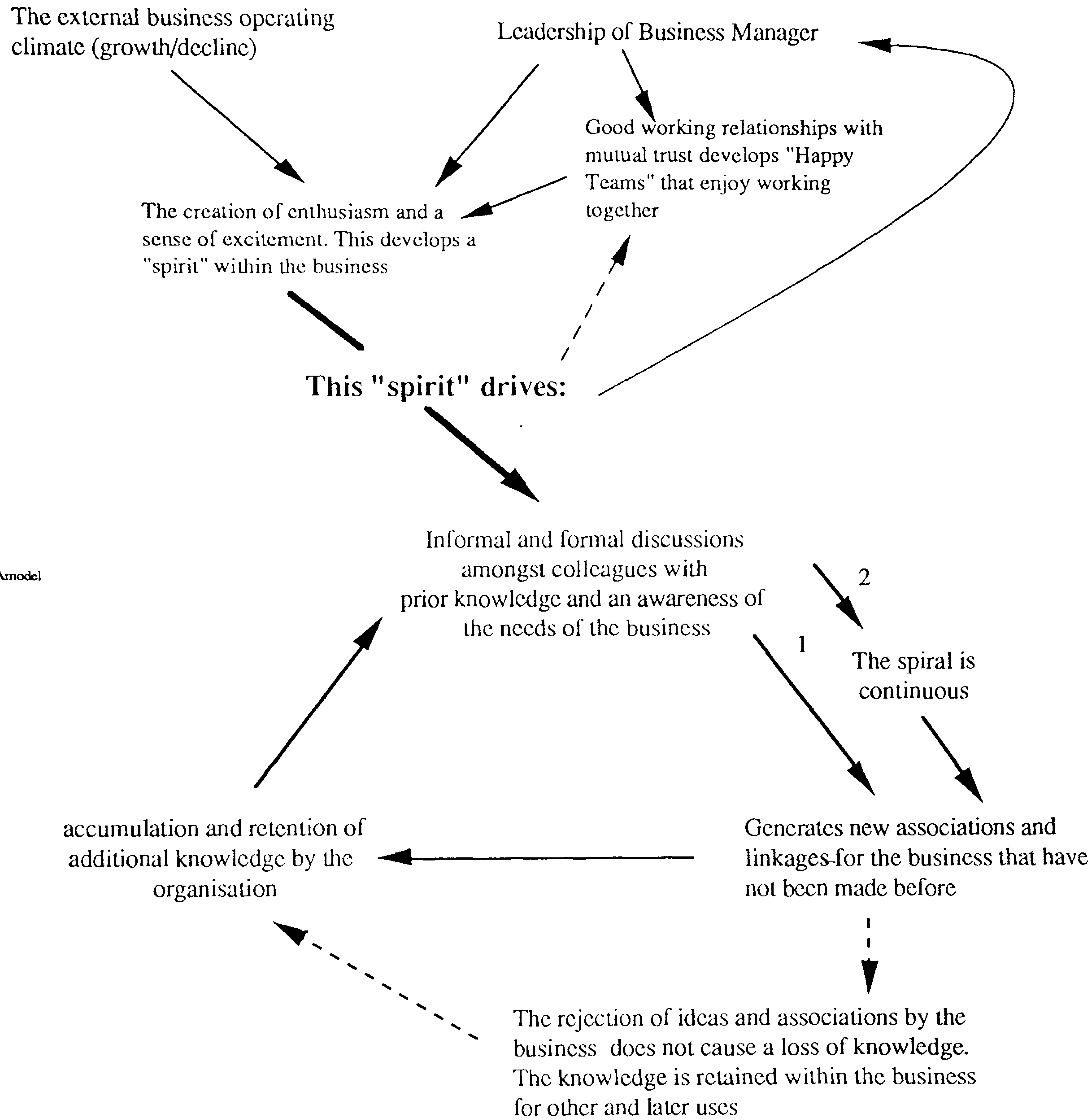
The cognitive maps presented in this chapter have revealed rich personal interpretations of the process of "Assimilation" from individuals operating within a "live" organisation. It is relevant here to mention the suitability of cognitive mapping as an interactive modelling technique. The simplicity of this modelling technique enabled the maps to be returned to the participants for corroboration and for further corroboration to be obtained by presenting them to a senior manager within ICI.

The nine models of "Assimilation" presented in the form of cognitive maps in Section 8.5 have added colour and detail to the author's theoretical model by uncovering a series of activities that together contribute to a process model of "Assimilation". The aggregation of these maps in Figure 8.17 produced a collective model that represented those themes that were common to all the maps. Hence this aggregated map represented the shared understanding of the key internal organisational activities and influences in "Assimilation". This third phase of the research has uncovered an extensive series of complex sequences necessary for the "Assimilation" of linkages and "Associations" into genuine business opportunities. It is the sequence of these mechanisms that make up the process model of "Assimilation" shown in Figure 8.20. The complexity of the process may help to explain why inward technology transfer in general and "Assimilation" in particular is so difficult to achieve; for a wide range of activities need to be in place in order for the process to occur. The diagram in Figure 8.20 shows the dynamic nature of "Assimilation" which is typified by the interelatedness of all the internal organisational mechanisms. These dynamic features of this model represent the key difference between a process model and a static model, typical of a variance type approach.

This model has built on Cohen and Levinthal's (1990) theory on absorptive capacity by reinforcing the importance of prior related knowledge and by revealing the importance of credibility and respect amongst individuals within the organisation, the absence of which will limit the effectiveness of the internal cumulative learning process.

Figure 8.21

Model of "Assimilation"



File: McD3rdAmodel

Chapter 9

Chapter 9

Collation and summary of the findings from the three phases of research

The aim of this chapter is to pull together and integrate the findings from the three pieces of fieldwork conducted for this research. This chapter shows how a series of internal activities affect an organisation's ability to engage in inward technology transfer. Hence collectively the research is shown to offer an improved understanding of "receptivity". Section One shows how, collectively, the in-depth studies uncover and characterise these internal organisational factors. Section Two discusses the role of technology scanning in raising an organisation's awareness and enabling the creation of associations and novel linkages. Section Three discusses the internal knowledge accumulation process that facilitates the assimilation of technical ideas into genuine business opportunities. These internal processes are brought together in Section Four in the form of a model of inward technology transfer.

9.1 Introduction

Using the conceptual framework of Awareness-Association-Assimilation-Application, developed in Chapter Three, the three phases of research have, collectively, explored the notion of "receptivity" (Lefever, 1992). This was defined in Section 1.1.2 as an organisation's overall ability to be aware of, to identify and to take effective advantage of technology. It was argued in Section 1.1 that an organisation's internal activities affect its ability to participate in inward technology transfer (Seaton and Cordey-Hayes, 1993). This was explored further in Section 2.5 where it was argued that a firm's ability to engage in inward technology transfer is largely a function of the firm's level of prior related knowledge and that its ability to capture and exploit external technology are history dependent (Cohen and Levinthal, 1990). This suggests that an organisation's innovative ability is largely a function of its accumulated technological competence. This highlights the folly of many prescriptions of "how to be innovative" and the futility in merely calling for firms to be more innovative when it would appear that such innovative behaviour is dependent on a firm's prior activities, particularly in research and technology. The findings from this piece of research support this overall theory and contribute to it by showing that while prior knowledge is necessary it is insufficient for effective inward technology transfer to occur. There are a variety of internal factors, in addition to prior related knowledge, that affect an organisation's ability to be aware of, to identify and to take effective advantage of technology. These are discussed in the following sections and shown collectively in a model in Section 9.4.

The findings from Phase One of the research help to characterise the notion of prior knowledge by showing how the provision of an "information rich" environment and the recruitment of high quality staff by an organisation facilitate the development of an organisation's "receptivity" to externally developed technology. These points will now be explored.

For many years it has been a policy within ICI to recruit only the best graduates. Furthermore Section 5.2 showed that postgraduate scientists in universities were concerned with academic freedom and viewed ICI as the ideal employer citing the reputation and quality of its science (Jones, 1992). This recruitment policy and the organisation's reputation enables it to add to its knowledge base by attracting high quality personnel.

In addition it was revealed that ICI recruited those with research doctorates into roles other than just research. Evidence of this was provided in the findings from Phase Two regarding use of technical staff in commercial roles by ICI Watercare; specifically in the role of Technical Product Managers These hybrid roles were shown to facilitate the coupling of technical and commercial scanning and networking which is necessary for the creation of novel linkages and associations. This is developed in Section 9.2.

Section 5.2.7 illustrated the "information rich" environment in which the ICI businesses within this study operated. This finding was shown to be consistent with the chemical industry in general, which has a long history of providing its scientists with extensive information resources. Section 5.2.8 refered to the 1919 report from the British Chemical industry commission on German chemical companies in the occupied region of Germany to show how the large chemical companies have long recognised the importance of keeping their research scientists informed and up-to-date with technological developments.

This demonstrates a recognition by the chemical industry in general and chemical companies in particular of the importance of new information to the business's scientific and technological activities. Eighteen different information sources are cited in Section 7.3 which individuals within the organisation found useful.

9.2 The role of continuous technology scanning in inward technology transfer

The semi-structured interviews used in Phase One of the research revealed the importance of the role of the individual in the inward technology transfer process. This finding was also confirmed in the subsequent comparative study of two ICI businesses (Phase Two). The first study identified two specific, informal, non-routine activities that were undertaken by individuals on behalf of the organisation; these were "scanning" and "networking" and were used to "top-up" the individual's level of awareness and knowledge. This information was subsequently brought back into the organisation for dissemination and to up-date its knowledge base.

Technology scanning was shown in Section 7.8.3 to contribute to an organisation's level of awareness of externally developed technology. Furthermore,the recognition by the organisation of the importance of scanning and networking was shown to be necessary in order that individuals could scan effectively on behalf of the organisation. The provision of extensive library facilities, including the provision of a wide variety of journals (see Section 7.3) illustrates the organisation's recognition of the scanning activity as a regular consistent activity rather than an activity that is undertaken occasionally or when a need has been identified.

9.2.1 The importance of the non-routine activities of scanning and networking

The findings in Section 5.6 revealed the importance of the internal activities of scanning and networking in remaining vigilant of the external environment. Hence, several propositions were developed for Phase Two of the research in order to examine in detail the role played by these non-routine activities. These are restated below:

[P1] Effective scanning depends on the explicit recognition by the organisation of the role of technical and commercial scanning.

[P2] Effective networking depends on the explicit recognition by the organisation of the role of networking

The findings from the Second Phase of the fieldwork are presented in Chapter Seven and confirm the importance of these non-routine activities; all the participants expressed the importance of scanning and networking in providing useful information. Furthermore the findings revealed that effective scanning and networking by individuals on behalf of the organisation is dependent on the recognition by the organisation of the importance of these activities (Propositions 1 and 2). Without the support of the organisation an individual is clearly limited in the extent of activities in which he/she may engage, no matter how well-intentioned. For example, if the organisation does not actively encourage its employees to attend conferences and exhibitions, to visit customers and competitors, through the provision of resources and a supportive culture, it is extremely unlikely that these activities will be undertaken.

The findings in Chapter Seven, also suggest that ICI, as an organisation, recognises the importance of the role of technology-scanning. The variety of information sources made available to the businesses of ICI and the people within those businesses (see Section 7.3), coupled with the substantial resources provided for scanning activities, is clear evidence of the commitment the company has to ensure its businesses and its people are aware of information that may be useful and potentially valuable. Individuals within <u>both</u> ICI businesses spent substantial amounts of time scanning for information and several research scientists spent the equivalent of one full working day a week. Section 7.4 shows the provision of large travel budgets for personnel to attend conferences and exhibitions. The histograms in Sections 7.2 and 7.4 clearly show the extensive scanning and networking undertaken.

There was also evidence from the findings in Section 5.2 that ICI provides additional support, in terms of liberal socialisation controls and norms of behaviour, for external informal interaction (networking). The study revealed that interactions with people were identified, by both the ICI businesses, as the most useful source of information above all other sources. This was because of the "richness" of the information that could be gathered in the form of tacit knowledge. This view is supported by Nonaka (1990) who stresses that the creation of new knowledge is dependent on the recognition by the organisation of the importance of tapping the "tacit knowledge" of individual employees.

A noticeable difference in the extent of external networking undertaken by the ICI Watercare and ICI Solvents businesses is revealed in Section 7.7. Respondents from the Watercare business believed there was strong encouragement within the ethos of the business to spend time outside the company, whereas the respondents from the Solvents business believed that there was little, if any, encouragement to spend time outside the business. Hence, the extent of external networking undertaken by the Solvents business was lower compared to that of the Watercare business, providing further support for Proposition Two.

9.2.2 Tuning the scanning process through an understanding of the organisation's needs

The notion of "tuned-scanning", that is, reducing the level of "noise" in the scanning signal by focussing the scanning process, is an interesting concept that was developed in Chapter Three. It is based on the simple premise that it is necessary to fully understand the technical and commercial capabilities of the business and its future plans in order to scan effectively. Hence, the gathering of internal information, via internal scanning, will help to improve an individual's understanding of a business's capabilities thereby increasing the signal to noise ratio in any subsequent external scanning undertaken. This is represented schematically in Figure 9.1.

Two further propositions were developed to explore this area in detail in the second phase of research. These were:

[P3] A thorough understanding of the business's operations, markets, capabilities and future business plans is essential for effective scanning and networking.

[P4] The coupling of internal and external, technical and commercial Scanning will produce business "Associations".

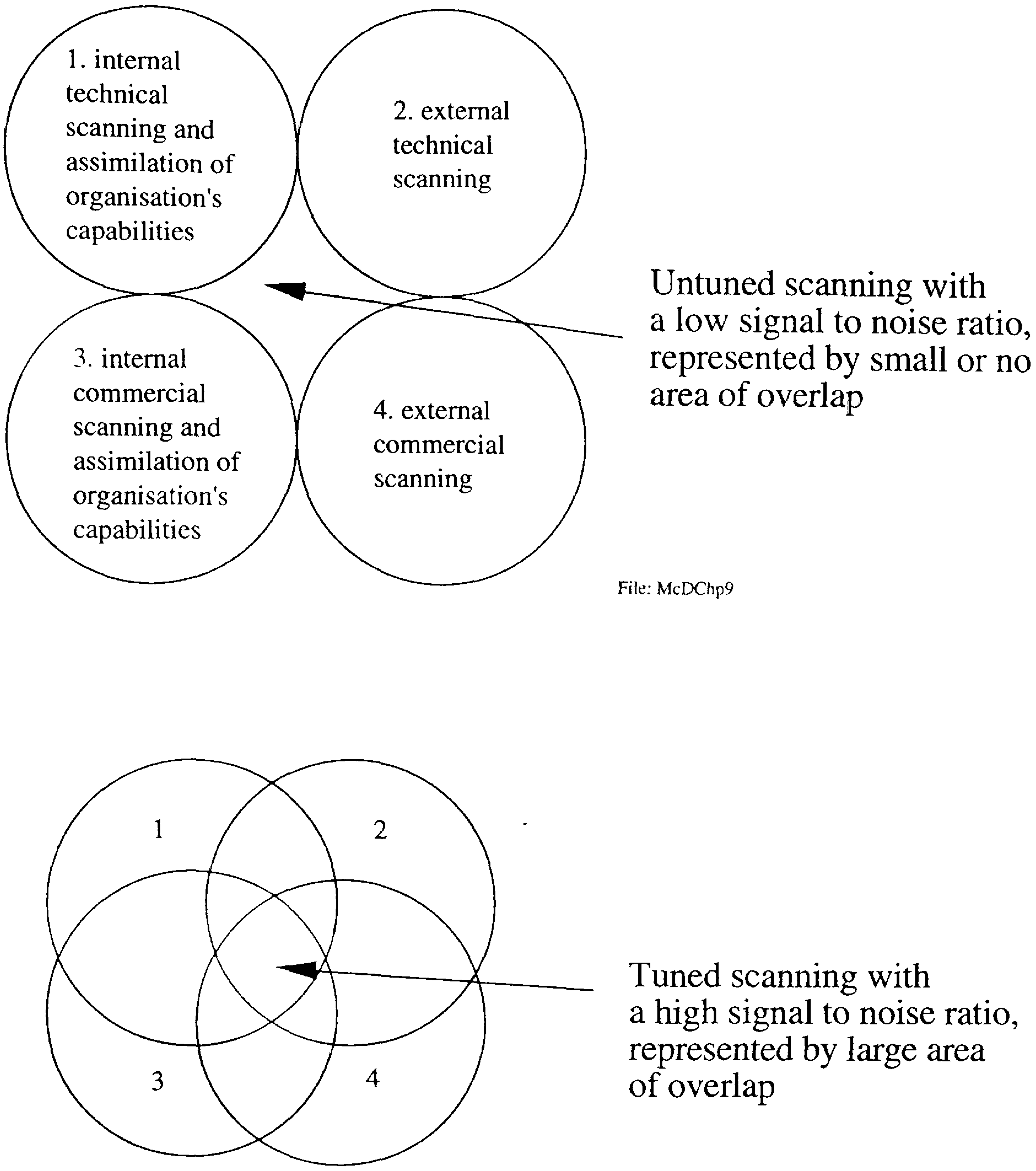
There was support for Proposition Three in the findings presented in Section 7.8. This revealed that respondents from both businesses had a thorough understanding of the needs and capabilities of their business. This was fostered through the use of a matrix organisational structure and the use of business teams. These facilitated additional lines of communication within the organisation, which enhanced internal awareness of the business's activities (Proposition Three). This finding was supported within the literature. Moreover, the literature suggested matrix organisational forms are particularly suited to science-based or technical organisations (see Allen, Lee and Tushman, 1980; Katz, 1982; Wolf, 1982; Ford and Randolph, 1992).

Sections 5.2 and 7.4 illustrates the extensive internal communication patterns that exist within ICI and argued that this management style has previously been described as "fuzzy" (Marsh, 1989). This framework has led to a style of management that emphasises informal communication and provides a great deal of freedom and autonomy for individuals. This, in turn, demands a high level of mutual confidence and respect from everyone involved in order to ensure the organisation functions effectively. Organisations which deploy this style of management may be described as "high-trust organisations". Hence there is evidence within Section 7.8 and 5.2 that ICI recognises the importance of ensuring its individual employees are aware of the internal needs and capabilities of their businesses. In particular it recognises the importance of internal informal interaction (networking) and supports the process through the provision of the following:

- An "open" and informal style of management;
- A matrix organisational form;
- Business teams.

Collectively these three factors provide an environment that values information as a commodity and facilitates the development of a high level of internal awareness of the business's capabilities, activities and future plans. Section 7.5 shows that the respondents from both ICI businesses emphasised the importance and value of interacting with people (ie networking) internally, within ICI, and externally, outside ICI, in order to maintain a high level of awareness. They believed networking was a necessary activity in order to remain aware of developments within their business (internal networking) and within the industry in general (external networking). Hence, there is support for Proposition Three and the overall theory on networking (see Figure 9.1 below).

