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PARTNERING AS A PROCESS TO FACILITATE KNOWLEDGE TRANSFER

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Partnering as a process to facilitate knowledge transfer

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1.1 Research overview:

1.1.1 Background

Despite the widespread opinion that the UK is one of the most prolific producers of technology in the world, it is generally considered to have lagged behind many of its trading partners in putting that technology to use. The perceived inadequacy of technological innovation within UK manufacturing industries has prompted considerable research. The debate has focused on the alleged inability of much of UK industry to commercialise and profit from its scientific and technological developments. Many theories have been advanced to account for Britain's 'innovation gap'. Some cite long term government under-investment in Research and Development (R & D); the skewing of publicly funded R & D towards defence; the so-called 'Hanson style of management' which is characterised by emphasis on short-term earnings; or the comparatively low level of private sector R & D spending in the UK. In short, we are constantly reminded that technological knowledge alone is insufficient for successful innovation and that Britain fails to exploit or commercialise the technology it has developed. This debate prompted the government to publish a White Paper 'Realising our Potential' (1993) on science and technology to re-address the balance.

The rising costs of conducting R & D have forced many organisations to look for *partners* in R & D. Internal R & D is increasingly focused on core competence whilst research in all other business activities is covered by collaborations, partnerships, strategic alliances, etc..

Technology partnering is a viable process to improve the technology base of Small and Medium Size Enterprises (SMEs) within various industries, such as automotive, oil and gas, electronics, food retailing, transport haulage, etc. While this activity is not new, it seems clear that more and more SMEs 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 R &D. Technology partnering is one route supplier firms can take to improve their in-house knowledge of process, product and materials technologies. The major theme of this thesis is to consider what makes technology partnering between large and small firms happen?

This activity of purchaser-supplier technology collaboration presents an opportunity to explore just how it has developed in the UK and assess the superiority of the management practice against other channels to transfer technology. A study of the general and idiosyncratic organisational factors involved in the process should help improve our understanding of technology partnering. Hence, the focus of this piece of research is:

Knowledge transfer and the extent to which purchaser-supplier technology partnering can facilitate that process.

The following sections provide a brief outline of the study; where it was undertaken, how it evolved as well as the nature and type of technology partnerships.

1.1.2 The research setting

The research was undertaken as part of a new pilot Postgraduate Training Partnership (PTP) between BHR Group Limited and Cranfield University established in 1992. The partnership, which is one of five currently running around the UK, is designed to enable research to be carried out on subjects highlighted by industry. The pilots were modelled on the German Fraunhofer concept - which function as focal points for applied industrial research supported by the government as well as industry.

The BHR Group/Cranfield University partnership is devoted to process technology. Other PTP PhD topics at BHR Group include process intensification, high pressure abrasive waterjet cutting, pipeline pigging, sealing, mixing and human-computer interaction.

As part of the PTP scheme, associates participate in a structured management development programme which included skills training in time management, project management, presentation, effective selling, negotiations, managing teams, business planning, finance and report writing.

1.1.3 The research project

This research project primarily derived from an earlier study [BHR/Metcom (1990)] to determine new approaches to collaborative technology and market development between the major users and purchasers of engineering products and their UK SME suppliers. The BHR/Metcom study carried the premise, which is borne out in this research, that:

"Many small companies find themselves distanced from their ultimate customers and have difficulty in assessing their needs ... Small UK engineering firms find it difficult to invest in the necessary technology and market development to meet 'world class' standards demanded by their home market".

The principal objective of the BHR/Metcom study was to enable SMEs' to improve their products and services through collaborative technology and market development with the major users. The first stage of the study consisted of a market review of the major users' requirements. Several large companies were selected for interview and high level meetings were undertaken to determine: Market requirements and supply problems within the UK; whether the major users were prepared to work in closer collaboration with their SMEs to help develop their products. A number of opportunities were identified, from which, Pilot projects were selected to test the approach and assess the level of industrial interest and commitment. The views of several other research organisations were also heard in order to assess the applicability of the approach to other industrial sectors.

The aims of the first phase of this study was to incorporate these conclusions and take the recommendations further principally in the automotive industry. The reasons for selecting this industry are considered in chapter four.

The second phase of the research study, which was sponsored by the Offshore Supplies Office, explored how SME suppliers of products and services in the North Sea oil and gas industry can link with oil operators and major contractors in order to share their technological expertise and present practical yet attractive solutions. The study involved conducting a review of the changes brought about in the offshore supply industry through the need for operators, contractors and suppliers to work more effectively in order to meet the low cost and risk reduction needs of North Sea operators.

Although the automotive and oil and gas sectors are essentially manufacturing and process industries respectively, the broader principles to partnering may be observed through a cross-industry study. Indeed, it may be argued that there are more similarities than differences. Both industries are extended enterprises and incorporate supply chains which are inextricably linked - providing a natural channel to cascade skills, new technologies and information. Both industries have reached maturity which has forced them to re-think their inter-firm relations in pursuit of cost reduction. Both industries embody supply sectors which have a history of inter-firm collaboration, albeit at different levels of development, enabling them to offer the purchaser larger packages where one firm acts as the prime supplier and carries out all the interface with the purchaser. Both industries are mainly geographically centred around a single area effectively creating a critical mass or the 'Houston effect'.

In view of these similarities, it was considered to be of great value to explore the technology partnering process within a parallel industry study.

1.1.4 An overview of the presentation of the research

This Chapter aims to introduce the technology partnering concept describing how it evolved with reference to a wider review of the literature. It highlights the need to study partnering in the context of technology transfer and cites the main themes derived from the literature review.

Chapter Two considers in greater depth the recurring themes in the literature with particular regard to firm's prior knowledge and the extent to which they need to collaborate, the importance of maintaining and strengthening external inter-firm linkages and managerial attitude in the context of a partnering relationship. The aims of the research are then presented.

Chapter Three introduces the research propositions and subsequent questions. It explains the operationalisation of the propositions into semi-structured interview questions, and considers the design and eventual application of the research instruments used in the study.

Chapter Four sets the aims of the research into context. The research methodology adopted in this thesis and referred to from herein is described as *phased research* or progressive research, with each piece of research building on the findings of the other.

With the propositions, questions, and information needs clearly established and the means to collating that information and within which industry stated, **Chapter Five** argues that an iterative process to analysing the data thus ensuring increasing familiarity of the data is the best approach.

The following three chapters present the preliminary findings and some early conclusions of the two phases of research. The first two chapters consider the motor industry case while the third investigates the response of the offshore supplies industry to technology partnering. **Chapter Six** begins to apply the three measures of data analysis to the motor industry.

Chapter Seven concludes this particular industry analysis by presenting three case studies depicting varying levels of technology partnering arrangements which display the specific properties uncovered in the research, and act as a stepping stone on the guide to best practice. It also explores the extent of 'networking' in the motor components industry and the existing industry initiatives that, in part, enable technical managers from many firms to meet and understand each others' capabilities.

Chapter Eight presents the second phase of the study which explores the issues involved in forming and sustaining partnerships in the offshore supply industry.

Chapter Nine aims to apply the conclusions of Phase One to Phase Two and to use this comparison to assess if any 'general' conclusions may be drawn.

A summary and integration of the substantive findings of both research phases is shown in **Chapter Ten.** This chapter questions the seemingly disparities in size and market position between the partners and explores how small firms can overcome through innovation and service focus.

A <u>third</u> yet continuous and integrated study enquiry falls under the proposition that an imbalance of power between partnership firms (purchaser and supplier) presents a formidable barrier to otherwise progressive alliances. It became clear during the early part of phase one that contrary to easy talk of 'openness', the reality is that small suppliers do not trust their purchasers with cost information, and dislike continued pressure to reduce costs through 'collaboration'. These points are considered in greater depth below (section 1.2.4) and throughout chapters five and six, and finally in chapter seven during the evaluation.

The conclusions in **Chapter Eleven** locate the work within the intellectual field and evaluate the substantive findings of the research as well as considering some limitations of the research approach.

Figure 1.1 summarises the organisation of the thesis while the following section discusses the evolvement of partnering. It first considers why firms collaborate and then examines the various structural types of collaboration.