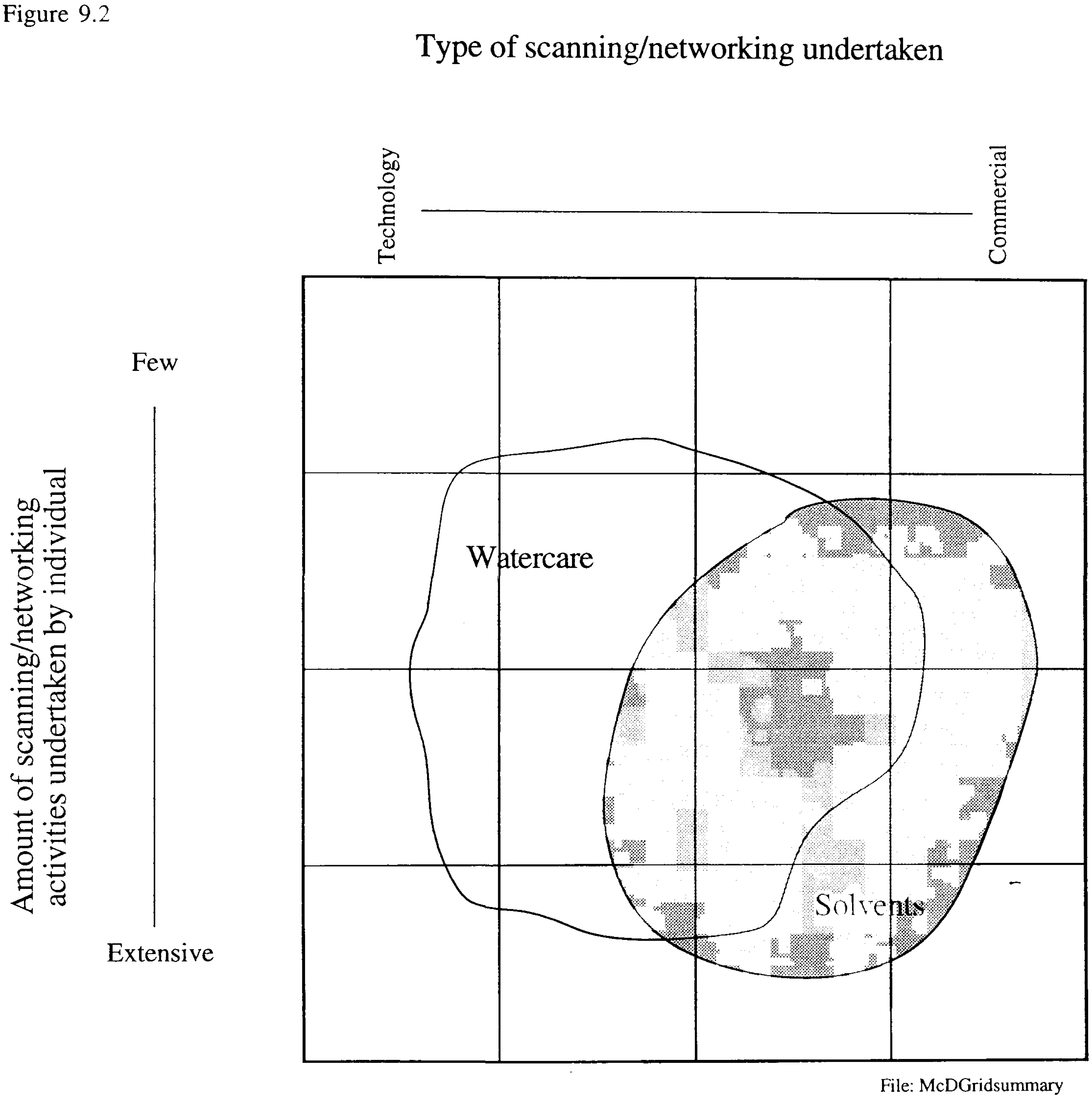
Figure 9.1



The conceptual scanning framework, developed in Chapter Three and shown schematically in Figure 9.1, suggests that a range of scanning activities is necessary in order to facilitate the creation of linkages and associations that had not been made before (associations), which the business could subsequently assimilate into genuine business opportunities. Section 7.7 showed the relationship between the various scanning activities and also showed that the absence of one or more of the four scanning activities ((1) internal technical scanning; (2) external technical scanning; (3) internal commercial scanning; (4) external commercial scanning) would reduce the effectiveness of the overall scanning process. The internal technical and commercial scanning activities improve awareness and understanding of the business's technical and commercial capabilities and needs (Proposition 3). This understanding is used to "tune" the external scanning or search process. In addition the findings in Section 7.7 showed how the absence of either external commercial or external technical scanning would lead to the creation of mainly technical or trading associations respectively. Hence, there was support for Proposition 4.

A summary of the findings from Section 7.7 is shown schematically in Figure 9.2. This shows that the Solvents business undertakes very little technology-scanning, hence, the opportunities generated are in the form of "trading associations"(commercial opportunities). Consequently there are few genuine "business associations" created. The Watercare business, however, undertakes a range of technical and commercial scanning and networking activities which tended to generate genuine business opportunities.

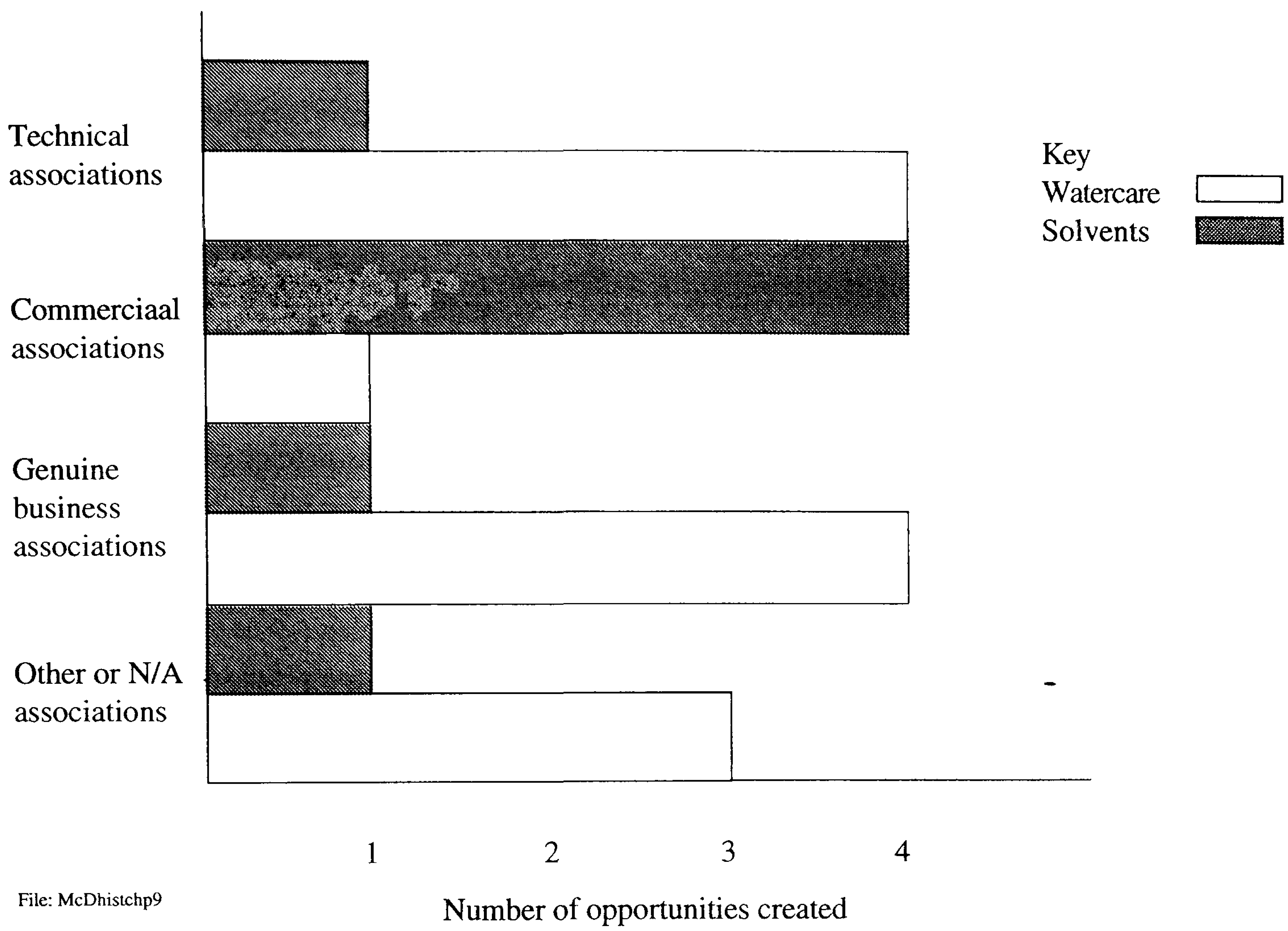
Figure 9.2



Section 7.7 shows that considerably more genuine business associations have been created by the Watercare business compared to the Solvents business as a result of their scanning and networking activities. These findings are shown in the form of a histogram in Figure 9.3.

Figure 9.3

A summary of the outcomes produced through scanning and networking



9.3 Characterising the "assimilation" of technical and commercial ideas into genuine business opportunities

Section 3.5 illustrated that while the creation of novel linkages and associations is a necessary part of the inward technology transfer process it is, however, insufficient. These associations have to be applied for competitive advantage in order for technology transfer to be effective. Hence, the organisation has to assimilate these associations into genuine business opportunities that it has an intention to exploit. It was argued in Section 2.5 that prior related knowledge enables an organisation to recognise the value of new information, capture and apply it to commercial ends (Cohen and Levinthal, 1990). Prior related knowledge at the individual level provides an ability to recognise the value of new information, facilitating the creation of linkages and associations that have not been made before. At the organisational level this is enhanced through communication amongst individuals with diverse and different knowledge structures. Section 5.2 showed how the use of business teams facilitates the interaction of individuals with diverse backgrounds. This type of working environment enlarges an individual's experience and outlook and provides him/her with an improved understanding of the organisation's entire activities.

These findings were supported in the literature by Davis and Lawrence (1977) and Kolodny (1979).

The findings from Phase Three of the research are presented in Section 8.7 in the form of a model of "assimilation". An extensive series of complex sequences is revealed as necessary for the "assimilation" of linkages and "associations" into genuine business opportunities. It is the sequence of these mechanisms that make up the process model of "assimilation". This model reinforces the importance of Cohen and Levinthal's (1990) notion of prior related knowledge and contributes to it by characterising the notion of "absorptive capacity". Several other internal factors are uncovered whose presence influences the process of "assimilation". These are "credibility and respect", extensive "informal and formal communication", and "a spirit within the business".

The model relies heavily on the notion of mutual "credibility" and "respect" for colleagues. This notion builds on the evidence presented in Section 5.2 which showed that ICI has built a reputation for recruiting high quality staff and has a history of using knowledge effectively. In addition the findings also revealed that knowledge that is "wrapped up" and inaccessible is of limited use to the organisation. Hence the importance placed on interaction. Section 8.7 revealed how during these interactions, potential ideas, views and opinions are exchanged. The objective is to acquire additional business-specific information and knowledge about commercial and technical associations. This is <u>one</u> of the major advantages large organisations can have over small and medium sized organisations. The specialist functional departments are able to offer an "informal internal consultancy service" to colleagues with technical and commercial ideas (associations). Furthermore, the combination of a matrix structure and the use of business teams ensures there is extensive lateral communication between functions. It follows that communication skills are also developed as individual business team members learn the "languages" of the other functions. This view is supported in the literature by Allen (1983); Davis and Lawrence (1977); Galbraith (1971).

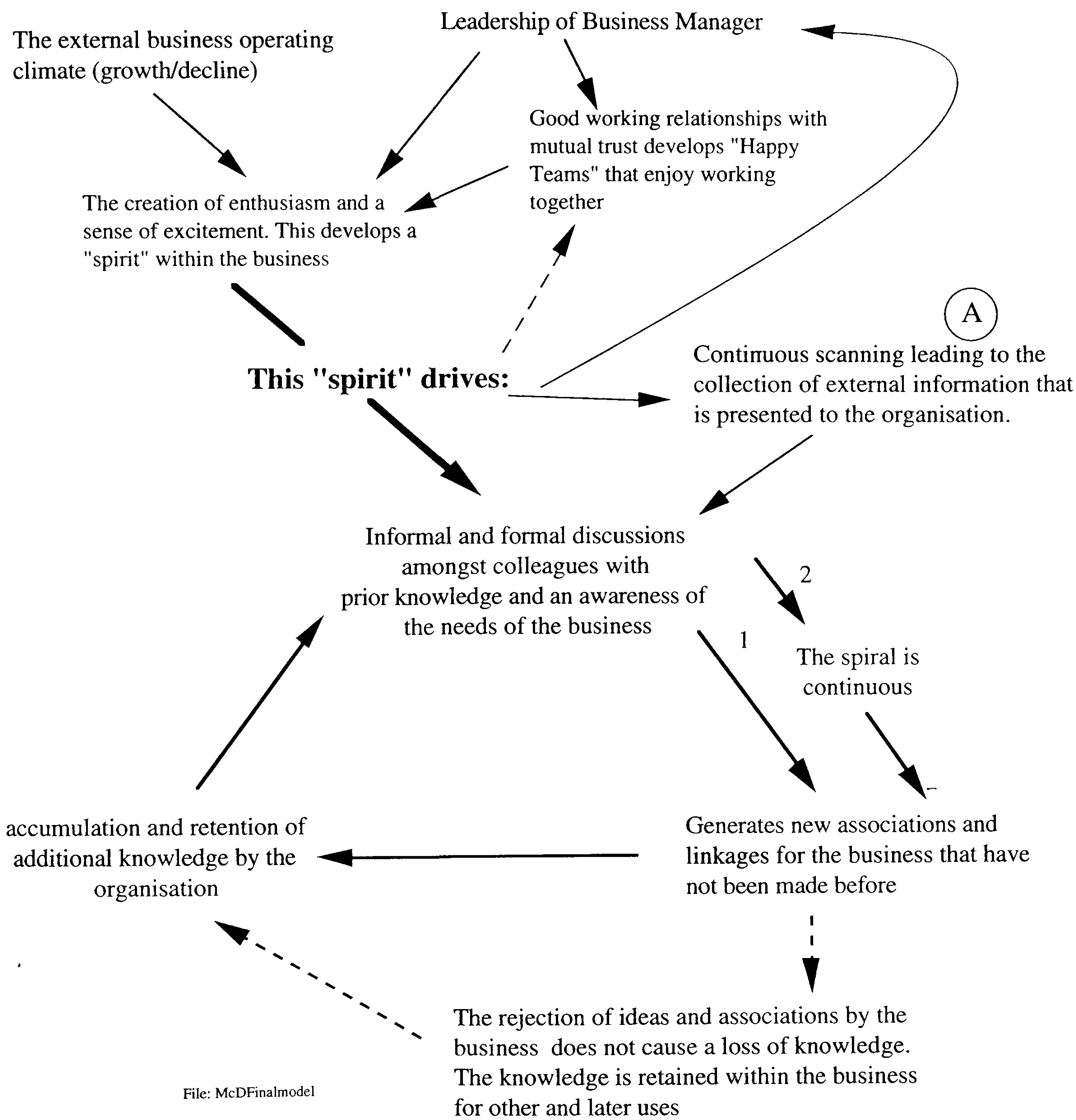
Finally a number of common themes were revealed in Section 8.6 whose combined presence appeared to manifest itself in the form of a "spirit". This is characterised by enthusiasm and excitement and represents a specific form of organisational culture. Furthermore, this was shown, in Section 8.6, to be an effect of the presence of a number of other factors. These were: a positive operating environment, strong business leadership, and "happy teams".

9.4 Towards a process model of inward technology transfer

The diagram shown in Figure 9.4 combines the output from Chapters Five, Seven and Eight. It portrays the relationship between the factors uncovered in each separate phase of research. It uses the model of assimilation presented in Section 8.7 but also shows how the activities of external scanning and networking contribute to the inward technology transfer process (see note A on model, Figure 9.4). The complexity of the process model may help to explain why inward technology transfer in general and "Assimilation" in particular is so difficult to achieve; for a wide range of activities need to be in place in order for the process to occur. The diagram in Figure 9.4 shows the dynamic nature of the internal activities which is typified by the interelatedness of all the internal organisational mechanisms.

Figure 9.4

Model showing the internal factors that affect an organisations ability to engage in inward technology transfer



This model of inward technology transfer has built on Cohen and Levinthal's (1990) theory on absorptive capacity by reinforcing the importance of prior related knowledge and by showing how the internal activities of scanning and networking affect an organisation's awareness of externally developed technology. Furthermore it shows how a combination of credibility and respect, coupled with extensive informal and formal communications amongst individuals within the organisation facilitates an internal knowledge accumulation process. The model offers an improved understanding of how the internal processes affect an organisation's ability to engage in inward technology transfer ("receptivity").

The preceding discussions and model of the inward technology transfer process have shown that the existence of a blend of certain organisational characteristics and non-routine activities is a necessary requirement in determining a business's "receptivity" to externally developed technology. The ability to accommodate and support such a variety of activities demands careful and skilful management of a business's internal environment. This particular issue is discussed further in Section 10.4, Chapter 10.

Chapter 10

Conclusions, contribution and implications of the study

10.1 Introduction and summary

In this final chapter the research project is discussed in the light of the original research framework. Conclusions arising from the specific research activities are discussed with regard to the research questions raised at the beginning of the thesis. The collective findings from the three research activities, presented in Chapter Nine, have demonstrated that a variety of internal organisational activities are necessary to enable an organisation to engage in inward technology transfer. This was shown to have built on the earlier research conducted by Lefever (1992) and Seaton and Cordey-Hayes (1993) who argued the need to focus on understanding the factors that enable organisations to participate in technology transfer rather than on the provision of information about access to technology. Furthermore a review of the literature in Section 1.4.3 highlighted the importance of the role of the individual in the process. Hence, the research framework and subsequent research questions focused on the role of the individual within an organisational setting.

The use of a conceptual framework to explore the notion of "receptivity", by breaking down the process down into a series of sub-processes, is also discussed. Furthermore, the use of a process theory approach is shown to have uncovered not only the key variables involved in inward technology transfer but also the dynamic nature of the process.