Figure 1.1

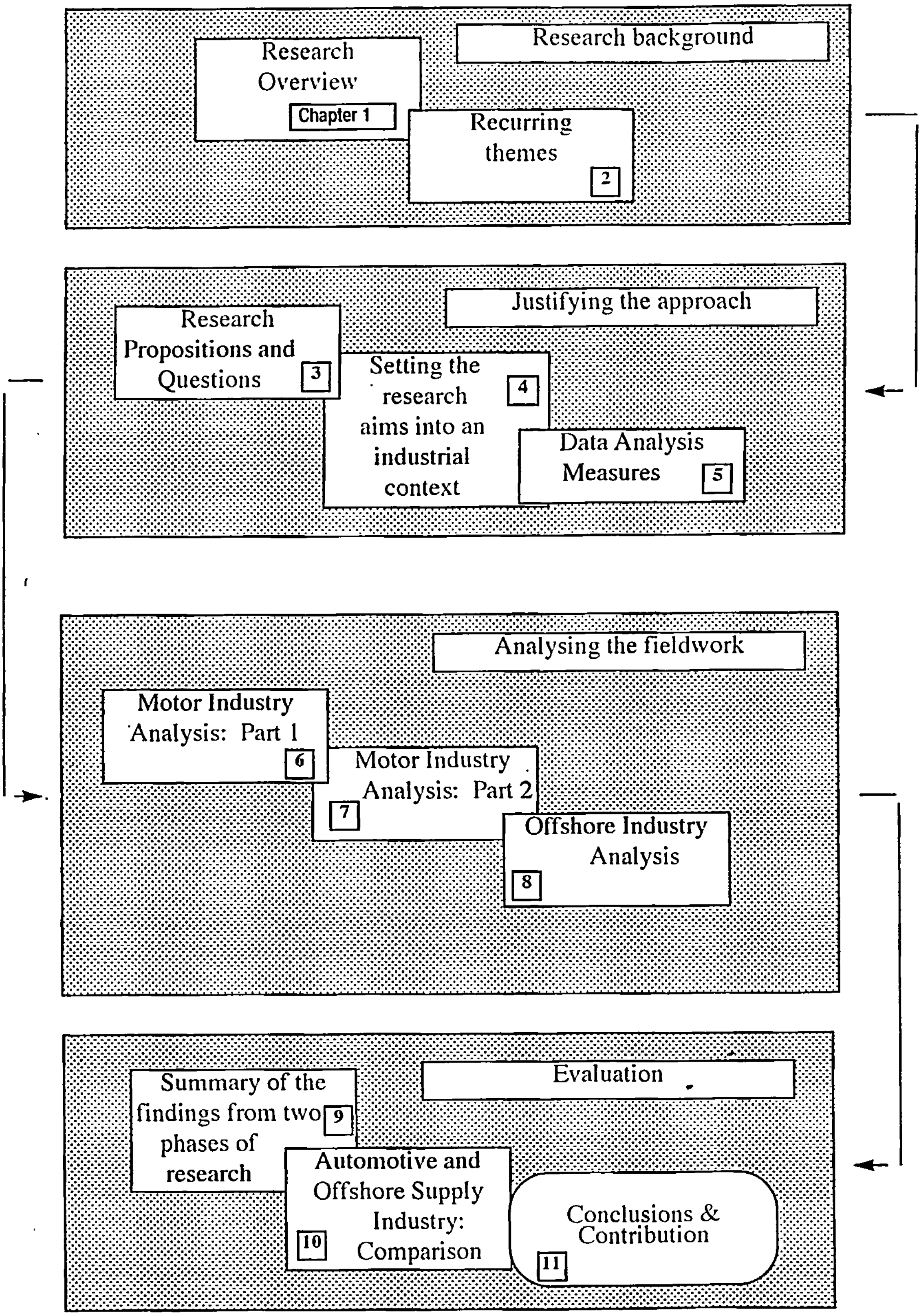


Figure 1.1: Organisation of thesis

1.2 The development of partnering

1.2.1 What is collaboration?

There are a plethora of definitions for 'partnerships', (occasionally referred to in this thesis as 'alliances'). They are formed by firms with other firms - suppliers, customers - and with universities and research and technology organisations. Collaborations take place in the research, development, manufacturing and marketing functions, and take a wide variety of forms. (Dodgson (1994). The most important distinctions between technology partnering arrangements are those which facilitate access to *technological capability* (called 'vertical;' alliances) and those in which the partners seek access to a certain market ('horizontal' alliances). technological alliances can be classified as 'pre-competitive' and competitive' according to the distance of the alliance from real market competition. (Nueno and Oosterveld, (1988)).

1.2.2 Why do firms collaborate?

The more general reasons why firms form partnerships with each other are varied. Hennart (1986) summarised the four main objectives for partnerships as being economies of scale and diversification of risk, overcoming new market entry barriers, pooling of complementary knowledge and reducing political risk for multinationals. Contractor and Lorange (1988) offer four more: technology exchanges, co-opting or blocking competition, overcoming government-mandated trade barriers and vertical quasi- integration advantages of linking the complementary contributions of the partners in the value chain. (eg access to technology, materials labour, capital etc.). Dodgson (1991a) comments that collaboration can 'enable firms to reach a critical mass of financial and human resources that may be necessary to conduct research, develop standards, or enter new markets. Some firms pursue collaboration as a way to improve the flexibility and responsiveness of the organisation to emerging opportunities'. The interest here is on how firms share complementary knowledge.

Mowery (1988) suggests that technology is increasingly the focus of collaboration and that technological collaboration is appearing in a wider range of industrial sectors and firms. There are broad differences in the actual *focus of collaboration* between industries and technologies. Mowery highlights these differences showing that in telecommunications, integrated circuits, commercial aircraft and robotics the focus of collaboration is *product development*; in automobiles and steel the focus is the *production process*; and in biotechnology and pharmaceuticals it is *marketing and distribution*. Other studies argue the way that the focus of collaboration *changes over time*. Kogut (1988), James (1989) and Mody (1990) contend that the focus of collaborations alters with product life cycles. In one of the most sophisticated studies of the focus and form of collaboration, Cairnarca, Columbo and Mariotti (1992) argue that these vary along with industrial and technological development. Based on a study of over 2000 agreements in information technology between 1980 and 1986, they develop a technology life cycle model and relate collaborative activity to it. These various stages, and their consequences for collaboration, can be summarised as follows:

(i) Introduction: the first introduction of early, pioneering applications on to new markets, when there is considerable technological uncertainty. The propensity towards collaboration is very high, and the agreements focus on R & D, technical standards and 'technology watching' to see how things are developing. At this stage many of the collaborations involve equity agreements.

(ii) Early Development: when market growth is very rapid, and technological opportunities are still very high. The propensity to collaborate is at its highest, and this is manifested in large numbers of non-equity investments to allow firms rapid access to specialised know-how in partners. Agreements focus on R & D, standards and joint development.

(iii) Full Development: in which technological uncertainty is much reduced, and markets are expanding less rapidly. The number of agreements in relation to the size of the market declines, firms pursue strategies of internalising know-how, and there is a contraction of non-equity forms of collaboration.

(iv) Maturity: which occurs as market expansion slows right down, and technological efforts focus on using the knowledge accumulated in earlier periods. Non-equity collaborative agreements increase as firms attempt to revitalise technology and to exploit existing technology in peripheral markets.

(v) Decline: which is marked by market contraction and exhausted technological development. Firms are rationalising and concentrating their efforts. Agreements between firms decline, and equity-based arrangements predominate in a wide range of commercial and manufacturing agreements.

The authors suggest that their evidence supports this life cycle model, although they admit that its empirical testing poses serious methodological problems. They nevertheless provide one of the most plausible analyses of the changes purposes and forms of technological collaboration.

1.2.3 The evolving process to partnership sourcing:

During the late 1970s and early 1980s, many US and European firms found themselves besieged by intense competition, primarily from Japan. Some larger firms began to focus on lead time and continuously decrease the time required to fill customer orders and resolve quality problems. These companies began to realise that the performance of the manufacturing department, and suppliers, was limited by their engineers' designs. Partnerships then began to emerge between these companies and their suppliers. For companies who spend who spend as much as 80 per cent of their manufacturing cost on purchased inputs from suppliers, the quality and lead time for finished goods are bounded by supplier performance. [Lamming (1993)].

Partnership sourcing between firms is an attempt to replace traditional confrontational purchasing attitudes with a commitment to long-term relationships based on mutual trust and agreed objectives. It is viewed as offering not only the opportunity of reducing total costs but a mechanism leading to significant quality improvements, greater innovation and responsiveness to change.

An inter-firm partnership is based upon commitment, trust and continuous improvement. Two different definitions of trust are frequently used in the literature that relates to forming cooperative relationships: confidence or predictability in one's expectations, Zucker (1986) and confidence in the other's goodwill, Friedman (1991). The second definition is adopted in this research. Sako (1992) refers to the importance of trust, and notes three types of trust between organisations: Contractual trust is the practice of keeping to formal and legal promises. Competence trust is the confidence that a customer or supplier is able to do what is promised. Goodwill trust is the sense that your partner will behave appropriately without the need for specific promises. Helper (1991) considered the type of supplier-customer relationships that can lead to better performance. The type of relationships were thought to have two dimensions: information exchange and commitment. Information exchange includes both the nature and mutuality of the information flow between supplier and customer, whilst commitment refers to:

"... the supplier's degree of certainty that the customer will continue to buy its products for some length of time".

Helper's US research survey, conducted in 1989, demonstrated formal commitment between assemblers and their suppliers using statistical data: between 1984 and 1989 the average contract for all North American suppliers, including the transplants, nearly doubled in length from 1.2 years to 2.3 years. A subsequent study by Cusumano and Takeishi (1991) showed contracts between domestic (US) assemblers and suppliers averaging 1.7 years and those initiated by transplants were 2.5 years, whilst the length of contracts in Japan were found to average 3.2 years. The fact that Japanese assemblers do not have written long-term contracts, relying instead on short-term stipulations for deliveries but very long-term (next vehicle model) involvement of the supplier, based upon mutual trust, is an indication of the very different business culture that partnership requires. The extent of how far the Japanese working practices have transferred into the UK through the transplants is considered during the second round of fieldwork in chapter four.

With regard to information exchange from suppliers to their customers, Helper found that an 'impressive' 19 per cent of US suppliers felt happy to provide customers with a breakdown of each production step, (compared to just 3% in 1984). Many European suppliers have not grasped the full implications of partnership and there are still some significant national differences. For example, in summarising the situation, the NEDC (1991) in a report on Nissan Motor Manufacturing (UK) concluded that:

"Quality from other European and Japanese suppliers tends to be better than from the UK: on a rough arbitrary scale, Nissan sees Japan as being 100, other European countries 80 and the UK, on average, 65-70."

In the same report, a postal questionnaire to 30 suppliers (12 of which were current suppliers to Nissan), it showed:

"46 per cent of existing suppliers think it reasonable to hide cost savings from the customer, despite the implications for a relationship based on trust."

Of the total number of suppliers surveyed, 51 per cent thought it unreasonable that a supplier should be expected to pass on reductions in its manufacturing costs to the customer. The otherwise pessimistic statistical conclusion from the two surveys is that 81 per cent and 46 per cent of US and UK component suppliers respectively think it commercially and ethically right to conceal cost breakdowns from their customers. Such reticence to reveal information rests in the attitude of management - a theme that will be returned to in later chapters. All the talk about increased 'cooperation' in the motor industry could mean merely that suppliers have acquiesced in the short term to assembler demands for not just low prices, but high quality and just in time delivery, too; no real foundation for a mutually cooperative working relationship. Turnbull (1989) conducted a survey of 50 automotive component firms in the West Midlands and found that, in terms of supplier dependency to one main customer, only two firms were completely 'dedicated' suppliers to one assembler whilst the majority had less than 50 per cent of their business with any major customer. The author concluded that there was very little evidence of a 'partnership' developing between assemblers and suppliers. The level of suppliers' dependency on customers and the true extent of partnering between firms will be returned to in chapter six.

In terms of measuring the success of the initial negotiated agreement, Doz and Shuen (1988) consider the 'expected and unexpected outcomes' which two firms foresee within a given range of environmental circumstances. They suggest that whilst some expected outcomes will be shared between the two parties, others will not and will constitute the 'hidden agenda' of each partner as it enters the partnership.

Cole and Yakushiji (1984) conducted a comparative study between the US and Japanese automotive industries and estimated that 'superior supplier relations gave the Japanese a $300 - $600 per car cost advantage in the early 1980s.' A study involving involving case studies [CBI, (1991)] analysing the cost advantages arising from Nissan (UK) Supplier Development Team conducting an intensive Kaizen exercise on one of their suppliers reported that in a ten day exercise, involving a small section producing extruded hose, 128 problems were identified. Improvements led to labour savings of 20 per cent, a 70 per cent reduction in work in progress which is equivalent to a stock reduction of £70,000, and the shop floor space available for extra production.

The proposition that technology partnering can improve SMEs' technology capabilities is tested within chapters six, seven and eight. This thesis explores the development of technological collaboration in the motor components and offshore supply industries and whether or not alliances involve real or only apparent technological collaboration. In other words, to what extent is technology partnering working in these two industries and what are the distinguishing characteristics between firms which appear to participate and those which demonstrate a developmental record.

1.3 Summary

As well as providing a background to the study, this chapter briefly cited the intensity of debate on the UK's record of innovation. By considering the evolvement of partnership sourcing, it noted the specific characteristics of partnerships and joint ventures.

It may be argued that by first creating the right internal (organisation) conditions to make partnerships work with other firms and second managing that partnership or product/project alliance, the small firm's technological capabilities can be improved. Technology partnering is one management practice which can address the 'cause' of poor technological performance within SMEs rather than the 'symptom'. Government agencies are quick to criticise the poor R & D performance within British firms - since they often rely too heavily on the output of their holding companies abroad - yet their programmes which (financially) support R & D within firms simply attack the symptoms rather than their cause, ie they are more akin to pain killers for terminally ill companies. The LINK programme, for example, which is designed to encourage firms to work jointly with the science base on pre-competitive research relevant to industrial needs. The aim of the scheme is to ensure rapid take-up of research ideas by bringing together industrial and academic workers from the earliest stages of the development of a new technology. However, it has been criticised by some authors which argue that collaboration is not in the competitive interests of small firms. In addition, the CBI (1990) criticised this programme for 'spreading the money' too thinly and there being a lack of appreciation that different technologies and different industry sectors have different characteristics and needs. In other words, programmes such as LINK can encourage and provide the framework to facilitate technological partnering between large and small firms. However, the recent White Paper "Realising our potential - A strategy for science, engineering and technology" noted earlier, has recognised the need to make specific arrangements to encourage SMEs to take advantage of the R & D being undertaken in, for example, government laboratories and under government auspices. In addition, the relatively new Science and Technology Agencies, (such as the Central Science Laboratory - launched in April, 1992 and within the Department of Ministry of Agriculture, Fisheries and Food [MAFF]) should help to fulfil the government's recognition that programmes undertaken for its own defence or civil purposes can also provide results of value to industry and commerce.