The limitations of the research project are discussed with respect to possible future research projects that could be undertaken. In particular the notion of "application" is discussed within the wider context of the management of technology within organisations. This section discusses the tension that exists within organisations between the need for "efficiency", exemplified by routine activities, and the need for "receptivity" exemplified by exploratory, non-routine activities. This section goes on to show how organisations need to manage this tension in order to participate effectively in the complete inward technology transfer process.

The chapter concludes by discussing the implications of the research with respect to technology policy in the UK.

10.2 Evaluation of substantive findings

It was emphasised in Chapters One and Two that there had been few studies in the specific area of inward technology transfer, and that much of the research into the broad area of industrial innovation had been undertaken with the implicit use of the linear model of innovation. More recent research was highlighted that showed the limitations and weaknesses of current technology transfer mechanisms and highlighted the need to adopt an interactive approach when studying technology transfer (Rothwell, 1992; Seaton and Cordey-Hayes, 1993; Lefever, 1992). It was also argued in Chapter One that while previous literature had recognised that certain internal factors needed to be in place to enable organisations to engage in technology transfer (Cohen and Levinthal 1990; Seaton and Cordey-Hayes, 1993), these factors had yet to be identified because the majority of research had focused on providing information about access to technology rather than on uncovering <u>how</u> organisations can participate in technology transfer. Few attempts had been made to establish how an organisation's internal activities affect its ability to capture and exploit externally developed technology. This had led to a lack of understanding of the internal organisational activities involved. Hence, the findings from this research project have contributed to the literature by uncovering a series of internal activities that affect an organisation's ability to participate in inward technology transfer.

The dynamic nature of the interactive processes uncovered in this thesis and shown schematically in Figure 9.4, by the sequencing of the these mechanisms, provides colour and richness to our understanding of the internal organisational issues involved. Hence this has built on Cohen and Levinthal's (1990) theory of "absorptive capacity". This has been achieved by (a) uncovering the importance of the non-routine activities of scanning and networking; (b) reinforcing the importance of prior knowledge and showing how through extensive communication it facilitates the assimilation of externally developed technology; and (c) showing how mutual credibility and respect amongst individuals within an organisation contributes to an internal knowledge accumulation process. The identification of these variables <u>and</u> the sequencing of them, offer an explanation of how organisations are able to capture externally developed technology and assimilate this new information with their own capabilities.

10.2.1 The use of a conceptual framework to analyse the inward technology transfer process

The conceptual framework developed in Chapter Three viewed inward technology transfer as a series of complex interactive processes rather than as a simple decision process. It broke down the inward technology transfer process into a series of sub-processes ("Awareness"-"Association"-"Assimilation"-"Application"). The framework showed the elements which constitute the inward transfer of technology from the viewpoint of the receiving organisation. Hence, it provides a novel way of analysing the complex set of internal organisational factors involved, and facilitated the design of three, separate, in-depth internal research activities.

The 4A conceptual framework and subsequent research activities have uncovered the nature of the internal processes and have provided the insight into how they affect an organisation's ability to capture, assimilate and apply technology to commercial ends. The complexity of each of these components and of the overall inward technology transfer process was highlighted in Chapter Nine with the integration of the findings from the three research activities and the development of a model of inward technology transfer.

The importance of the internal, non-routine activities of scanning and networking was shown in Section 7.8 to be a key factor affecting an organisation's level of "awareness". Furthermore, it was shown that the absence of such activities will limit the capacity of an organisation to generate "business associations" thereby raising the threshold level for the development of subsequent business opportunities.

The complex processes involved in "awareness" and "association" were operationalised and brought together in a scanning model (Figure 3.5) which showed the iterative inter-relationships of the four different activities that need to be in place in order to achieve effective scanning. What appeared, initially, to be a relatively simple process of search is in fact, a multiple composite process. Support for the notion of "tuned-scanning" in the conclusions in Chapter Seven demonstrates how scanning must be tuned into the appropriate needs of the business, thus ensuring that identified technology and market opportunities are assimilated with existing technical and commercial competences, that is, organisational capability. The result is a process that produces an increased level of business opportunities for consideration by the business as opposed to "noise" in the form of information that, while interesting, may be inappropriate to the business.

This is a development of Section 3.2.2 that argued the difficulty of applying other people's technology and the need for this technology to be in a usable form in order that the organisation can reap any benefit (MacDonnald, 1992). The conclusions presented in Section 7.8 reinforced the need to fully integrate the technology with the receiving organisation's internal technical and commercial capabilities. In addition they offered an explanation of how this can be achieved by uncovering the internal activities that enable an organisation to integrate its capabilities with the search process. Furthermore the conclusions in Chapter Seven showed that the identification of potentially useful technology is indeed relatively straightforward when compared to the more difficult task of finding technology to match a business's needs and capabilities. This finding may be of particular interest to intermediaries involved in technology transfer. Such organisations, many of whom were established during the mid 1980's are involved in developing the technology base of small and medium sized (SME) companies, by searching for suitable technology on their behalf.

The operationalisation of "assimilation" as an internal knowledge accumulation process offers an explanation of how organisations are able to use, manipulate and retain knowledge. Previous theories on the subject of organisational knowledge accumulation, presented in Section 2.5, argued the existence of such a phenomenon, (Nelson and Winter, 1982; Pavitt, 1990) but failed to offer any specific explanations as to how organisations accumulated this knowledge.

In the conclusions in Chapter Eight, the importance of human-centred factors such as: "communication skills", "credibility", "prior knowledge" and "respect" was identified. These factors are in themselves necessary but not sufficient for technology transfer to occur, supporting the overall theory, first developed in the 1960's, that 'transfer of technology is dependent on agents and not agencies' (Burns, 1969). This theory, however, seems to have been abandoned over the past twenty years by practitioners who have concentrated on providing access to technology via the printed word. This thesis reinforces the theory that the study of the development of technology needs to view technology as a combination of knowledge, skills, and organisations (all embodied in "organisational know-how") rather than the economist view of technology as an artefact that can be bought and sold. Hence, future studies of technology transfer need to adopt a more human-centred approach.

10.2.2 Limitations of the 4A framework

It is important to understand that the 4A framework as a concept, has its limitations. These limitations are a consequence of the fact that, whilst it expresses the nature of the internal organisational processes, and identifies a number of key areas that constitute such processes, it does not itself operationalise these processes. To this extent the model developed in this thesis is not a formal operational model of inward technology transfer in the traditional sense, but it functions rather as a conceptual framework or a vantage point from which to explore the issues involved.

Furthermore, the framework itself is not operational in that it does not lend itself to any form of prescription. However, three of the processes were explored in-depth and a process model of inward technology transfer was subsequently developed in Chapter Nine.

10.2.3 The use of a process theory approach in uncovering the notion of "receptivity"

A process theory approach is used in this thesis in preference to the more common variance theory. It was argued in Chapter One that such an approach would not only uncover the key variables that affect inward technology transfer but also show how these variables affect it. It was shown that variance models, as they are known, tend to search for variables that are seen as necessary and sufficient conditions for an outcome. Whereas a process theory tends to produce models that identify conditions that are seen as necessary but whose presence alone is insufficient to cause an outcome. Hence process theories, and subsequent process models, offer a more realistic explanation about explained variance, by providing a richer illustration of how and why the outcomes occur when they occur. This is shown in Chapters Eight and Nine through the development of a number of models displaying the relationship and sequencing of the variables involved. Variance models tend to be static in nature and as such do not reflect reality. For example, the findings in Section 8.7 revealed not only that the key variables involved in "assimilation" are prior knowledge; mutual credibility and respect; and extensive communications, but also that the sequencing of these activities was also necessary in order to produce the desired outcome. The dynamic features of the model of "assimilation", illustrated in Chapter Eight, and the model of inward technology transfer in Chapter Nine highlight the key difference between process models and variance models. In uncovering the sequence of activities that form a process a wiser interpretation of reality is achieved. Hence, a contribution is made to process theory by showing how it is able to offer an accurate and realistic interpretation of events within an organisational setting.

10.3 Appraisal of the chosen research method(s)

This research project has involved three separate research activities. However, it is not simply the undertaking of a number of research activities that is important but the manner in which they relate to one another and the relevance provided by them. The research design used in this thesis uses the "4A" conceptual framework developed in Chapter Three to isolate sub-processes for investigation within the overall process. Each phase of fieldwork builds on the findings and experiences of the previous phase. This form of research has enabled the researcher to probe, over time, further and further into a particular area.

The condensed field experience or case study approach used in this research has involved a number of research techniques including: documentation analysis, structured and semi-structured interviews and cognitive mapping. This multi-method approach, with its emphasis on breadth, has necessarily compromised the depth of skills normally associated with single method approaches. This was especially true of the elementary form of cognitive mapping used in Chapter Eight. This not only leaves the feeling that it would have been interesting to pursue various research methods further, but also exposes the researcher to criticism from the single-method specialists.

The need, in the research methodology, for a detailed investigation from within an organisation in order to uncover the processes involved in "receptivity", clearly limits the number of organisations that can be investigated in such a way because of the time needed to understand the organisation. Hence, a limitation of the technique selected is that all the studies conducted within this research were carried out within large chemical organisations and the vast majority within <u>one</u> organisation. Furthermore these are both successful companies with impressive records of innovation. Both of these points limit the extent to which the findings may be generalised. There was, nonetheless, considerable similarity in the findings from the large chemical companies studied, suggesting that the findings were not particular to one organisation. While the case study approach used in this thesis has the advantage of providing a closer insight, the large survey technique allows for a larger and more diverse range of responses to be collected and analysed.

In addition, the use of an internal investigation has implications for the targeting of individuals within the organisation. Chapter One has shown the existence of a number of key individuals in the innovation process; the "product champion" and "gatekeeper", for example. Respondents who have previously been involved in technology/product development were used. However, such identification was based on past performance which does not necessarily reflect current performance, hence the selection of respondents did not necessarily take account of those individuals currently involved in technology/product development. Furthermore, those participants interviewed represented only a sample of all those involved in inward technology transfer.

This raises another limitation regarding the profile of the respondents used in this research. In general the participants were all middle and senior managers with a university education, many with research or higher degrees. This is almost certainly not a representative sample of the profile of managers within organisations in the UK. This does, however, reflect the profile of the internal management within a large science based organisation.

10.3.1 Interactive modelling using cognitive mapping techniques

The use of an elementary version of cognitive mapping as an interactive modelling technique in Chapter Eight proved to be extremely successful. The clarity and simplicity of the technique, both in terms of creating the model from the recorded interview and the ability of participants to readily comprehend the model presented to them, afforded the researcher the ability to return the "mental maps" (models) for corroboration by the participants themselves. Moreover, feedback was obtained on the interesting way in which the actual processes and activities had been captured, modelled and displayed (see Appendix F). The two other methods considered, that of Personal Construct Theory and Expectancy Value Theory were considered to be too involved and lacking depth of enquiry respectively. Furthermore, interviews using Personal Construct Theory can be very time consuming and a lengthy intrusion into a senior manager's working day would have been inappropriate.

It is relevant here to mention the significance of the findings presented in Chapter Eight, concerning the strengths of this form of cognitive mapping, to the research methodology. As far as the researcher is aware, the technique of using cognitive maps coupled with extensive corroboration has not been used before in an organisational management situation.

A limitation of the elementary form of cognitive mapping as a modelling technique, as used in <u>this</u> fieldwork, is that it requires the researcher to be familiar with the research setting, that is the organisation. This enables the researcher to place all the inevitable organisational-specific language and jargon within the framework of the model. Without this prior understanding the researcher will either have to constantly interrupt the participant to check language used, and or the data will be lost or worse misinterpreted.

10.4 Implications for future research

Several areas offering opportunities for additional research have emerged from this study. For example, the concept of scanning was revealed in Chapters 5 and 6 to be an important factor in raising the level of "awareness" of an organisation. This concept was explored in terms of the extent and nature of the scanning and networking undertaken by individuals and the extent to which an organisation recognises the importance of these. However, an investigation focussing on the human-centred factors that affect the nature and extent of scanning and networking undertaken by individuals should reveal the extent to which these factors affect the process. For example age, seniority, education, training, experience, number of years in a commercial role, the number of years in technical role, etc. may all influence the nature of an individual's scanning.

The limitations of this research presented in the previous section regarding the generalisability of the findings offer a clear opportunity for a study involving a survey across a wider selection of firms. Such a survey could include science-based firms or large firms in general and should investigate the extent of scanning undertaken and the internal mechanisms that exist to facilitate the "assimilation" of externally developed technology with the organisation's internal capabilities. The findings from such a survey would enable greater generalisations to be made.

10.4.1 Exploring the factors which affect an organisation's scanning

The extent to which an organisation's operating markets influence the type and extent of scanning undertaken is an area that should also be explored further. In particular, the building of a "model" of the markets for the business that includes: the number of small customers, the number of large customers and the size of orders, will provide information regarding the environment in which the business operates. For example, a proactive customer base that is constantly demanding new products will have a considerably different affect on a business's technology-scanning compared to a customer base that is reactive and willing to accept the products offered by its suppliers. It is, however, important to note that any research involving the customer base of a business has to be sensitive to the existing relationship that the business has built up with its customers. Many organisations spend a great deal of time and energy building relationships with their customers. Hence, they will clearly be apprehensive about any form of third party contact with these customers.

Another area that is worthy of further research is the value and role of particular networks that are used extensively by firms. One of these is the supplier chain network. The findings in Chapter Seven highlighted the value of suppliers as a source of relevant information. In the same way, the sales force of the businesses of ICI would appear to provide a wealth of information to their customers. It seems that many small companies operate like "candles in the wind" relying on large firms like ICI, and in particular their sales and technical representatives, to keep them informed of not only technical developments in their industry but also commercial and legislative developments. For example, customers of ICI Solvents relied on its sales representatives for information regarding environmental legislation. A study looking at this particular relationship may reveal an important latent information life-line for SME's. An interesting piece of research was recently started in 1992, at INTA, Cranfield Institute of Technology. This project looks at partnership sourcing in the automotive industry as a way of facilitating "awareness" in the technology transfer process. It uses the premise that many SME's do not possess the necessary resources required to enable them to undertake extensive scanning and "learning". Hence, they can be "locked out" (Cohen and Levinthal, 1990) of technological developments in a particular field. The provision of an engineer, for example, by the automotive manufacturer to visit its suppliers and provide a wide variety of technical information may help to improve the "awareness" levels of the SME's.

10.4.2 Exploring the notion of "application" through characterising the organisational management and organisational style necessary for the complete inward technology transfer process

The final stage in the 4A conceptual framework of inward technology transfer was not explored in this thesis. The notion of the "application" concerns the profitable application of genuine business opportunities for competitive advantage. The literature is full of studies analysing the successful and unsuccessful applications of new technology. Many of these studies, however, while revealing certain necessary key factors, fail to show how these affect the "application" process. In order to uncover the actual activities involved and the affect they have, any research in this area needs to be conducted from within an organisation and grounded and tested in the practical world of organisational life. The findings from the two ICI businesses used in this research project highlight the importance of understanding not only the organisational environment but also the organisational management style.

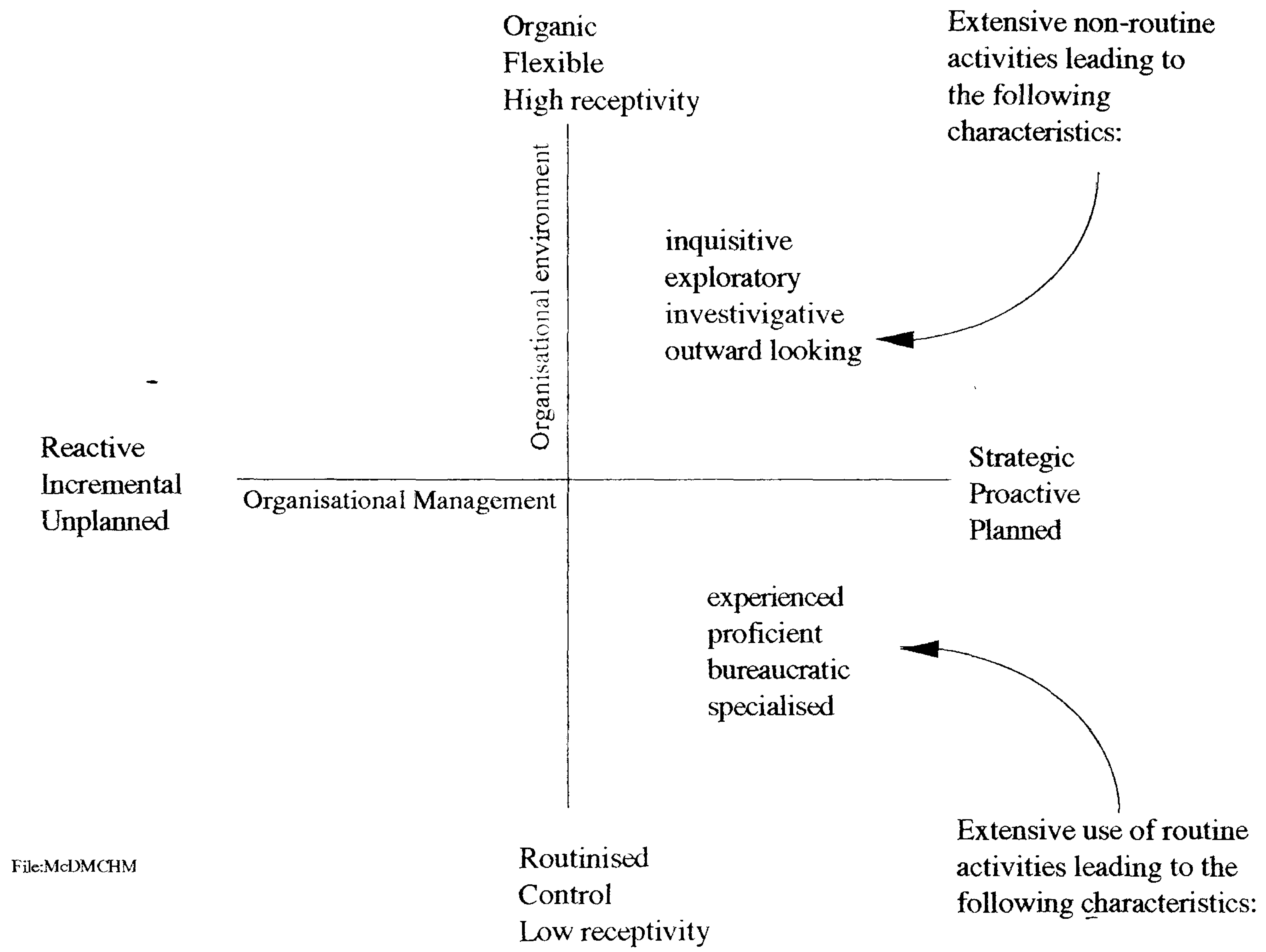
Two very different business environments were uncovered from the findings of this piece of research (Chapter 7 and Chapter 8). Despite their operating within the same overall organisational structure, that of ICI, the organisational environment of the Solvents business was less able to accommodate the existence of non-routine activities as compared with the Watercare business. An analysis of the history of the businesses can partly explain this difference. The Solvents business is a mature business which has to maintain existing production plants, ensure delivery of products and generally look after existing business activities. Its main concern is competing with rivals in established markets which requires efficient performance of routine day-to-day tasks. Maximum efficiency in routine or repetitive activities is achieved by using conservative approaches that emphasise structure and certainty, within a business environment that fosters such order and predictability. The constant manufacture, sale and distribution of products into the market place is a complex process that requires a wide variety of specialist activities. Over the past **one hundred years** (sic) the business has established many routines and procedures to ensure this smooth and successful delivery. This has resulted in an accumulation of expertise and specialisation within virtually every function.