The following chapters aim to provide an evolving analysis of what makes technology partnering happen and what a firm must have in place in order to participate successfully. They question if those more adept suppliers which have shown the flexibility to work with their main purchaser and, therefore, reaped certain benefits, are innovative by nature or are they led by the main purchaser towards technology imperialism, ie they have no alternative but to behave in a partnering mode due to the unequal balance of power in the purchaser's favour.

Chapter Two: Review of the literature themes

2.1 Introduction

The previous chapter presented the background to this research as well as providing a brief overview of the literature concerning the evolvement of inter-firm partnerships. It noted how collaboration between firms may be justified on many grounds including (i) the advantages of achieving economies of scale; (ii) sharing information and ideas and the combination of complementary skills and technologies can lead to new innovative products and production processes; (iii) cooperation allows firms to offer a broader scope of capabilities - a group of firms could offer customers a coordinated range of products or services, and so on.

This chapter reviews the main bodies of literature in more detail with specific reference to *technological collaboration.* Section 2.2 sets the scene with some definitions of the technology transfer process. Section 2.3 studies the internal capabilities of the firm highlighting what characteristics have been shown to be important for firms to possess in relation to learning and building their in-house technical know how. Section 2.4 reviews earlier studies with regard to the perceived importance for firms to have good external linkages with outside sources of expertise in order to learn about new technologies. It considers the importance of networks and the role of intermediaries in the innovation process. It also highlights some tensions that may occur between innovation and the technology partnering process. Section 2.5 explores the potential for power imbalances in the working relationship. The need to understand what factors influence good technology partnering performance is discussed in Section 2.6 as well as the importance for a prospective partnering firm to display the 'right' managerial attitude to support and maintain a partnering relationship. The final section considers what research aspects still need to be addressed.

2.2 Defining the technology transfer process

2.2.1 Some definitions

The concept of technology transfer has been defined in various ways throughout the literature. Common to all these definitions is the concept of technology being transferred from a technology provider to a technology recipient. Particular points where they differ are in the way technology is defined and the descriptions of technology providers and the recipient. Corsten (1987) defines technology transfer as the process of transferring a technology, ie a technical process or product, within a given system or between systems, with the aim of reducing the gap between potential and actual utilisation of a technology.

Baron (1992) carried out an assessment of a new advance (computer database listing a network of technical experts capable of providing help to clients in all technologies), in technology transfer. The author defines technology transfer in this context as,

"... any sharing of knowledge that ultimately results in a better commercial product, or a more efficient method of production."

Seaton and Cordey-Hayes (1993) provide a wider definition,

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

The authors add that this view of technology transfer has been developed as a consequence of observations about the limitations and deficiencies of much technology transfer research and practice.

The principle elements of the technology transfer system in the UK includes government laboratories, HEIs, Research and Technology Organisations (RTOs), regional agencies, the British Technology Group and a number of private technology transfer brokers, eg BASE International. For some of these institutions, technology transfer to industry is a primary aim, eg RTOs, while for others it is a secondary aim. Rothwell (1990) argues that there are several reasons for concern for the effectiveness of such mechanisms, namely,

"[1] The UK's relatively low rate of growth compared to its European competitors in both civil expenditure on R & D, and in industry funded business enterprise R & D, [2] The Regional Dimension. There is a marked concentration in high-technology production in the Southern half of England with a high concentration there in industrial firms' R & D units and in the employment of professional scientists and engineers ... HEIs and RTOs have a key role to play in helping technologically to upgrade the products produced by, and manufacturing processes used by, technologically less well endowed companies in the development of UK regions, [3] The Firm Size Dimension. The main area of disadvantage suffered by SMEs in relation to their larger counterparts is their inability to support appreciable numbers of qualified scientists and engineers in R & D".

The author further points out several repercussions:

- it limits their in-house technological know-how accumulation;
- it inhibits their external search for useful technology; and
- it inhibits their assimilation and further development of technology once it has been acquired from external sources.

In terms of the technical linkage difficulties which SMEs appear to encounter between themselves and **external sources of information and knowledge**, substantial empirical research work has been conducted in recent years, [Corsten (1987), Rothwell (1987), (1989), Baron (1992), Dorf (1988)]. Beije (1987) emphasises the importance for SMEs to access external knowledge rather than external information, suggesting that,

"... innovation in firms is a process of know-how accumulation based normally on a complementary mix of in-house R & D coupled to the results of R & D performed elsewhere".

Rothwell (1991) emphasises that many SMEs are constrained in their external search procedures by virtue of the fact that they lack in-house technical specialists. Rothwell and Beesley (1989) in a report to an ACARD sponsored study reiterated (above) that the most important factors determining an SMEs' propensity and ability to access external sources of technology were internal to the firm,

"... most notably the employment of qualified scientists and engineers (QSE) and the outward-lookingness of management".

A supportive study [Lowe and Rothwell, (1987)] demonstrated that, through a survey of 176 firms' interaction with HEIs in Sussex,

"... interaction with academe generally increases with QSE employment".

In many respects, **technology partnering** can address these limitations. It is an intermediate formula where two or more firms aim to combine their unique technological strengths enabling them to deliver innovative and lower risk solutions quickly and at less cost to the end user.

Consequently, in the context of this research technology partnering is principally about,

> a relationship between a supplier and customer that encourages the development of technology to meet the customer's requirements.

2.2.2 The forms of technological collaboration

Companies engage in strategic alliances for industrial, commercial, financial and technological reasons. More specifically, technology alliances can be 'vertical', when the main purpose is to get access to a technological capability, or 'horizontal', when the aim is to secure access to a market. While the vertical type of collaboration is likely to be particularly important within the motor industry over the next few years, as manufacturers look for new material, electronic, sensor, pollution control and energy saving technologies to enable them to improve their competitive position, the offshore industry is also searching for operating and capital expenditure reductions through contractor-supplier alliances. The following provides some distinctions between vertical and horizontal partnering arrangements.

Broadly, vertical collaboration occurs throughout the chain of production for particular products, from the provision of raw materials, through all the manufacture and assembly of parts, components and systems, to their distribution and servicing. The forms of arrangement may be privately created or promoted by public policy and range from a joint venture between a group of firms with a shared equity investment to a group of technologists from different firms within the vertical chain working together on an informal basis sharing knowledge. Nueno and Oosterveld (1988) define vertical technology alliances where the main purpose is to get *access to a technological capability*, and horizontal when the main purpose is to *secure access to a market.*

As section 1.2.1 noted, in a vertical alliance, companies generally participate in order to have access to a capability in a particular technology field. This field is perceived to be of critical importance by the companies involved although they compete in different markets with different products. Each company might be at a different time-distance from industrial exploitation of the specific technology and will exploit it in a different way. The alliance in this case is driven by the technology. The idea of 'vertical' sometimes suggests that as one looks 'down' the chain, then the firms' become smaller. This is rarely true, for example, a first tier component firm employing 350 people and earning an annual sales turnover worth over £15 m will often source its material from British Steel. However, this research is focused on large-small firm links. Small firms are argued to possess advantages over large firms in their ability to respond quickly and flexibly to rapid changes in some technologies and markets. Large firms with their greater resources and marketing and distribution competences, possess advantages over small ones. Combining these advantages may be an intent of collaboration.

In a horizontal alliance, several companies work together to define a market in which some of them might compete in the future. They are interested in setting some technological standards and this requires a lot of co-operation in research and development. Once the standards are defined, all companies have a clear idea about the key characteristics of the products which will go to that market. Development capabilities, quality, reliability, cost, speed in the introduction of products, markėting or other variables might still provide some companies with a differentiation or a competitive advantage, but the aspects of the technology will have been agreed and researched in collaboration. These alliances are therefore *market driven.*

Each form of alliance works best with its own mix of basic objectives, methods of operation, and strategic issues. Horizontal alliances often occur for what is termed 'pre-competitive' activities, or supposedly for only those activities in the product development cycle which occur prior to product commercialisation. This gives the impression that competitive risk is reduced and, consequently, the parties can be more open and trusting of each other. More will be said about this later.

There is, however, an important distinction between strategic technology alliances and those cost-reduction-lead partnerships. The strategic partnerships appear to be aimed at improving the long-term perspective and opportunities of the firms involved whereas the latter type are more concerned with control of operating costs of firms. The cost-economising type of vertical partnerships appeared the most common throughout this study. For example, the case study (section 7.3.1) the supplier was invited to design and manufacture a one piece engine fan pulley in preference to two pieces being spot welded together. Just eight months later and with timely advice from the assembler's senior technologists, the supplier had completed the design and begun to manufacture the pulley, achieving a cost reduction of over 42 per cent. Following the development, a whole set of press and welding operations were removed, further contributing to the reduction in costs. Other benefits to the assembler included the removal of concentricity and elimination of the surface gap between the two spot-welded pulleys, thus reducing the corrosive element. In particular, the case highlighted how the managerial attitude within both firms, epitomising openness and flexibility, served to accelerate the collaborative development process resulting in considerable benefits to the customer. Through a deeper understanding of the needs of their customer and employing technological innovation in both design, and manufacturing, the supplier so impressed the assembler in the UK that their engine fan pulley is now being supplied to the same assembler in Japan.

An example of horizontal-type partnerships may resemble the supplier association case study (section 7.3.2) which is defined as a 'mutually benefiting group of subcontractors brought together on a regular basis for the purpose of coordination, cooperation and development.' This may be interpreted to mean the continual development and increasing share of a specific market.

The previous chapter (1.2) observed that the *aims* of technological collaboration generally include improvements in the innovation process, and the various technological objectives of corporate strategy and public policy. Dodgson (1994) suggests that they encompass: improving the development process; enhancing efficiency in the production chain; merging previously discrete technologies and disciplines; learning through information exchange, and so on. The author also suggests that the *forms* of collaboration may include:

(i) Infrastructural forms: which are embedded in national technology and innovation systems, and are created especially to support that system, ie the universities, government laboratories and independent contract research organisations which offer collective industrial research provide infrastructural forms of collaboration.

(ii) Contractual forms: which may take the shape of a joint venture, formed by two or more partners as a separate company with shared equity investments.

(iii) Informal forms: which are very important for the innovation process in the way they occur between the 'invisible college' of peers.

It is the latter form of collaboration that is of great interest in this research. In this respect, Von Hippel (1988) describes the way that 'informal know-how trading' between peers occurs in a number of industries.

'Informal know-how trading is essentially a pattern of informal co-operative R & D. It involves routine and informal trading of proprietary information between engineers working at different firms - sometimes direct rivals.'

Kreiner and Schultz (1990) add some further observations,

'Informal collaboration can manifest itself within discussion groups and working parties; it is known to be important in a wide range of sectors and technologies, and has been argued to be a precursor to more formal partnerships.'

The idea of 'informal collaboration' will be returned to in chapter seven where three case studies are presented.

In terms of distinguishing between the various types of arrangement, Nueno and Oosterveld (1988) contend that technological alliances are often established without the appropriate consideration of their impact on the long-term overall competitiveness of the firm. Their study mainly concentrate on Pan-European projects with EU financial support. The four categories of technological alliances (vertical/horizontal; pre-competitive/competitive) are considered to be useful to analyse and understand them and to generate suggestions for improving their management. The authors selected eight aspects to differentiate alliances in each category:

(i) Objectives of the alliances.
(ii) Level at which the decision is made.
(iii) Time horizon.
(iv) Number of partners.
(v) Impact on the value added chain.
(vi) Evaluation of risk.
(vii) Existence of frameworks.
(viii) Stability of the alliance.

Figure 2.1 shows the results of the authors' analysis of the 15 situations studied. The author's felt that in spite of the richness of the data gathered in the field research, it is not possible to draw statistically meaningful conclusions.