The environment within the Watercare business is very different. It is a new, growing business with very few established routines and specialised functions. Moreover it does not have to maintain any plant or service an existing customer base. Consequently the culture is very different to that of the Solvents business. It is characterised by entrepreneurial behaviour (risk taking, proactivity) within an organic, organisational environment which supports and nurtures that behaviour. Such environments permit rapid response to market and industry demands and changes. Individuals within the Watercare business are more able to engage in non-routine activities such as scanning and networking because the business is young and has yet to develop its own routines. This encourages the development of new ideas for the business. Moreover, due to its lack of routinisation it has increased flexibility. Such an operating environment <u>supports</u> the non-routine activities necessary to develop new products and find new markets. However, this organic operating environment, is not, paradoxically, without its problems. The absence of any routines will produce difficulties and potential problems for the business as it attempts to apply genuine business opportunities for competitive advantage.

It is possible to portray the relationship between the type of organisational management and the type of organisational environment on a two axes graph (see Figure 10.1). The vertical axis shows organisational environment and the horizontal axis shows the type of organisational management.

Figure 10.1

Characterising the organisational management and organisational environment necessary for inward technology transfer



Adapted from Cordey-Hayes (1992).

From the evidence presented in Chapters Seven and Eight, there is more emphasis within the Solvents business on "efficiency", whereas within the Watercare business, there is more emphasis on exploration and investigation. Hence the large amount of scanning and networking undertaken by the Watercare business.

There is clearly a "tension" between the need for organisational routines necessary for the efficient manufacture, marketing and distribution of products **and** the need for non-routine activities necessary to develop new linkages and associations leading to new business opportunities (see Figure 10.1). The existence of this tension appears to be necessary if a firm is to be successful in becoming "Aware" of new information, if it is to succeed in creating new linkages and "Associations" that have not been made before, and if it is to be successful in "Assimilating" these and "Applying" them to commercial ends.

The different organisational characteristics, shown in Figure 10.1, that are required for different stages of the inward technology transfer process offers further insight into the extensive range of organisational capabilities necessary in order to participate in inward technology transfer. A similar concept has been suggested by Slevin & Covin (1990), who argue that organisations require phases of both innovativeness and routine in order to survive. This, they suggest, may be achieved by "cycling" between organicity and bureaucracy.

Chapter Three illustrates how a combination of "stochastic" and "cartesian" behavioural patterns is necessary for the long term survival of a natural system (Allen and McGlade, 1987). Similarly this research has shown the importance of the presence of a combination of such behaviours within an organisation if it is to engage successfully in inward technology transfer. The effective management of a range of stochastic **and** cartesian behaviours will enable organisations to recognise the value of new, external information, assimilate it **and** apply it to commercial ends. Hence, any study of the process of "Application" needs to consider the management of this tension.

10.5 The implications for technology policy in the UK

While not strictly the dominion of this thesis, the opportunity will be taken here to briefly discuss some of the policy issues which have emerged from this research.

Firstly, product life cycles are becoming shorter and shorter; in the 1960's and 1970's the life-cycle of a production car used to be between 10-15 years, now it is approximately only five years. Hence, organisations are having to change and adapt rapidly in order to compete. The old "Fordist" model of industrial organisations, characterised by the rationalisation of labour by mechanisation, the segmentation of functional activities and indirect mediated links to consumers, is being replaced by a new model that enables organisations to be more flexible and adaptable. This is characterised by the integration of functional activities and closer ties between producers, suppliers and consumers. Individuals within the organisation must also change and adapt to these new conditions. Bessant et al (1993) discusses the need for organisational adaptation and change with respect to Continuous Improvement (CI) in British Manufacturing. Such changes have implications for research scientists within industrial organisations. The traditional role of a research scientist as a world expert in a particular field, using a convergent, narrow-focus approach, who works in the lab trying to uncover new and cheaper ways of producing chemicals and products, is being replaced by researchers who have additional attributes. These include an ability to interact with customers, thereby increasing awareness of specific customer needs, market changes, the activities of competitors and the larger environment. This study has uncovered a number of important non-routine activities that organisations and senior managers need to recognise as important so that they may be able to provide the necessary internal support and environment for their research scientists and managers, enabling them to link rapidly any technical advances with customer needs thus creating new opportunities for the business. While there is still a need for research scientists who are able to focus narrowly and take a reductionist approach, this study has shown the value of divergent activities such as scanning and networking. Scientists need to have a mix of convergent skills to enable them to focus on a specific area and divergent skills such as technology scanning that will provide them with fresh, new ideas.

Secondly, Britain's industrial history should serve as a reminder that technology is a key factor in competitiveness, and hence in economic performance and growth. Its importance has, in no way, diminished with time. We are, however, constantly being reminded that the UK's technical and industrial capabilities are being eroded. Numerous views have been expressed (most recently by Sharp and Pavitt (1993)) as to why this is the case and more importantly how it can be turned around. The recent Government White Paper on science, engineering and technology places the process of innovation at its heart. It stresses that successful innovation will occur out of the interaction between the science base, technological development and the needs of the market. This demonstrated a break with recent popular modern thinking, concerned with the need for market or customer-led industries. Indeed this thesis has shown that, contrary to the model used by economists, technology cannot be simply bought and sold. The exploitation of externally developed technology is largely dependent on cumulative knowledge built up over many years of research and technology experience.

This research project has characterised the internal factors that affect an organisation's ability to engage in inward technology transfer. In addition it has viewed technology as a combination of knowledge, skills and equipment, that is often specific to a particular firm and a large part of which is tacit knowledge that flows from trial and error and learning; it is embodied in the term organisational know-how.

The importance of these internal activities in the inward technology transfer process raises an important implication for small and medium sized companies. The limited resources so typical in many small companies hinders their ability to provide the necessary environment, in terms of recruitment of high quality staff, extensive information sources, training and time for the non-routine activities of scanning and networking, to facilitate inward technology transfer. This raises a more fundamental problem. It is those companies who most need technology who are ill-equiped to acquire it and it is those companies who need to introduce technology scanning, for example, who can least afford it. Emphasis needs to be placed on "enabling" organisations to participate in technology transfer rather than only on the technical content. Hence the focus of future technology policy should be on providing, for those organisations who don't possess the necessary internal skills or activities, those mechanisms that will help increase their awareness of externally developed technology, assist in the creation of linkages between their internal capabilities and external technology and help in assimilating these associations into genuine business opportunities that the organisation can exploit.

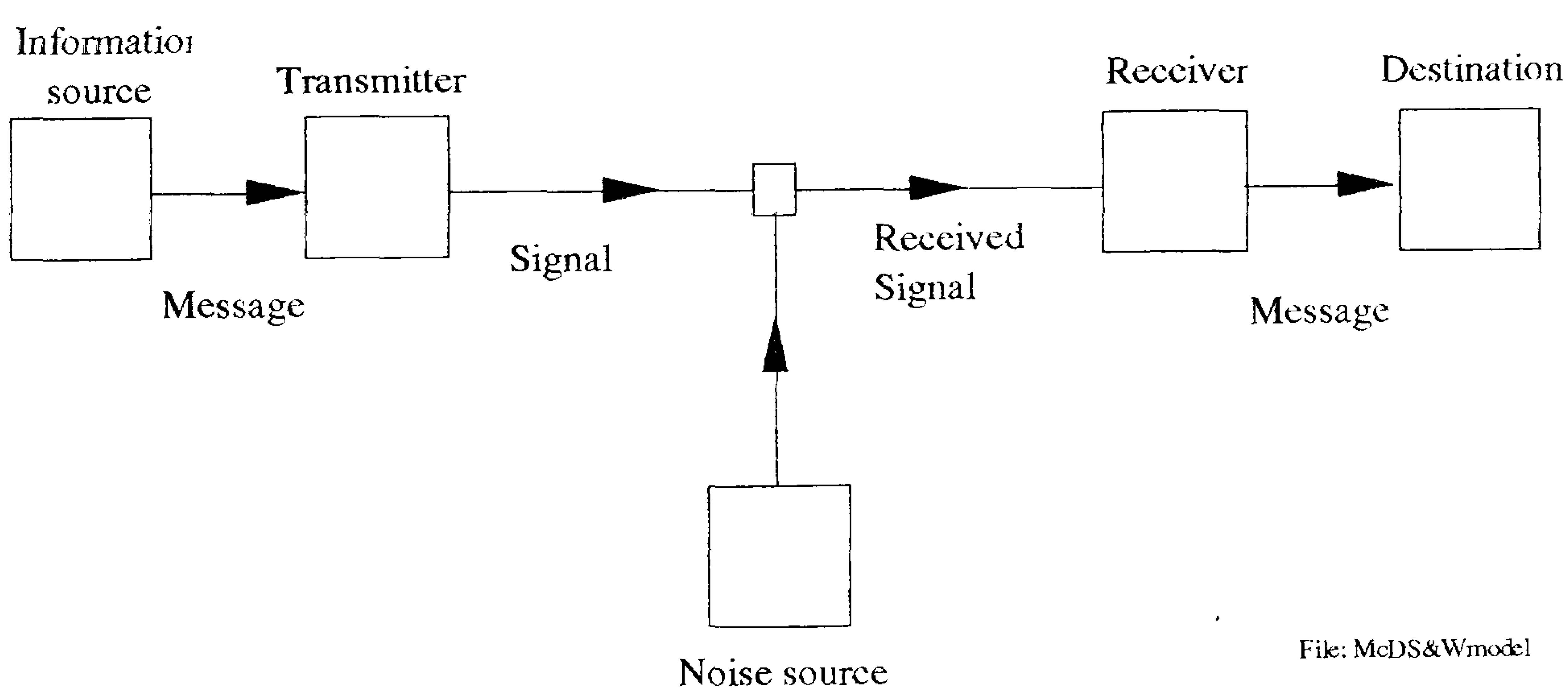
Appendix A

The concept of the signal-to-noise ratio

The signal to noise ratio was first introduced as a concept in human communication theory by Shannon and Weaver (1949). Warren weaver, an engineer and without a background in behavioural science extended Cluade Shannon's mathematical theory of communication to human communication theory. The model is shown in Figure A.1. The components in this model are defined as: "The *information source* selects desired *message* out of a set of possible messages... The *transmitter* changes the message into the *signal* which is actually sent over the *communication channel* from the transmitter to the *receiver*... The receiver is a sort of inverse transmitter, changing the transmitted signal back into a message, and handing this message on to the destination... In the process of being transmitted, it is unfortunately characteristic that certain things are added to the signal which were not intended by the information source... All of these changes in the transmitted signal are called *noise*" (pp. 7-8).[1]

Figure A.1

The Shannon and Weaver Model of Communication



[1] For a full review of the history of Communication Science see Rogers (1986).

Appendix B

Development of Technology Leverage Model

An interpretation of the development a model used at ICI Chemicals and Polymers to show the relationship between research activity and business characteristics

Paul Trott

Innovation and Technology Assessment Unit
Cranfield Institute of Technology

February 10th 1993

The relationship between research activity and business characteristics within ICI Chemicals & Polymers (C&P) Ltd: The development and use of a model.

Introduction

The purpose of this paper is to explain the factors that affect the decisions regarding the amount and type of research activity undertaken by each business within ICI C&P. The paper is based on an ICI C&P internal report produced by the Strategic Planning Group for the Research & Technology (R&T) Executive (Scholefield, 1989). It highlights the importance of relating the type of research activity with the strategic characteristics of a business and presents a model to facilitate this process[2].

Background

Prior to 1987 the amount of research activity undertaken by each business was based around the annual budgeting process. Each Business Manager and Research Manager of each business would present their case for a tranche of the R&D budget. Many senior managers believed that decisions regarding the amount of research activity to be undertaken by each business were arbitrary and not consistent. The process consisted of fierce and passionate debates, and decisions were based largely on "gut-feel". This was because the Business Managers were regarded as "Barons" who fought hard to protect and build their "fiefdoms". This behaviour was understandable as few people wanted to belong to a "fiefdom" that was in decline. Accepting a cut in R&D expenditure was viewed, within ICI, as similar to cutting off the branch on which you were sitting!

In 1987 at the formation of ICI Chemicals and Polymers Ltd. the head of Research and Technology wanted to try to adopt a more strategic approach to this decision making process. He sought a process that was based more on theoretical argument and less on "gut-feel". A number of Strategic Planners at ICI were given the task of addressing this issue of research activity allocation.

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2 See ICI internal report by J Scholefield, 1989, for a more detailed explanation.

Research & Technology Strategy within ICI C&P

Within the chemical industry in general, and ICI in particular, research has traditionally been viewed as a good thing, that has over the years produced many financial benefits to those who have been involved in it. ICI's position as the largest spender on R&D in the UK is evidence of this (see R&D Score-board; Independent, 1992). Needless to say such a philosophy influences management thinking and strategy development. Within ICI the role of technology receives a high profile and is consequently discussed during strategic management meetings. Within ICI C&P it was the accepted view that if the businesses could afford research they should have some! Thus the amount of "directed" or applied research was generally governed by how much each business could afford; allowing for a little "strategic research"[3]. Each Business Manager and Research Manager would then fight for their respective research groups. An indication of the lengths Research Managers would go to secure funding was recently made clear to me. For example, if a Research Manager was in doubt about allocation of funding for one of his business's research projects, one way to ensure funding was to inform the senior management that the business's main competitors were doing research in that area:

> "*If we told management that Du Pont* [competitor] *was doing work (R&D) in this area it was almost guaranteed that we would get funding.*" (Extract from discussions with researchers at ICI)

It was generally accepted by the Business Managers and Research Managers that in times of growth and profits the research groups would normally continue with the possibility of the creation of new groups. However, in times of downturn and slumps research groups would often be cut and sometimes lost.

The Strategic Management Group at ICI C&P wanted to ensure that the appropriate type and quantity of research activity was allocated to the appropriate business. In order to do this they wanted a more defensible and accurate method of allocating research activity.

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[3] Strategic Research or Basic Research is defined as areas of research that are of interest to the business or group in general. A small part of the total R&D budget is allocated to "Strategic Research" or basic research.

Section 1

Classifying the strategic position of a business

Within the bulk chemicals industry traditional marketing tools and methods for classifying the strategic position of a business have been less successful when compared with other industrial sectors. This is mainly due to its dependence on the costs of feedstocks. It is extremely difficult to classify accurately a business because decisions in the commodity markets and decisions by governments may radically alter the profitability of a business. For example a major shift in the price of coal or electricity can radically alter the cost of feedstocks. This may turn a highly profitable business into a loss making business. Consequently a large amount of research activity within a business whose profitability is largely determined by the cost of feedstocks is fraught with danger as it may be wasted by a single governmental decision. Hence allocation of research activity needs to consider these wider issues.

Portfolio Planning

The portfolio method of marketing planning adopts the analytical approach of financial investment, which has the objective of spreading risk and the opportunities of profit across a balanced range of investments. In a similar way to an investment portfolio, different combinations of products and markets may be devised by companies according to their objectives, experiences and resources. This planning method is used particularly in the formulation of strategy, by many large firms (including ICI) who manage several businesses. Levitt (1975) posited that most companies have products/businesses that can be classified in one of the following categories:

1. 'Yesterday's winners'- products/businesses, at one time profitable, which, because of declining demand or intensifying competition now contribute little if anything to corporate earnings.

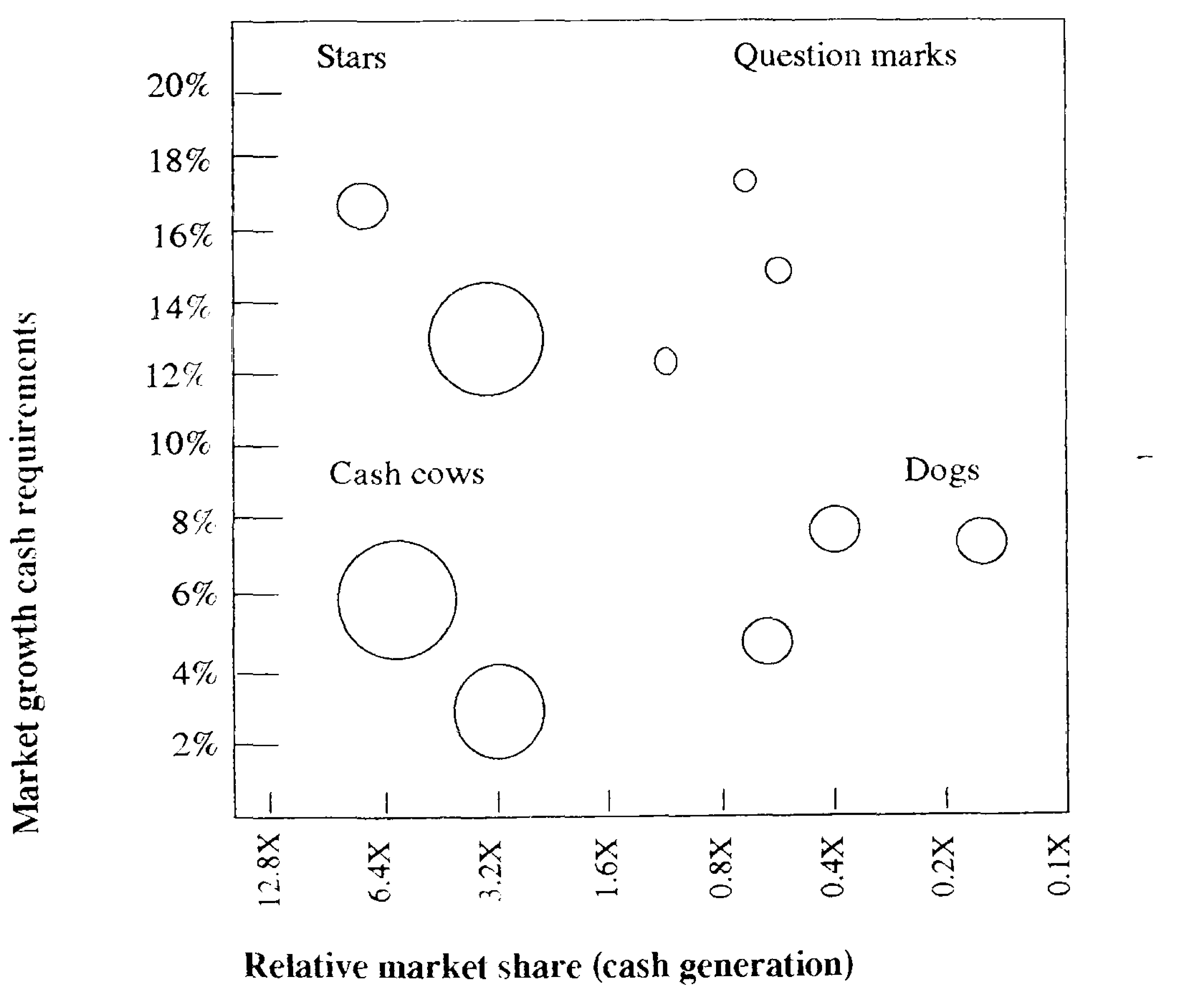
2. 'Today's providers'- these products/businesses are the backbone of corporate profitability, 'the milk cows on which all else feeds'.