2.3 Prior knowledge and the extent to which a firm needs to collaborate

2.3.1 The technological base of SMEs

Discussions concerning the technological base of an organisation tend to focus on R & D activities and other technical activities. 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) argued that in industries where the 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 the procedures for forming new ones, the character of the decision making processes, the links between R & D and production and marketing, etc."

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 supported by Adler & Shenhar (1990) who suggest that an organisation's technological base is made up of four dimensions.

Figure 2.1

	PRE- COMPETITIVE	COMPETITIVE
VERTICAL	1. Unclear objectives 2. Decision making at technical level 3. Long term horizon (> 5 years) 4. Many framework - induced partners 5. Little consideration of future impact on VAC 6. Weak evaluation of risk 7. Projects and frameworks 8. Low stability	1. Reasonably defined objectives 2. Technical/top decision making 3. Medium term (3 - 5 years) 4. Few self-selected partners 5. Future impact on VAC considered 6. Strong evaluation of risk 7. Projects within/outside frameworks 8. Medium/high stability
HORIZONTAL	1. Well defined objectives 2. Top decision making 3. Long/medium term (5 years) 4. Several self-selected partners 5. Little consideration of future impact on VAC 6. Weak evaluation of risk 7. Projects within/outside frameworks 8. Medium/high stability	1. Very well defined objectives 2. Top decision making 3. Short term (3 years) 4. Very few self-selected partners 5. Little consideration of future impact on VAC 6. Strong evaluation of risk 7. Projects outside frameworks 8. High stability

CATEGORIES OF TECHNOLOGICAL ALLIANCES
(Nueno and Oosterveld (1988))

1. Technological assets: These are the most immediately visible elements of the technological base - the set of reproducible capabilities in product, process, and support areas.

2. 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.

3. External assets: These are the relations that the firm establishes with current and potential allies, rivals, suppliers, customers, etc.

4. 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.

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. From this standpoint, it may be argued that it is more appropriate to consider an organisation's 'knowledge base' rather than select individual parts for analysis.

2.3.2 The technological needs of SMEs

Several distinctions have emerged from the literature with reference to the technological needs of SMEs; the ability of SME management to understand their own requirements within the market place; their ability to scan for and to recognise the value of ideas which are new to their firm given their in-house capabilities; and their ability to then articulate those needs to those intermediaries or other sources of external help.

SMEs need to understand not only the technology needs of their business in relation to other business and marketing plans and the overall corporate strategy, but also recognise the benefits of acquiring the technology.

MacPherson (1992) suggested that successful manufacturing SMEs need not contain a full range of in-house technical resources. The internal limitations can be partially offset by delegating task-specific work to professional consultants, university departments, or large firms. In other words, such collaboration with outside sources of knowledge can ignite the critical learning process. Adler, et al (1992) suggests that the starting point to establishing such internal and external linkages would be to ensure that clearly articulated policies are in place which can guide the day-to-day decision making together with policies which are comprehensive, compatible with strategic priorities, compatible with each other, and useful as decision guides - not just bureaucratic hurdles. SME management must also have the receptivity in order to exploit external knowledge and thus cumulatively improve its innovative capabilities and above all, a good understanding of why and how such linkages can improve their business. These points will be referred to again in chapter three where the research propositions are presented.

The following section briefly considers the earlier studies relating to how organisations learn and exchange know how through good external linkage processes - collectively emphasising the importance of partnering to facilitate knowledge transfer. Cohen and Levinthal (1990) argued that organisations need **prior related knowledge** in order to assimilate and use new knowledge. They suggested with reference to learning as a skill that the progressive improvement in the performance of learning tasks is a form of 'knowledge transfer' and referred to earlier as 'learning to learn', [Ellis, (1965)].

2.3.3 Organisational learning

Within organisational theory there has been a range of explanations for the problems firms have in learning to do new things. Argyris and Schon (1978) developed a three-fold topology of learning which they describe as single-loop, double-loop and deutero-learning. Briefly, single-loop learning is where the firm detects and corrects an error, double-loop learning occurs where a firm detects and then corrects errors yet in a way that involves a modification of a company's underlying norms, policies and objectives. Deutero-learning is where firms need to learn how to carry out single and double-loop learning.

"When an organisation engages in deutero-learning its members learn about previous contexts for learning. They reflect on and inquire into previous episodes of organisational learning,or failure to learn. They discover what they did that facilitated or inhibited learning, they invent new strategies for learning, they produce these strategies, and they evaluate and generalise what they have produced."

Hedberg (1981) discusses 'unlearning', remarking,

"Understanding involves both learning new knowledge and discarding obsolete and misleading knowledge. This discarding knowledge - unlearning - is as important a part of understanding as is adding new knowledge. In fact, it seems as if slow unlearning is a crucial weakness of many organisations."

This may explain why some firms are 'locked-in' to inferior paths of technological development. Under such circumstances, the need for 'unlearning' is very important.

In relation to partnering arrangements, some studies suggest that such alliances do not actually yield the results expected by either or both partners, and even when a measure of success is achieved the tensions in making partnerships work sometime dwarf success in the eyes of the participants. Doz and Shuen (1988) contribute some interesting ideas that relate to this last point. In the context of learning and adaptability of the partners, they argue that there are three learning processes in continuing partnerships: learning about the partner, learning about the task, and learning about outcomes. In the last learning process, the partners initially start off with a too rosy picture of the expected outcomes. The authors argue that this over-expectation can result from the bargaining process, where each partner is encouraged to oversell its advantages and capabilities and undersell its weaknesses. They also point out how much bargaining processes takes place within firms, as the advocates of partnership tend to oversell the advantages of collaboration to top management. This cumulative process may have led to the observation that the partnering concept has become lost in a sea of rhetoric rather than becoming a widespread reality.

Another issue of interest and importance that relates to learning and noted by Hedberg (1981) is 'unlearning',

"Understanding involves both learning new knowledge and discarding obsolete and misleading knowledge. This discarding knowledge - unlearning - is as important a part of understanding as is adding new knowledge. In fact, it seems as if slow unlearning is a crucial weakness of many organisations."