3. 'Tomorrow's hopefuls'- these products/businesses are being developed or have been recently launched; as yet they are not self-supporting but their sales performance so far suggests that they may become 'the milk cows of the future'.

Within the portfolio planning theory several models have been developed including: 'Boston Consulting Group' Matrix (BCG, 1972); 'Shell International' Directional Policy Matrix (Seidi, 1979); 'A D Little' Business Profile Matrix (Wind, 1982). The BCG matrix uses the generation of cash flow as a measure of a success. Descriptive labels are attached to each sector of the matrix to help conceptualisation. These are based on the life cycle of a business.

Within ICI C&P, Portfolio Planning is regarded as a useful management tool and is used to allocate resources selectively in a capital constrained environment. The category of each business is loosely based on the concepts developed by the 'Boston Consulting Group' (BCG, 1972) using the two parameters of market growth and market share (see Figure 1).

Figure 1



Note: Circle area is proportional to size of business concerned, eg turnover.

In a 'Harvard Business Review' (HBR) survey to evaluate the strategic portfolio planning practices of the top U.S. companies; Haspeslagh (1982) found, amongst other things, that while portfolio planning helped managers solve problems of managing diversified industrial organisations, its use did not guarentee success. Effective implementation of plans into practice was necessary for success. Moreover, the 'HBR' survey found that portfolio planning was unable to successfully address the issue of new business generation. Market share and market growth, while necessary, are insufficient measures of a business's potential competitive position. As indicated earlier, within the bulk commodity chemical industry the technological position of a business also needs to be established so that the influence of technology on the business may be assessed. This can often reveal additional competitive strengths within a business, thereby significantly increasing its perceived value. This additional insight enables a more comprehensive analysis to be made of a business's competitive position. Moreover, it can often determine the strategic future direction of a business.

In a study of management practices in 37 companies Leontiades (1983) found that the distinguishing factor shared by these companies was that they did one thing particularly well. They had developed significant strength in one feature of their business which gave them a comparative advantage over their competitors. Such a strength has been termed "Core Competence" (Hamel & Prahalad, 1990) or leverage. While this concept is well known, although less well understood, one of the problems in applying it is that the features which result in this competence change over time in line with environmental changes (Blois, 1980). Hence, leverage should be viewed as a dynamic factor.

The influence of Technology on a business's competitive position

The following arguments are based on the simple premise that the type of research should be related to the extent of influence that technology has on the business' competitive performance. Using the 'Boston Consulting Group' Portfolio Planning Model two businesses with high growth and high market share would be classified in the same business category, that of "Star". If this business classification is then adopted by Research and Technology Planners one would expect a similar research activity for businesses in the same category. However, where a business's competitive position is largely dictated by, for example, the cost of feedstocks, then the spending of large sums of money on the development of new technological processes could be wasted by a slight change in the price of feedstocks. Hence, the business needs to be aware of the extent of influence its technology and its technological base has on its competitive position. This is termed Technology Leverage[4].

In 1989 the research policy of the ICI C&P Research & Technology Executive was:

> *"Where the technology leverage is low the objective should be to maintain the technology position. Where the technology leverage is high the objective should be to grow the technology position as well as to seek competitive advantage in technology."*

As indicated earlier within the high volume, bulk commodity, chemical industry Technology Leverage will depend upon the influence of other factors in the cost chain such as feedstock and distribution costs, and also on market opportunities (or growth). In general Technology Leverage will be high when the influence of feedstock and distribution costs are low.

Feedstock leverage

Feedstock leverage is low where the costs are a very small element of the costs of the product or where the feedstocks are freely traded on a global basis.

Distribution leverage

Distribution leverage is low where the costs of distribution are a small element of the product's costs. Where the distribution costs are high the market is often broken up into a number of small geographical segments.

Thus we can illustrate Technology Leverage in the following way:

Figure: 2

Feedstock Leverage	High	Low
Distribution Leverage	High	Low
	Low	**High**

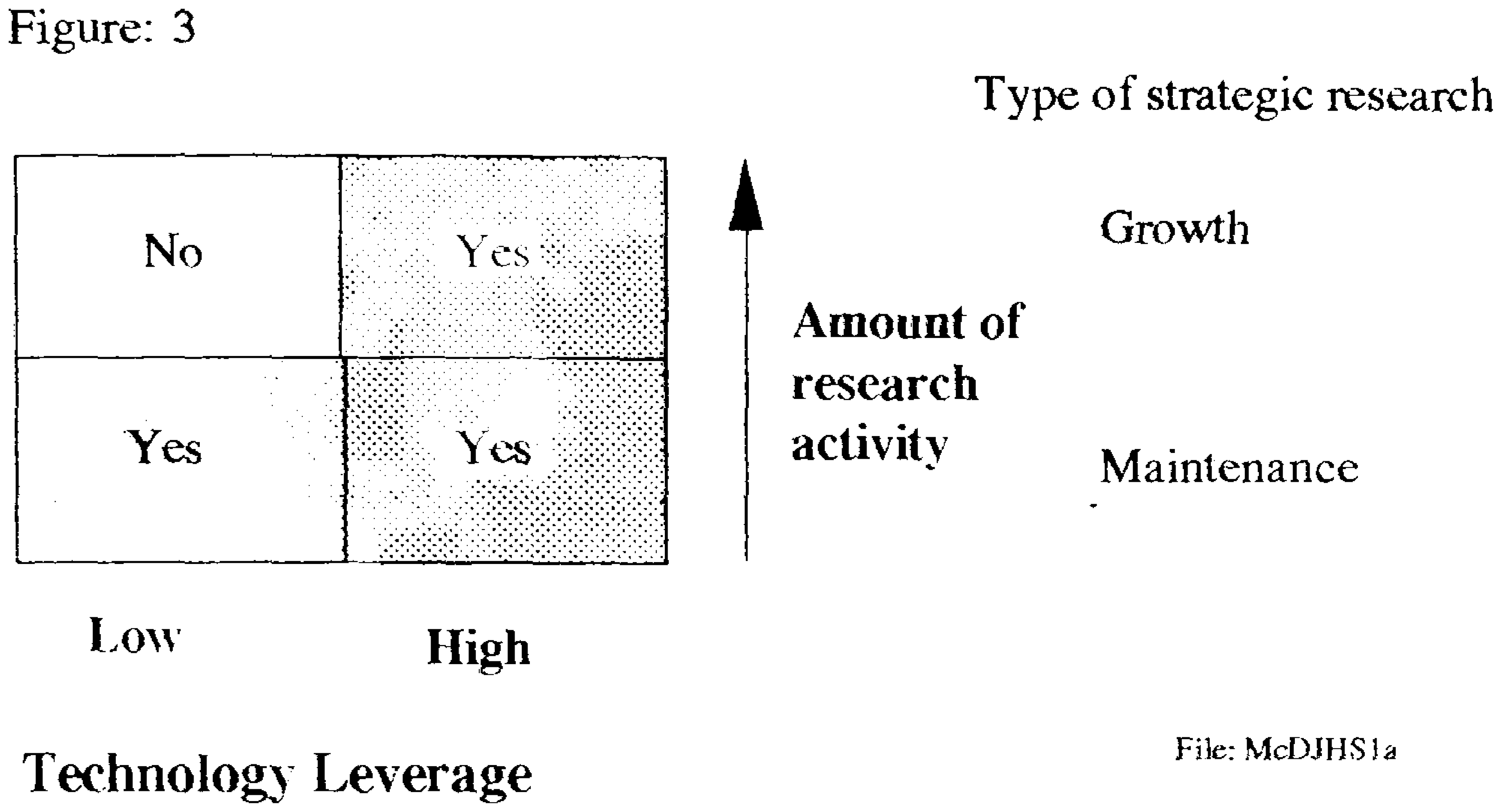
Technology Leverage

File: McDJHS1c

4 See ICI internal report by J Scholefield, 1989, for a more detailed explanation.

Hence, the basic model only recognises two categories of business, those with **High Technology Leverage** and those with **Low Technology Leverage**. Where the Technology Leverage is high the objective should be to grow the business's strategic position and seek competitive advantage. Whereas a business with low Technology Leverage should generally be conducting research to maintain the business's technology and its strategic position (see Figure 3 below).

Figure: 3



Developing the Technology Leverage matrix

The following discussion attempts to combine the Technology Leverage concept with the Boston Consulting Group Portfolio Planning Matrix, to try and develop a useful tool for establishing the amount of research activity appropriate for a business's strategic position.

To accurately establish the competitive position of a business, we must involve some assessment of commercial potential. If we combine the Technology Leverage concept and the portfolio planning framework we introduce a more comprehensive assessment tool for determining a business's competitive position.

Market growth

Market Growth is used by Marketing Planning and Strategic Management in Portfolio Planning Theory as a measure of the commercial prospects for a business (see page 7). Where many opportunities for growth appear to exist, the market opportunity would be viewed as positive. Where market growth opportunities do not appear to exist the market opportunity would be viewed as negative[5]. This variable has been added to the basic model (Figure 2) which only showed Technology Leverage. See Figure 4:

Figure 4

Technology Leverage	High	High	Low	Low
Market Growth	-ve	+ve	-ve	+ve
	1	2	3	4

File: McDJHS1b

Strategic business position

If we now introduce the other variable from Portfolio Planning Theory, Market Share, each of the four strategic business positions in Figure 4 may be subdivided (Figure 5):-

5 See Foxall (1984) for a more detailed explanation of portfolio planning theory.

Figure 5

Technology Leverage	Low	Low	High	High
Market Growth	Low	High	Low	High
	1	2	3	4

Strategic business position

File: McDJHS5b

Technology Leverage	Low	Low	Low	Low
Market Growth	-ve	-ve	+ve	+ve
Market Share	Low	High	Low	High
	1	2	3	4

Technology Leverage	High	High	High	High
Market Growth	-ve	-ve	+ve	+ve
Market Share	Low	High	Low	High
	5	6	7	8

Strategic business position

Explanation of Strategic Business positions

Position 1 (Low Technology Leverage)
A business with feedstock advantages, but low market share and growth, is probably consuming valuable resources with few prospects of contributing to the resource base in the future. Moreover, with technology having little influence on the business's competitive position, an exit strategy should be considered for business's in this position.
Technology Strategy: Withdraw

Position 2 (Low Technology Leverage)
A business in the category of high market share and feedstock advantage is likely to have a good profitability and be worth staying in. While its technology leverage is low it is necessary to maintain the technological position of the business to ensure it continues to provide revenue for the business. The negative market growth suggests this would be an

example of a "Cash Cow" situation. Such businesses enjoy dominant positions within their markets but those markets experience relatively low/negative growth. As a result the investment can be "milked" of the high cash contributions they earn as a consequence of the wealth of knowledge gained through experience of managing the business.

Technology Strategy: Sustain technological position

Position 3 (Low technology Leverage)

The positive market growth looks attractive but with low technology leverage and low market share the strategic technological position of the business is weak.

Technology Strategy: Withdraw

Position 4 (Low technology Leverage)

With high market share in a growth market a business in such a position would appear to be in a strong strategic position. However the contribution to net cash flow is low because a business in such a position demands large investments to maintain growth. The portfolio planning theory would suggest an incremental growth strategy for a business in this position. However with low technology leverage the business's strengths would appear to be dependant on external cost factors. Hence the strategic emphasis should be on maintaining the technological position with possibly incremental growth of marketing strategy.

Technology Strategy: Sustain technological position

Position 5 (High technology Leverage)

Although a high technology leverage exists, with low market share and low growth prospects a withdraw strategy should be considered.

Technology Strategy: Withdraw

Position 6 (High technology Leverage)

With a high technology leverage it is necessary to maintain the technological position of the business to ensure it continues to provide revenue for the business. This would be another example of a "Cash Cow" situation. The investment can be milked of the high cash contributions they earn as a consequence of the wealth of knowledge gained through experience of managing the business. N.B. The extent of expenditure required in order to maintain its technological position may be considerably different to positions 2 and 4 due to its high technology leverage.

Technology Strategy: Sustain technological position

Position 7 (High technology Leverage)

With low market share or an unestablished position, as with a new business the net contribution to cash flow is zero or even negative. However, it is from such businesses that the next generation of cash cows must come. With high technology leverage it may be necessary for a business in this position to seek a technological advantage in order to compete successfully.

Technology Strategy: Exploit technological base

Position 8 (High technology Leverage)

With high market share in a growth market and with high technology leverage a business in such a position is clearly in a strategically advantageous position. However, the contribution to net cash flow is low since the investment requirements of such a business are extremely high. Foxall (1984) argues that "there is often a temptation to reduce these investments in order to gain immediate cash flow benefits . . . this often proves to be a myopic strategy since the long term possibility that the business will develop into a lucrative cash cow is jeopardised"; hence the need for steady incremental growth.

Technology Strategy: Grow technology incrementally

The eight strategic business positions above can be categorised into four distinct technology strategies (see Figure 6):

Figure 6

Technology Leverage	Low	Low	High	Low	Low	High	High	High
Market Growth	-ve	+ve	-ve	-ve	+ve	-ve	+ve	+ve
Market Share	Low	Low	Low	High	High	High	High	Low
	1	3	5	2	4	6	8	7
		Withdraw			Sustain		Grow incrementally	Exploit technological base

File: McDJHS4

Technology Strategy

By using the concept of Technology Leverage the above matrix provides a more comprehensive tool with which to establish the strategic position of a business within a portfolio planning framework. This can be demonstrated below using the four businesses within the Chlor-Chemicals group:

Figure: 7

	Chlorine derivatives (Solvents)	Clor-Alkali	Watercare	Electrochemical Technology
Technology Leverage	Low	Low	High	High
Market Growth	-ve	-ve	+ve	+ve
Market Share	High	High	Low	Low
	2	2	8	8
McDJHS4b	Sustain	Sustain	Exploit technological base	Exploit technological base

Technology Strategy

Section 2

Classifying Research Activity

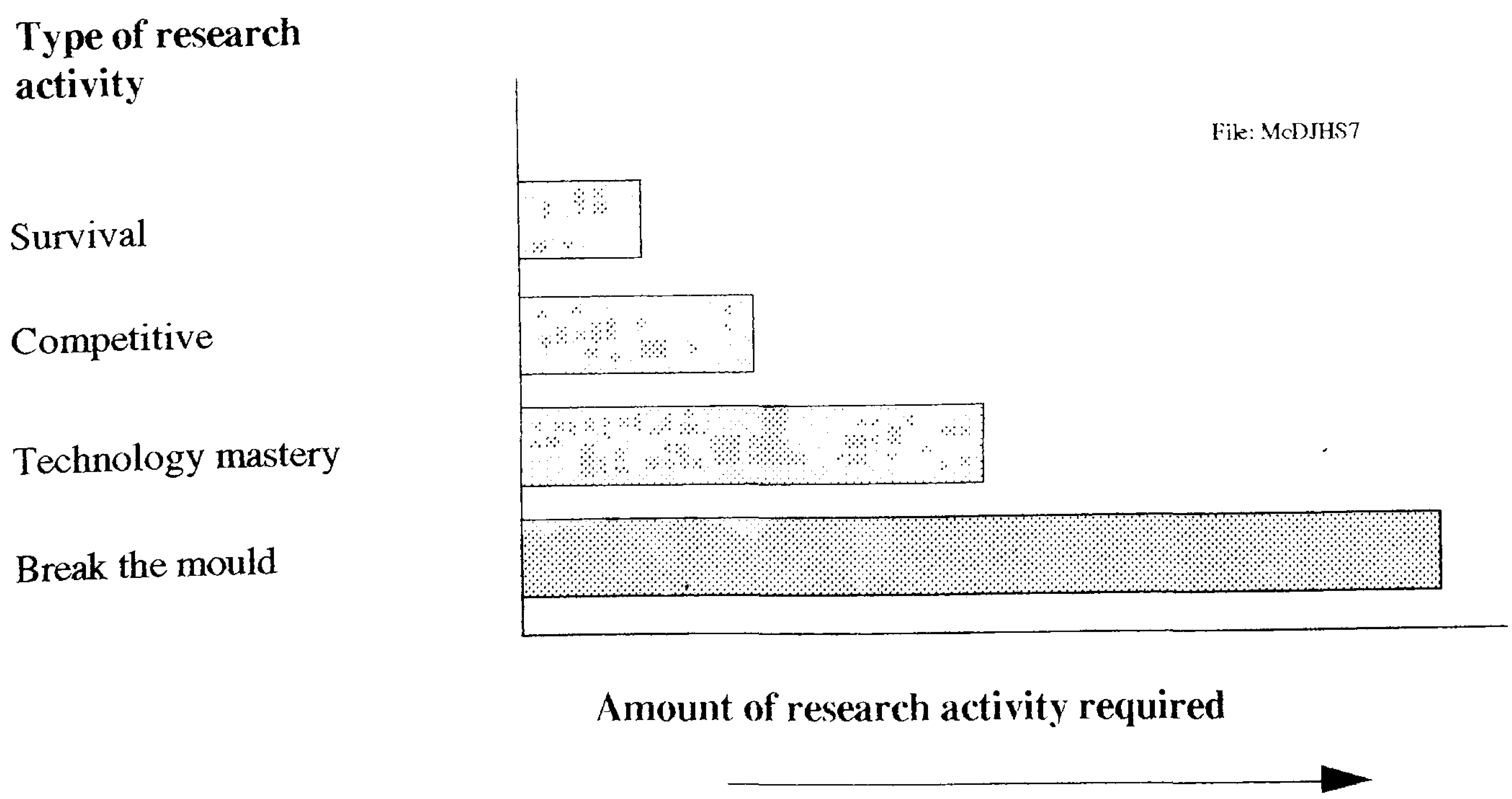
Within the chemical industry much of the technological resources consumed by the business is in the form of engineering and plant maintenance (often called Technical Service). This is commonly spread over a wide area of technologies (see Section 1).

In addition a firm may decide to develop a number of key areas of technology that it believes are important to the future of the business. This type of concentrated activity where the business attempts to build technological knowledge competencies is referred to as research. There are clearly different resource requirements between providing "Technical Service" and conducting research. The building and development of technological knowledge competencies take time and demands a large amount of research activity.

The strategic Management Group at ICI suggested that "if one assumes that research (as distinct from Technical Service) will not be conducted within a business that is to be closed, then there are essentially two forms of activity for the R&T department, "Growth" and "Maintenance"" (Scholefield, 1989) (see Figure 3). Furthermore, within these two groups it is possible to conduct significantly different types of activities. Hence, these categories were later subdivided into the following four groups (see Figure 8):

Maintenance:	A Survival	**Growth:**	C Technology Mastery
	B Competitive		D Break the mould

Figure 8



Explanation of suggested categories of research activity:

<u>Survival</u>

This type of activity is conducted if the decision has been made to exit the business. In such circumstances the role of the Research & Technology Department (R&T) is to ensure its interim survival against technological mishaps to process or product. This would be a reactive problem solving role and may be termed "survival research".

<u>Competitive</u>

If the intention is to sustain the business then the role of "research" is to maintain the relative competitive technological position by making improvements to both product and process. However, as indicated in the previous section the amount of research activity required to maintain a high technology leverage position will be significantly greater than that required to maintain a low technology leverage position. Thus it seems reasonable to split this category in two: Cometitive (Low Technology Leverage) and Competitive (High Technology Leverage).

<u>Technology Mastery</u>

Incremental growth of a business in a strong position involves improving the product and process relative to the competition. This will also involve keeping abreast of technological developments that may affect the business's products or processes.

<u>Break the Mould</u>

If the aim is to create a technological advantage then a much higher order of novelty and creativity is required.

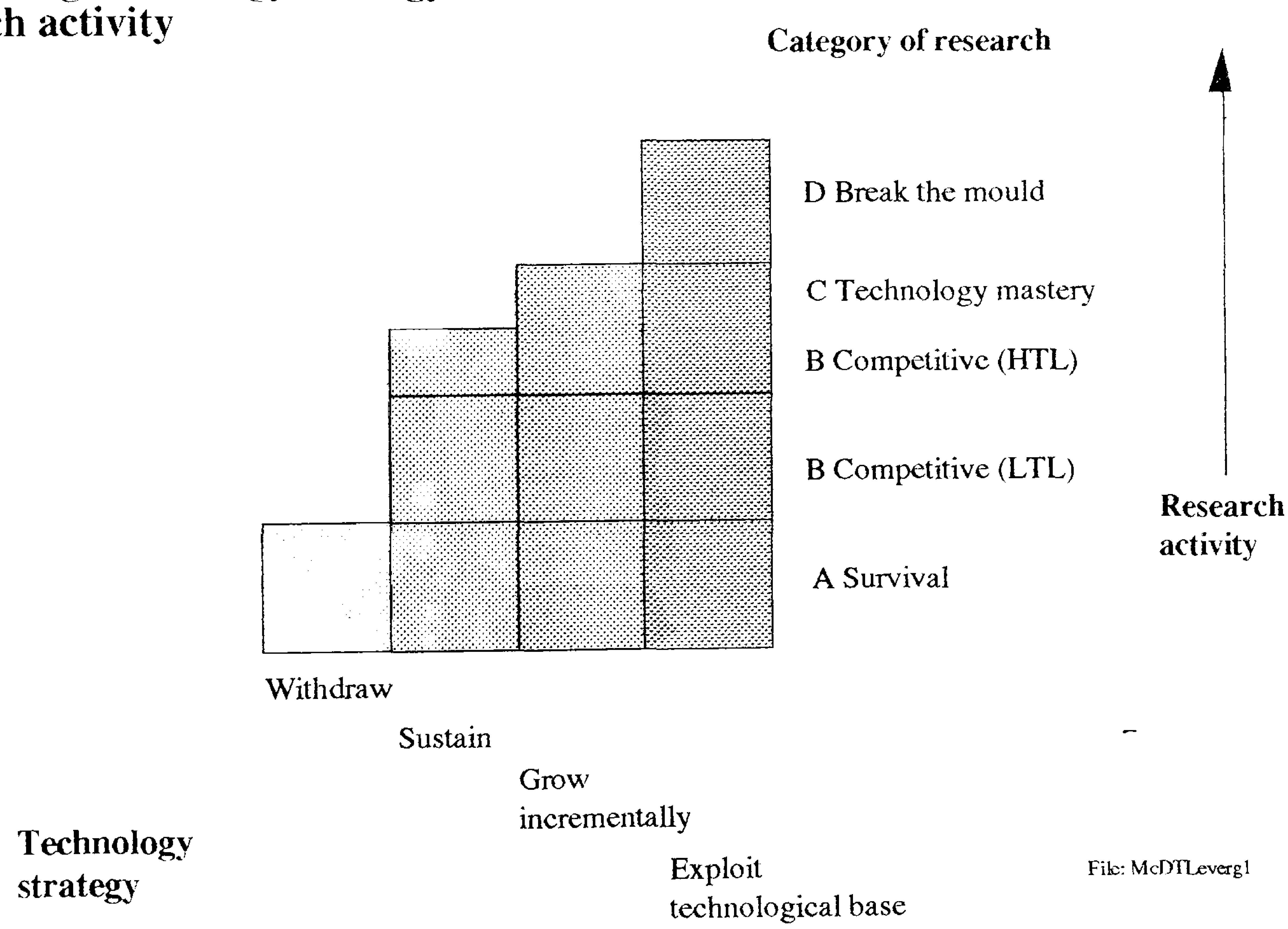
Section 3

Linking technology strategy to research activity

The relationship between research activity and business characteristics can be shown by combining the classification of business category (Figure 7) with research activity (Figure 8). This model (shown below) offers guide-lines for the allocation of research, taking into account a number of characteristics. These guide-lines are based on the simple premise that the type of research should be related to the extent of influence that technology has on the business' competitive performance (see Figure 9).

Figure 9

Model linking technology strategy to research activity



Hence, a technology strategy of "Withdraw", should be conducting "Survival" research. Whereas a strategy of "Exploit Technological base" should be conducting "Break the mould" research.

Quantification of research effort

Quantifying research effort is often linked to the setting of annual research budgets. Determining budgets is influenced by short term fluctuations and availability of funds as well as by the long term strategic technological needs of the business. Twiss (1980) argues that it is extremely difficult to establish a basis for allocation of funds that is acceptable to all parties. He outlines a number of approaches:

a. Interfirm comparisons.

By analysing the amount of research expenditure being conducted by its competitors a business is able to establish an appropriate figure for its research effort.

Chemical industry within the UK

(R&D expenditure (1991) as a % of sales)

ICI	4.58 %
BOC	2.22 %
Unilever	1.83 %
Courtaulds	1.56 %
Albright & Wilson	1.23 %
Laporte	0.65 %

(Source: Independent, 1991)

b. A fixed relationship to turnover.

This is normally related as a constant percentage. Turnover normally provides a reasonably stable figure that grows in line with the size of the company.

Figures for ICI businesses

(R&D expenditure as a % of turnover)

C&P average	2.0%
Chlor chemicals average	1.8%
Chlorine Derivatives	0.4%
Watercare	6.4%
Chlor Alkali	0.4%
Electrochemical Technology	6.4%

c. A fixed relationship to profit.

Twiss argues that this is highly undesirable and implies that research can only be afforded when the company is doing well.

d. Reference to previous levels of allocation.

This approach takes into account the cost of previous research projects and uses these as guide-lines for setting new budget.

e. Costing of an agreed programme.

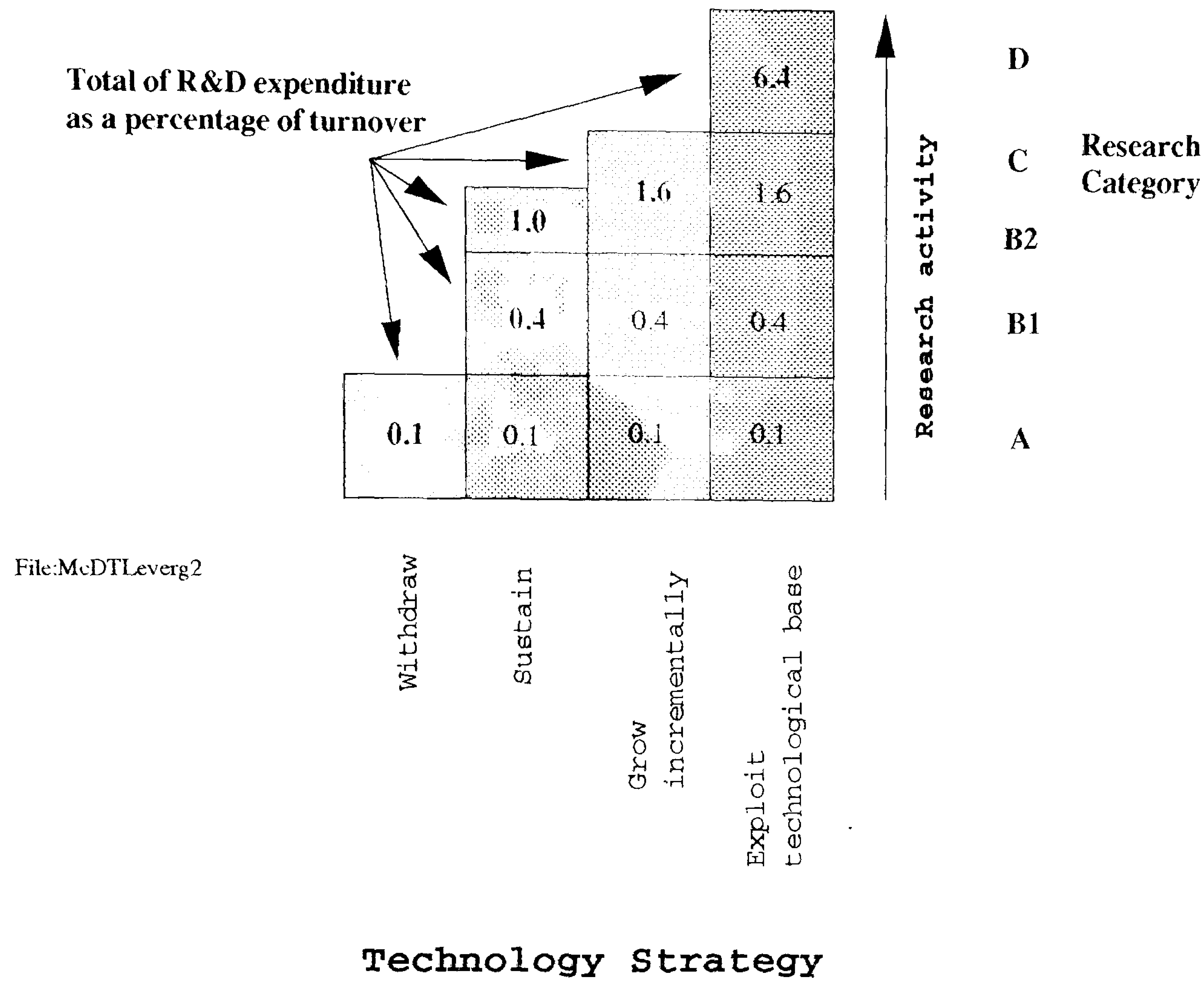
Due to the nature of the activity of research it is extremely difficult to accurately cost a programme.

In practice ICI use a combination of a, b and d. However, judgement and negotiation will often play a significant role as suggested in Section 1. The Portfolio Management approach enables profits from todays successful businesses to be invested into the new growing businesses that will hopefully, in turn, become profitable. In addition many businesses, including ICI, also invest in Basic Research or Strategic Research. This is research that is seen as of interest to the company as a whole and in the long term interest of the company.

Using the fixed relationship to turnover approach mentioned above (b), the following figures have been developed from an analysis of research expenditure by competitor companies within the chemical industry[6].

[6] See Scholefield (1989) for details of the competitor analysis figures.

Figure: 10



Using the model above, a business in category 1 should be spending approximately 0.1 % of turnover on research and technology. Whereas a business in category 4 should be spending approximately 6.4 % of turnover on research and technology.

Use of the model

A business's expenditure on research activity would be reviewed annually or quarterly. The model is used as a guide to establish whether a business's research activity is appropriate for its business position. Experience at ICI has shown that without such a guide research activity can drift over time resulting in too much or too little research activity appropriate for the business. The model provides the facility for Business Managers and Research Managers to monitor research activity. In practice this involves a constant analysis, adjustment and realignment. For example, each quarter the ICI C&P executive would meet and discuss quarterly results. During these meetings, a business's strategic position could be reclassified according to performance and external environmental factors (see Section 1). That is, a business's category may change from say 3 to 4 or from 2 to 1.

Discussion

1. The model attempts to introduce some theory into what was traditionally an arbitrary competition for research activity. The model provides a framework within which discussions may take place. In practice the model is used to check decisions made by Research Managers and Business Managers as opposed to being used as a model for dictating decisions. It is testament to the robustness of the model that, unlike many models introduced at ICI, this particular one remains in use by the ICI C&P Executive, five years after it was first introduced.

2. There are often problems when outsiders suggest a procedure or structure for strategy development. They often over simplify the reality of the interactive process in which the company develops its approach to its businesses. However, this paper describes the internal development of a model by senior management who have over twenty years of experience of working within the company.

3. Much of ICI's success in its early years was based around new scientific and technological developments. In fact in the past the business leaders and senior managers have tended to be scientists or engineers, hence its predisposition towards expenditure on research and technological development. Today ICI remains on top of the league in terms of UK expenditure on Research and Development (Independent, 1991) even though all its business leaders are no longer scientists and engineers.

Within the UK the company has built a reputation for emphasising and supporting science and technology. Only recently a study by Jones (1992) of postgraduate scientists showed that ICI was viewed as having "an almost academic reputation for the quality of its science". It is against such a background that one may argue, with some justification, that the role of science and technology receives a high profile within ICI; hence the technology perspective within this strategic management model.

4. The model presented in this paper offers a framework for strategic management to make decisions regarding the allocation of research activity. In addition it includes a technological perspective for classifying a business's strategic position. Many strategic management tools while paying lip service to the importance of technology fail to

accommodate a technological perspective in the decision making process. Hence, there is an over emphasis on the financial or marketing perspective Ansoff (1968); BCG (1972);.Porter (1985).

5. This paper provides a backcloth for the inward technology transfer model currently being developed. It shows how the role of strategic technology management and the selected "growth" strategy of a business can influence the business climate within which individuals operate. For example, if a strategic decision is taken to exit a business this will clearly have a profound influence on the nature of activities within the business. One would expect the activities of a business operating in a climate of growth are to be different from those of a business operating in a climate of decline. That is not to say a growth strategy will necessarily represent a more "receptive" business. A business in a "cash cow" situation, while it may be less "receptive" to expensive new product developments, it will, on the other hand, be extremely "receptive" to developments and technology that will help to reduce costs and improve efficiency.

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Innovation & Technology Assessment Unit, Cranfield Institute of Technology. **Appendix C**

Interview — Pt 1— Background information

Name..D.O.B.......................................

Business...

Function..

Main Activities...

....

....

Career Background

Please briefly describe your career background, in terms of function, up to the present date:

....

....

....

Number of years worked within an essentially research environment:........................

Number of years worked within an essentially commercial environment:....................

Educational background

Qualifications..

....

Membership of professional bodies/institutes...

....

Additional information..

....

....

Who do you think are your business's main competitors?

....

....

Thank you for providing me with this background information. I will collect this questionnaire from you when I meet with you to discuss the research in more detail.

Paul Trott

Appendix D

Structured Interview

Thank you for agreeing to participate in this interview. This interview forms part of a survey of businesses within ICI and the survey is part of my research for a Ph.D, which I am studying for at Cranfield Institute of Technology. The research is in the area of innovation and in particular concerns the organisational factors involved in the innovation process. The research is being sponsored by ICI Chemicals & Polymers. I have signed all the necessary confidentiality agreements and I am therefore subject to all the company's regulations.

The information you provide in this interview will be treated in the **strictest confidence** and will only be used for academic research. Individuals and or businesses will not be identified in any analysis or report. I would be grateful for your personal and honest views.

---

1. How much of your time, a week, at work do you spend scanning for useful information?
('scanning' here means unstructured formal and informal methods of information search)

....

2. What technological information sources do you currently most frequently use in your work? (see prompt list, mark with T)

....

....

....

3. What commercial information sources do you currently most frequently use in your work? (see prompt list, mark with C)

....

....

....

Possibilities

Specific journals	___	General journals/newspapers	___
Current awareness prog.	___	On-line databases	___
Browsing in the library	___	R&T Library	___
Information scientists	___	Exhibitions	___
Research/Trade Associations	___	Company accounts	___
Consultants	___	Other chemical companies	___
Internal meetings	___	Internal company reports	___
Catalogue enquiries	___	Social friends	___
Information Profile service	___	Customers	___
Academic contacts	___	Competitors	___
Suppliers	___		

4. Do you have any difficulties in gaining access to these sources?

....

....

....

Journals

5. Details of journals/literature most commonly used:

....

....

....

6. Where do you get these from?

....

....

7. How do you read these journals?

....

....

....

....

8. Do you ever get the opportunity to browse in the library?

If yes: How often?

....

9. How do you view browsing in the library?

....

....

....

....

10. What are your most useful sources of relevant information for your business?
(relevant here means to have a direct bearing on your business)
(useful here means necessary for your work or helpful in your work)

....

....

....

....

11. Do you receive any other sorts of technical or commercial information from colleagues?

What sort of information is this?

....

....

....

11b. Was this solicited on your part?
If no: Why do you receive this?

....

....

11c. Is this information useful?
(useful here means necessary for your work or helpful in your work)
....

....

12. Do you know of any other sources of information that would be useful to you?

If yes: What are these?

....

....

....

12b. Do you use these sources?
If no: Why?

....

....

13. How do you view the levels of technical and commercial awareness of people within your business?

....

....

....

14. If there is a conference or exhibition that you wish to go to what do you do?

....

....

....

....

15. To what extent are you able to go to any conference or exhibition that you wish?

....

....

15b. How often do you attend conferences/exhibitions?

....

16. To what extent are you able to arrange visits for yourself to other companies and or universities?

....

....

16b. How often do you visit other companies and or universities?

....

17. Do you believe your business encourages people in your position to spend time outside the company?

If yes: How does it do this?   If no: Why is this?

....

....

....

18. In terms of improving your level of awareness for your business, what **current** activities do you think you should spend more time doing ?

....

....

....

18b. What new activities do you think you should spend more time doing?

....

....

....

19. What are your initial thoughts when you come across possible opportunities for your business?

....

....

....

....

20. Do you feel your business encourages ideas and suggestions from people in your position?

Why is this?

....

....

....

21. Have you recently, say in the last month, come across some information, either through reading or discussions with other people, that you **thought** might be useful for your business?

If yes: How often does this occur?

....

21b. What was this information about? (obtain details)

....

....

....

21c. Were you able to do anything with the information?

....

....

....

21d. What happened? (obtain details)

....

....

21e. Was there any feedback?
What was the nature of this feedback? **or** What happens now?

....

....

....

22. When you receive or uncover useful information, how do you rate the authenticity, validity and credibility of this information?

....

....

....

....

23. Would you have reacted differently to that information if, for example, you had come across it in a different way or if it had come from another source?

Why would you have reacted/not reacted differently?

....

....

....

How would you have reacted differently?

....

....

....

24. Of all your sources of information which do you attach most credibility and validity to?

....

....

....

....

25. Are there any **sources** of information that you feel you would be more likely to act upon than others?
Why?

....

....

....

26. In your current position, which form of communication do you find you use most often?

....

....

27. With regard to your position, which form of communication do you find to be most effective?

....

....

28. In your current position which form of communication would you say was vital to the effectiveness of your role?

....

....

29. Given the opportunity, would you alter current communication methods?

....

....

The following questions specifically refer to interactions with people:

30. In a normal week, what proportion of all the different people you speak to are:

within your business:..........................   ..%
within your Chlor-Chems but not in your business:.......%
within ICI but not in Chlor-Chems:... ....%
Outside ICI:...................................   ..%

31. Who most frequently provides you with information that is useful for your business?
('your business' here means either Watercare or Solvents)

....

....

31b. What sort of information is this?

....

....

32. What interactions **within your business** produces the most useful information?

....

....

33. Excluding your business, what interactions **within Chlor-Chemicals** produces the most useful information?

....

....

33b. Excluding Chlor-Chemicals, what interactions **within C&P** produces the most useful information?

....

....

33c. Excluding C&P, what interactions **within ICI** produces the most useful information?

....

....

34. Do you gain any useful information from informal discussions and interactions with people from other

companies, including competitors, operating in similar areas of business?

....

....

....

35. What are your thoughts about the type of information you acquire from informal discussions with others?

....

....

....

36. Do you have any important external sources of information?
('external' here means outside ICI)

....

If yes: What are these sources? or If no: Why is this?

....

....

....

37. Do you know of any groups of people with whom you would like to discuss technological or commercial matters but for whatever reason are unable to do so?

If yes:
What are these sources?

....

....

....

37b. What sort of things would you like to discuss?

....

....

The following questions refer to the business:

38. In your current role, would you say you were familiar with the needs of your business?

How are you made aware of these needs? **or** Why is this?

....

....

....

39. Do you know what the business expects and requires from a (job title of interviewee) ?

....

If no: How do you feel about this? **or** If yes: How do you know what the business expects and requires from a (job title of interviewee)?

....

....

....

40. Do you know what your Business Manager expects and requires from (job title of interviewee)?

How do you feel about this? **or** How do you know what your Business Manager expects and requires from a (job title of interviewee)?

....

....

....

41. Are there any additional activities which you personally feel are an important aspect of the job; but which others might not appreciate?

If yes: What are these?

....

....

....

41b. Are there any activities that you feel are not an important aspect of the job; but others feel are important?

....

....

....

42. Considering the things required of someone in your position– what additional facilities would enable you to fulfil all these requirements?

....

....

43. How do you pass on information that you believe is useful to the business?
(obtain details of people involved, methods, ie formal, informal, written report, verbal communication, presentation etc.)

....

....

....

44. Why do you choose this method?

....

....

45. Do you feel it is a successful method?

....

46. How much attention do you feel that your ideas receive?

....

....

47. Do you feel that your ideas are understood?
Why is this?

....

....

....

48. Do you feel that your ideas are taken seriously or not?
Why is this?

....

....

....

49. Given a choice which method would you prefer to use to put forward ideas? (Reasons)

....

....

....

50. Do you think the decision to progress an idea is influenced by the source of the idea, the person making the idea, or what?

....

....

....

....

....

51. What influence does the person making a suggestion, putting forward an idea, have on whether the idea is progressed?

....

....

....

....

52. What do you think are the main needs of the Watercare Business?

....

....

....

53. What do you think are the main needs of the Solvents Business?

....

....

....

54. What do you think are the main needs of Chlor-Chemicals?

....

....

55. What current external events are likely to affect your business's activities in the near future?

....

....

....

56. How **technologically** competent do you believe your business (either Watercare or Solvents) is compared with your main competitors?

....

....

57. How **commercially** competent do you believe your business (either Watercare or Solvents) is compared with your main competitors?

....

....

58. Would you say you were familiar with the internal workings of your business?

If yes: How are you made aware of these workings? **or** If no: Why is this?

....

....

59. How do you try and ensure you are aware of information that might be important or relevant to your business?

....

....

60. How does the business ensure it is aware of technology that might be useful?

....

....

....

61. How does the business ensure it is aware of commercial opportunities that could be exploited?

....

....

....

Comments

Do you have any comments about either the subject area or about the interview?

....

....

....

....

Positive Outcomes from scanning and networking. (Ref: Q21 of survey)

	Scanning & networking	Information acquired	Potential Benefit	Positive Outcome	Type of outcome
W2	Received journal article from colleague.	It concerned a water purification research activity related to our business.	I have made contact with the organisation who produce these water purification products.	We are in the process of negotiation.	Genuine business opportunity
W19	Discussions with customer.	Customer wants to treat concentrated solutions of effluent using our technology.	This technology may also be useful to treat weaker solutions.	We have brought in a consultant, who has signed confidentiality agreements, to investigate. He will present his findings in due course.	Genuine business opportunity
W1	Reading a 1988 business study report from a US company that the business are working with.	The use of ozone to control odours.	We are researching the field of controlling odours. This US company are trying to use ozone to control odours.	The information has been passed to both business managers. They are both interested. We have to put some equipment together this will take time!	Genuine business opportunity
S10	Reading 'What's new in marketing'.	Article about Telemetry Technology that is being used by other companies.	We could employ this process to improve the "JIT" process for our business/customers.	Arranged meeting with Technical Manager and another member of the business team to discuss possibilities. Decided to test with an ICI business, who is also a customer.	Genuine business opportunity
W6	Meeting with an equipment supplier. (He visited ICI, he actually came to discuss another issue.)	Market share in "belt presses" that are used in the drying of sludge.	This information enabled me to solve a problem for one of my customers.	An opportunity exists for the business to open a channel for a market in this area.	Genuine business opportunity
W18	Literature search.	Identified a patent application that has recently been made in the US.	We have been trying to apply for a patent in the US with very similar technology. It appears that a patent has been granted to a US company while our application has been refused.	There may be an infringement on our patent. Our patent agents in the US are negotiating.	Technical opportunity

S8	Reading general competitor product literature.	Identified interesting technology. Colleague told me that a company in Canada was offering this technology for exploitation.	Our business are involved in similar work. May be able to discuss opportunities with this company.	Contacted ICI Canada to follow up this lead. We are about to sign a secrecy agreement to have a look at the technology/chemistry.	Technical opportunity
W15	Identified an interesting patent.	Patent concerned technology relating to membrane technology.	We have a research project in this area of membrane technology. This patent may be useful to the research.	This particular membrane research project is being undertaken at Leeds Uni. I have passed this information to them. They will be using this in the research.	Technical opportunity
W16	Reading 'Chemistry in Britain'.	Identified an item on water purification systems.	We have several products in the area of water purification. I passed this to a techno-commercial colleague, he will now deal with this.	He is a friend of mine, I will chat to him over lunch to see what happens.	Technical opportunity
N20	Reading 'New Scientist'.	Article about Polymer Electrolyte.	Relates to work currently being undertaken by one of the businesses.	Via ICI US contact eventually able to put author of the article in touch with people in R&T. They spoke on the telephone.	Technical opportunity
W3	Discussions with an academic at a conference at Warwick Uni.	The use of nutrients in liquid fertilizers. (Nitrate metabolism)	We sell liquid fertilizers. I now have evidence showing that ICI materials are better than competition.	I am giving a paper in May to the Paper Industry. Following discussions with colleagues in R&T, I will now be able to include this information in my paper and show that we are better than are competitors.	Technical opportunity
S14	Reading 'European Chemical News'. Also received this news from US sales force.	Announcement by competitor, French company, to build a new plant in US.	While this is a threat to one part of ICI it is also an opportunity for our business to increase sales by supplying this company with raw materials.	People in US will decide next step.	Commercial opportunity
W4	Reading document received from 'NRA'.	Explanation as to how 'NRA' are going to classify areas of coastline in UK.	This, in effect, tells us the market share for each of our products.	Passed this to colleagues. They will use this in marketing plans. Marketing plans will be used to convince Chlor-Chems to give us more cash!	Commercial opportunity
S9	Discussions with colleague from another ICI business.	Business strategy employed by another ICI business.	Relates to the business strategy being used by our business, this may be useful to our business.	Circulated this information to our business managers. We had a meeting and discussed possibilities. Now need to build some scenarios then look at implications for our business.	Commercial opportunity

S13	European Chemical Industry Association meeting on environment.	Discussions about the affects of the 'Montreal Protocol' on US solvent producers.	In '92 US producers may only be allowed to produce half the total of '91.	Large marketing opportunity has appeared for ICI. We are working on it now !	Commercial opportunity
S12	Visited a customer, had discussions.	During discussions he enquired about a product that was similar to one of ours.	The opportunity exists to sell our products to a Rubber company in China through our British customer.	Discussed this opportunity with Technical Manager. He will contact ICI Hong-Kong, who will contact the Rubber company in China to find out the company's precise needs.	Commercial opportunity
W7	Discussions during a meeting with 'Severn Trent'. The original meeting concerned a different subject.	They were interested in something we hadn't thought of, regarding an IT system.	They required some data that we were later able to supply.	We have built up a good relationship with 'Severn Trent', who could become one of our biggest customers!	other

File: WPositiveoutcomes

Chlor-Chemicals Appendix F

Chlor-Chemicals Business
ICI Chemicals &
Polymers Limited
PO Box 14 The Heath
Runcorn Cheshire WA7 4QG
Telephone (0928) 514444
Telex 629655 ICIMOH G
Fax (0928) 569459

Mr P Trott
International Ecotechnology Research Centre
Cranfield Institute of Technology
FREEPOST
Cranfield
Bedford
MK43 7BR

Your ref	Our ref	Direct line	Date
	ND/LJR	(0928) 51 1319	26 Apr 93

Dear Paul

Many thanks for the cognitive map. It is very interesting to see the processes mapped out in this way. A couple of small points. I cannot remember the context in which I said that "very little is written down" but it does not feel correct and I would delete. One point perhaps not captured is that individuals have ideas which link into both "Informal discussions ...." and "Meetings are very important ...."

Otherwise you seem to have captured our discussion admirably.

Kind Regards

Norman Daniels

Norman Daniels
Cereclor Marketing Manager

NDDH56

Appendix G: Parallel study conducted at Redsoap

A parallel study to the one carried out within ICI was coonducted within Redsoap. The identical procedure to that used in Chapter 8 was used in the collection and analysis of the data here.

H.1 Participants

A senior manager from Redsoap selected a representative sample of people.

Figure H.1

Business	Participant	Age	Yrs with business
Redsoap Detergents	New Product Dev. Mgr	50	30 yrs
Redsoap Detergents	Research Manager	58	30 yrs
Redsoap Detergents	Research Scientist	35	15yrs
Redsoap Detergents	Consumer Res. Scientist	45	25yrs

H.2 Cognitive Maps

The following cognitive maps were produced following interviews using the identical procedure to that outlined in Chapter 8.

Figure H.2

A Cognitive Map of the process of "assimilation" of technical or commercial ideas into genuine business opportunities; Redsoap Research, 10.

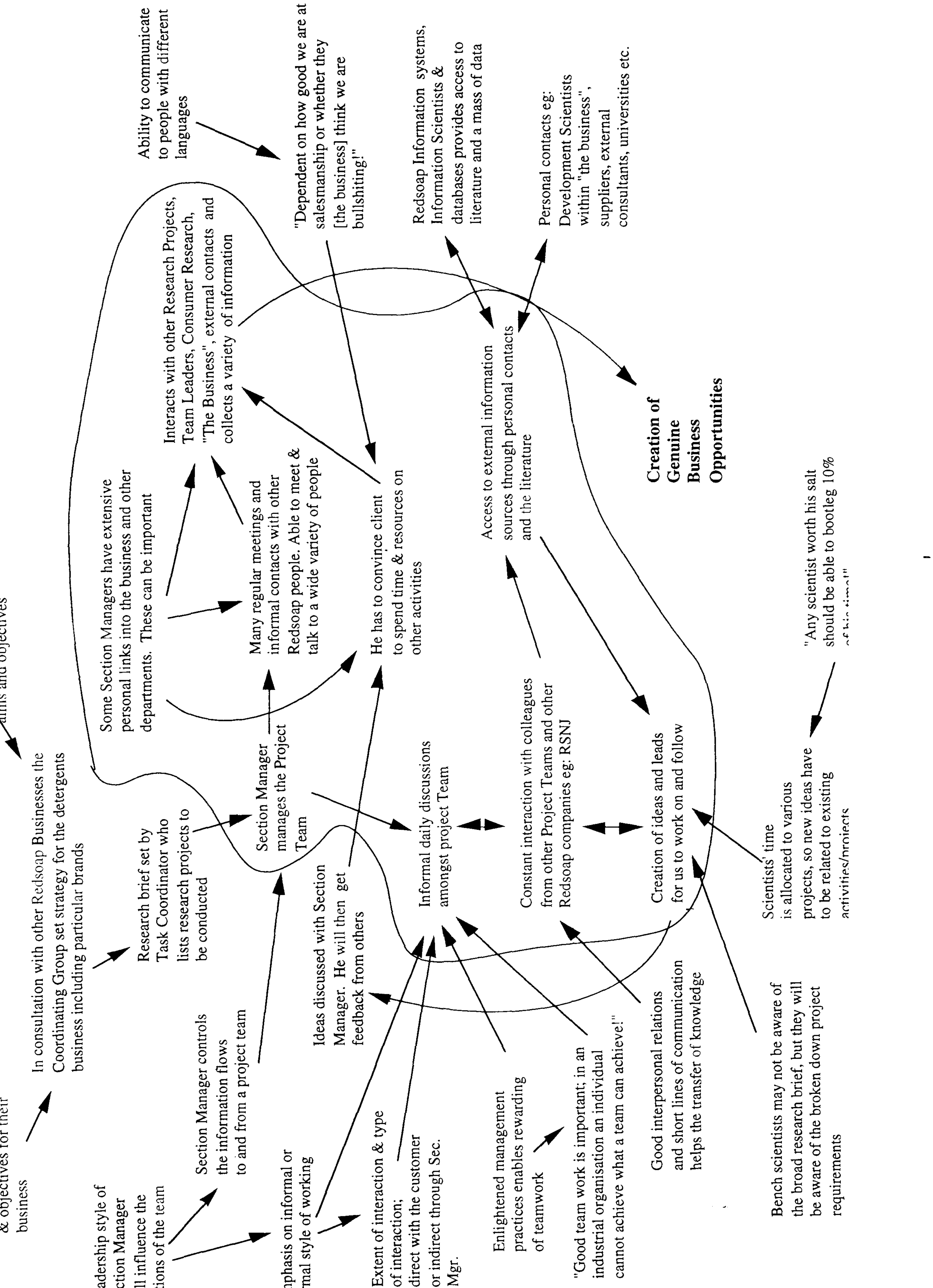


Figure H.3

A Cognitive Map of the process of "assimilation" of technical or commercial ideas into genuine business opportunities; Redsoap Research, 11.

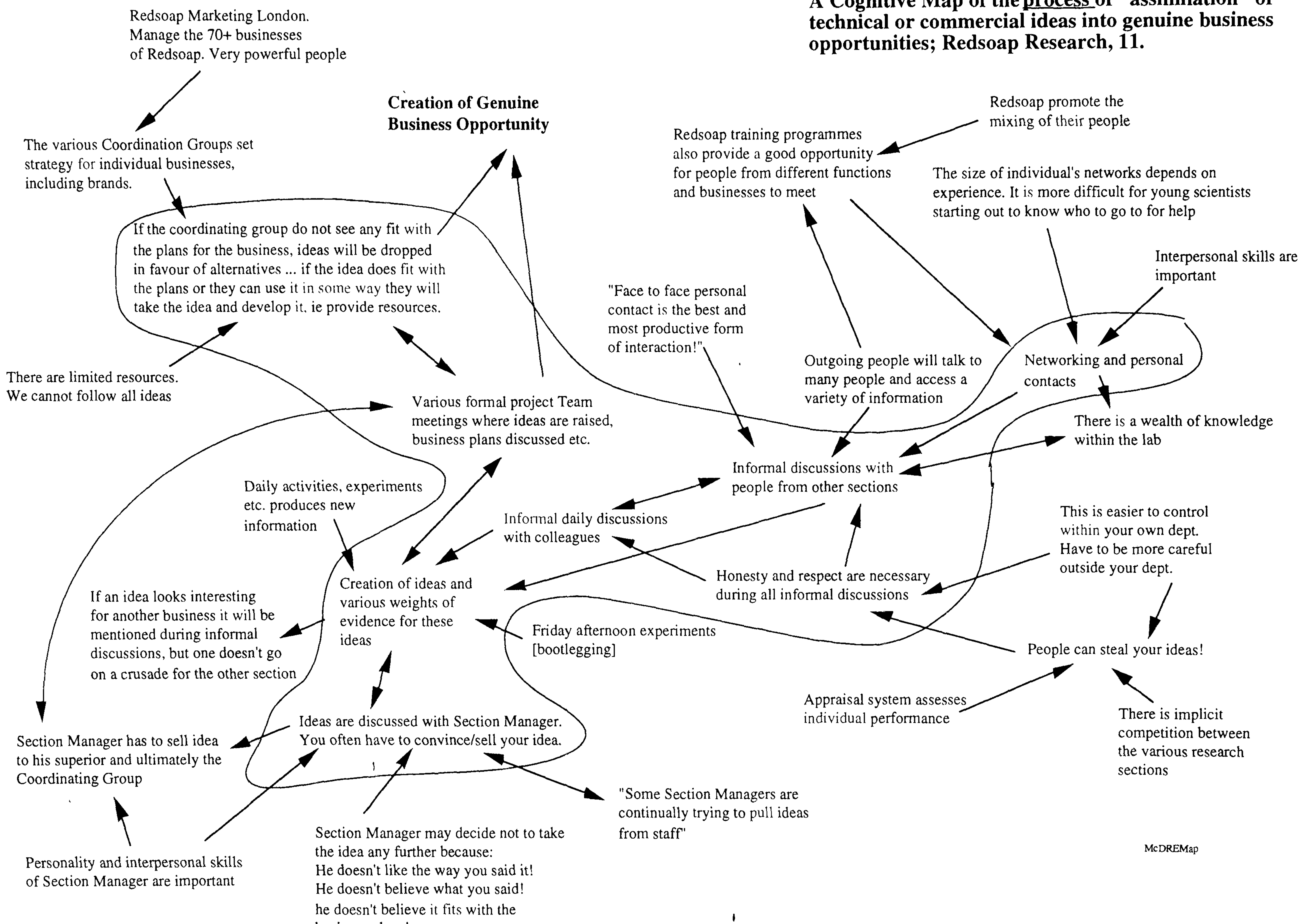


Figure H.4

A Cognitive Map of the process of "assimilation" of technical or commercial ideas into genuine business opportunities; Redsoap Research, 12.

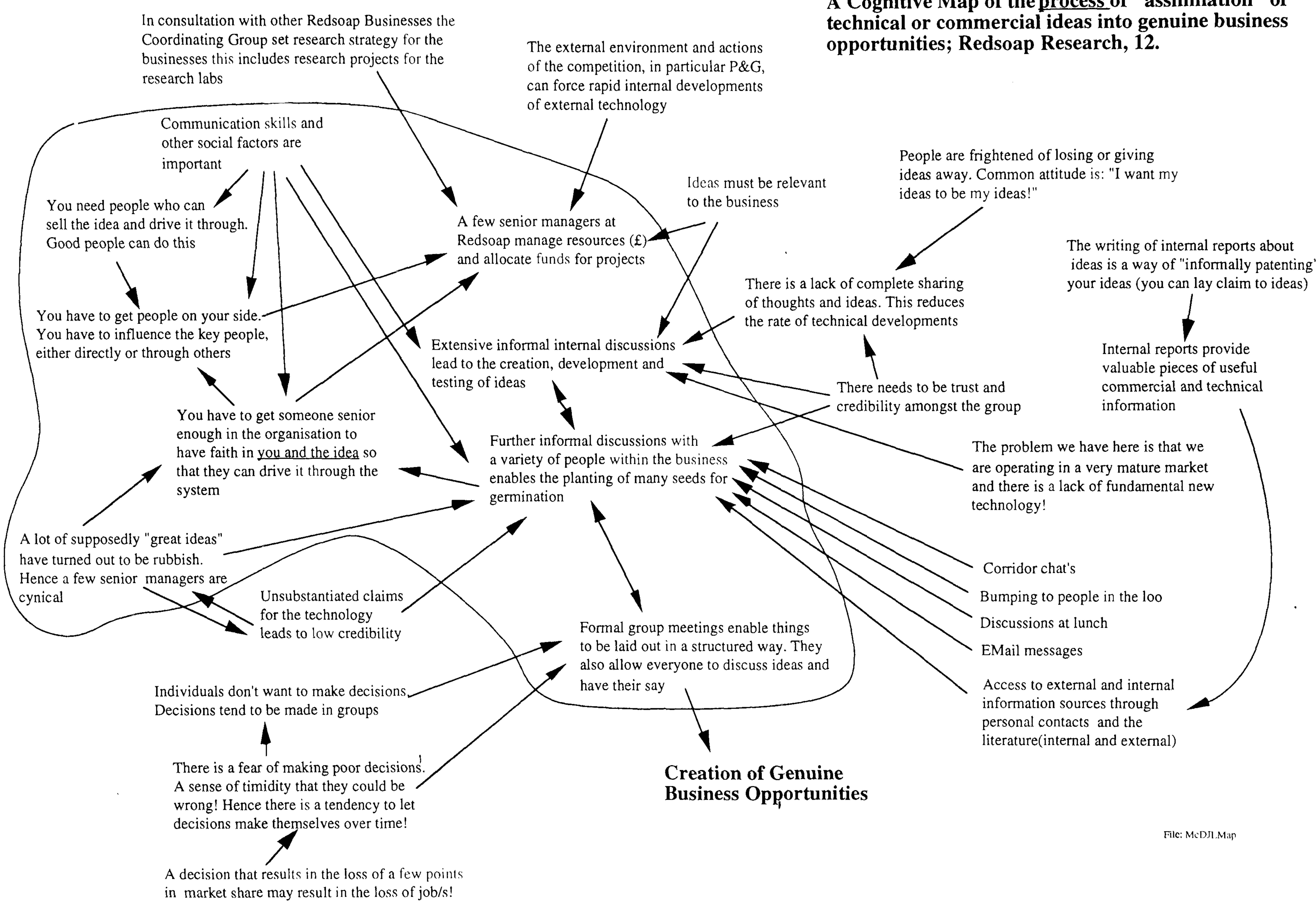
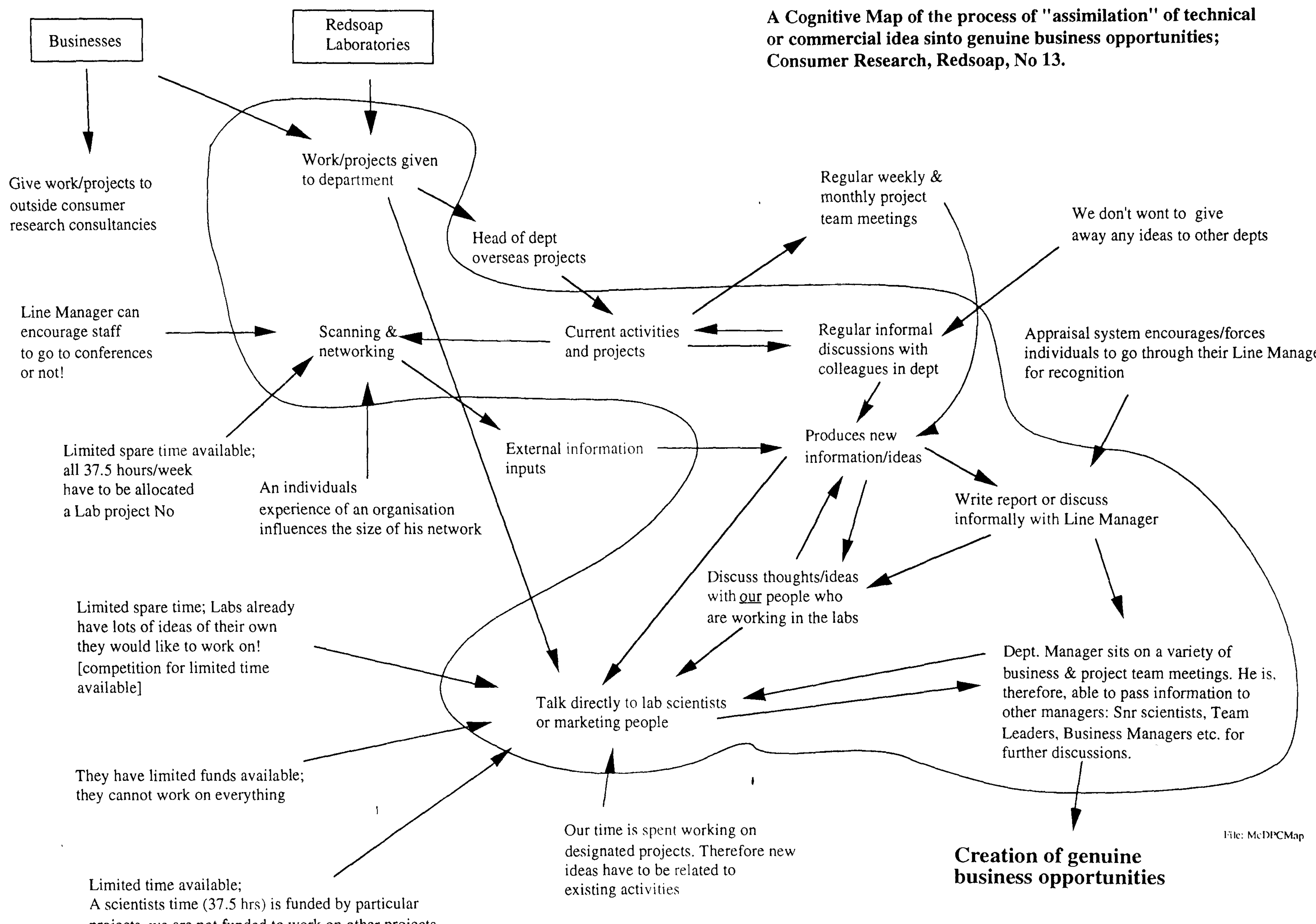


Figure H.5

A Cognitive Map of the process of "assimilation" of technical or commercial idea sinto genuine business opportunities; Consumer Research, Redsoap, No 13.



H.3 Analysis

The maps were returned to the participants for corroboration. They were also presented to the Group Research Manager for Redsoap. He was also able to recognise the organisation from the maps and was able to confirm that, from his 20 years of experience within Redsoap, the maps did indeed capture the activities and processes that exist within the business.

Figure H.6

Participant (Map No)	Total No of nodes	No of nodes accessed ≥ 2	No of nodes accessed ≥ 3	No of nodes accessed ≥ 4	No of nodes accessed ≥ 5	No of nodes accessed ≥ 6
10	29	21	11	9	4	2
11	30	16	12	10	6	3
12	28	13	12	9	5	3
13	25	15	10	9	5	1

Figure H.7

The distribution of common core-themes

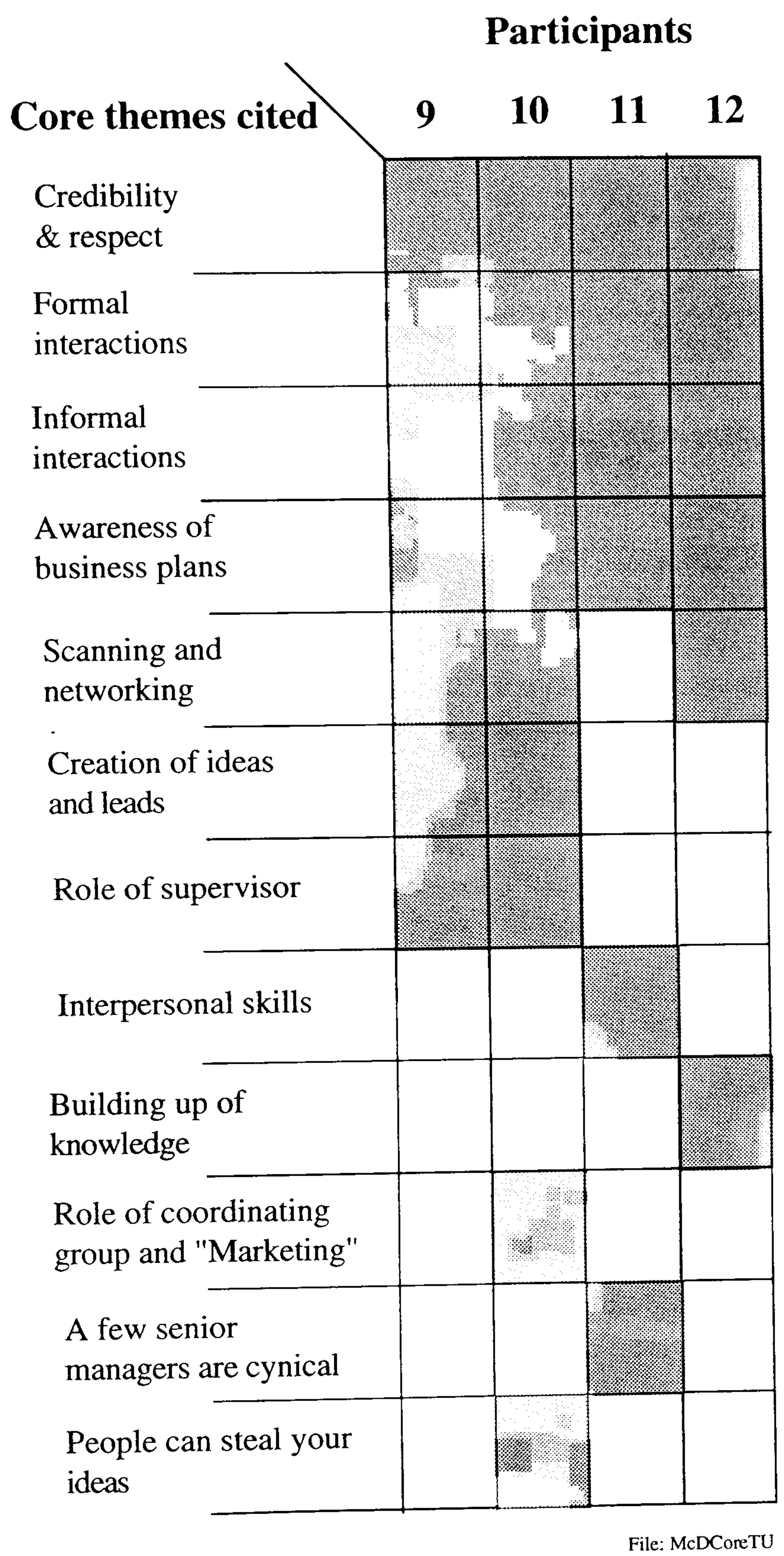


Figure H.8

Common non-core themes—Redsoap Maps

	Internal competition	Interpersonal & social skills	Limited resources	Leadership
Map 10	"Any scientist worth his salt should be able to bootleg 10% of his time!"	Good interpersonal relations and short lines of communication helps the transfer of knowledge	Scientists' time is allocated to various projects, so new ideas have to be related to existing activities/projects	"The business" eg Redsoap plc. set aims & objectives for their businesses & Leadership style of Section Manager will influence the actions of the team
Map 11	There is implicit competition between the various research sections	Personality and interpersonal skills of Section Manager are important & Communication skills and other social factors are important	There are limited resources. We cannot follow all ideas	Redsoap Marketing London Manage the 70+ businesses of Redsoap. Very powerful people & Section Manager has to sel idea to his superior and ultimately the Coordinating Group
Map 12	There is a lack of complete sharing of thoughts and ideas. This reduces the rate of technical developments	You need people who can sell the idea and drive it through. Good people can do this		In consultation with other Redsoap Businesses the Coordinating Group set research strategy for the businesses this includes research projects for the research labs
Map 13	We don't wont to give away any ideas to other depts	An individuals experience of an organisation influences the size of his network	Limited spare time available; all 37.5 hours/week have to be allocated a Lab project No	Line Manager can encourage staff to go to conferences or not!

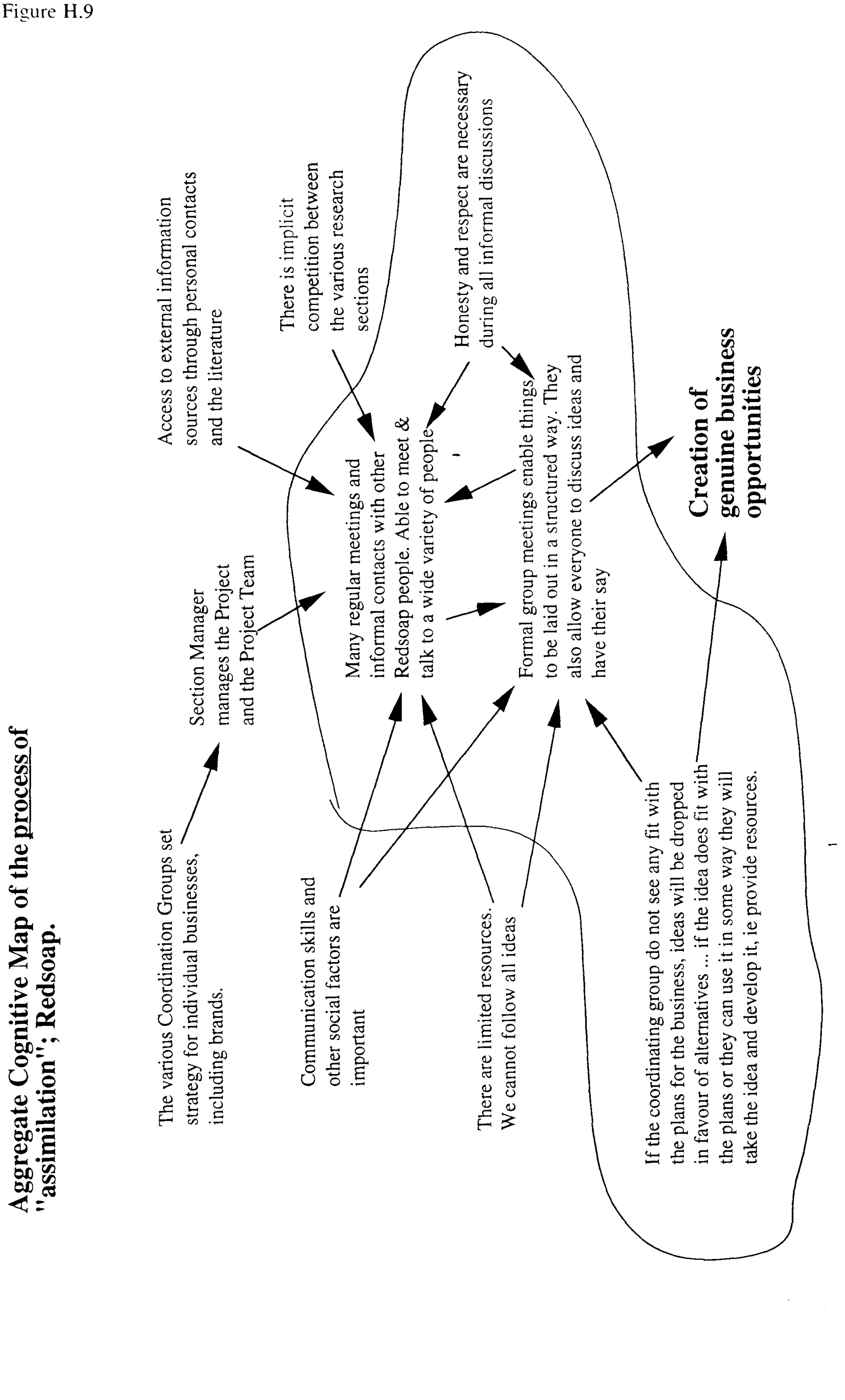
File: McDTable4

N.B. Activities taken direct from respective maps

H.4 Aggregate cognitive map

Figure H.9 represents an aggregate of all four Redsoap cognitive maps.

Figure H.9



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