This phenomenon of quick unlearning would seem to be another feature of those *receptive* firms participating in successful partnering arrangements, whereas the opposite epitomises those less successful firms regarding partnering. This point will be returned to in chapter nine.

The consistent message across the literature in terms to innovation is that some *careful selective recourse to external talent can tip the balance between successful and unsuccessful innovation.* However, in terms of how that collaboration takes place once the external aptitude is found is less clear. The following section considers the importance of firms to create and strengthen their external linkages in an effort to learn about and keep abreast of new technologies

2.4 The importance of external linkages

2.4.1 Introduction

A common feature of the studies undertaken from the 1950s into successful innovation is the extent of external inputs - from customers, suppliers and academia - into internal innovative activities (Carter and Williams (1957); Rothwell et al (1974); Maidique and Zirger (1985)). In Gibbons and Johnston's (1974) study it was argued that external information inputs are as, if not more, important to innovative activities. Lundvall (1988) notes that successful innovation depends on effective interactions between organisations. Partnerships with suppliers can provide privileged access to state-of-the-art components. Strong links with important customers facilitate effective feedback on market requirements and product performance. Collaboration with other firms, perhaps even with competitors, and with university, government and private research laboratories, can extend a firm's options in innovation. While such linkages are nothing new, they appear to be extending in nature and intensifying.

It is clear that large-small firm interactions can help both partners to overcome their innovatory disadvantage and at least partially combine their respective behavioural and material innovatory advantages. Rothwell and Dodgson (1991) note that appropriately constructed strategies, based on a combination of in-house technological accumulation *complemented* by external inputs can, in contrast, enable firms technologically to update existing products and/or move to new product areas. This means that it is not only in-house R & D commitment that should be a prime focus of corporate technology strategies; also of importance is having an external outlook directed towards creating a network of linkages enabling the firm to tap into suitable sources of complementary technological information and expertise.

2.4.2 The role of networks

The word 'network' is often used to describe the ways in which companies interact and work together. Clustering processes are becoming commonplace whereby companies come together to address common problems and market opportunities. As will be discussed in chapters seven and eight, the Llanelli Radiator Supplier Club and the Scottish Subsea Technology Group are types of facilitating groups of companies aimed at gaining some form of competitive advantage. Dodgson (1994) points out the nature of and regional focus of networks stating, '... networks are a convenient term for the complicated range of inter-relationships between industrial firms and the public and financial institutions which have historically proven to be so important in the creation and maintenance of innovative firms, and so often have a regional focus.' (See also Barrell and Image (1993) for a discussion about the various types of network, such as, intuitive, spontaneous, reluctant, focused, open-ended, etc.)

Why do firms network? Whilst a firm's internal management information system can tell them about historical events, it can tell them little about what new technologies are emerging, what is happening in the local competitive environment, and what new ideas are circulating in the market place. The point is that if a small company wishes to remain informed about a wide variety of issues across a broad spectrum of industry, then management time must be directed towards developing close networks. In a study of the West German foundry industry, in which the vast majority of firms are very small, Bessant and Grunt (1985) found that the skills and technological advantages that these firms enjoyed derived from their industry association and their preparedness to share licences within a wide network of firms.

Hobday (1991) argues that networks possess distinct advantages in innovation compared to large, vertically integrated firms. In a review of the network literature, the author highlights some of the claimed advantages, including:

• Regionally-based institutions (eg consultancy firms, trade associations and financial backers) can support and provide valuable information to firms in the network.

• Skill accumulation and collective learning occurs within the network, supported by the various institutions.

• The network promotes flows of key individuals between firms, enabling them to develop and exploit their talents.

• Flexibility and low overheads enable networked firms to perform tasks large firms could only do relatively slowly and expensively.

• Key individuals are attracted to dynamic new firms and the personal rewards for innovation can be extremely high.

As will be seen within chapter seven and eight when studying the motivation for some companies participating in the various industry-specific initiatives, there is an element of truth in these advantages. However, what appears to exist in one network may not exist in another. For example, in the Llanelli Supplier Association, technical personnel from one association member works at Llanelli Radiator's site for limited periods - a *one way* exchange. Conversely, the Scottish Subsea Technology Group tend to have less exchange in favour of frequent *two way* managerial contact between small and large firms. This type of network in Scotland suggests that small firms prefer to rely on a dense web of informal inter-personal connections that enhance learning and support technology development. The role of the facilitating organisation in this respect is considered in more detail within chapter seven and eight.

Because the operation of networks often requires both competition and cooperativeness, they are difficult to manage. It also becomes more complicated when examining the innovation process in networks, as inter-linked firms may be operating cooperatively with some firms in the process, and competitively with others. Again, as will be seen within the case studies (Llanelli Radiators), eventually, two supplier associations were running in parallel yet the management were reluctant to merge each association's activities given that some firms from each were direct competitors. However, after twelve months some integration was undertaken principally due to the increased levels of trust.

To summarise the main literature themes, Rothwell (1991) has shown that innovative SMEs have dense external networks (or linkages) in a variety of marketing and manufacturing relationships. These linkages are often informal alliances and industry associations. Nonetheless, they 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). However, it appears that not all firms have the foresight and capacity to forge and develop effective external linkages, formal or informal. Rothwell and Beesley (1989) suggest that the most significant factor determining an SME's propensity and ability to access external knowledge is internal to the firm; most notably,

"...the employment of qualified scientists and engineers and the outward-lookingness of managers."

In other words, SMEs appear to be disadvantaged in their ability to develop external linkages an informal alliances because they lack internal specialists.

It has been noted how organisations learn, ie through prior knowledge in order to assimilate and use new knowledge, and introduced the importance for small firms to develop good networks of technical expertise. The common theme emerging is that by creating and maintaining informal alliances this may enable firms to better exchange technical know how which can then lead to significant quality improvements and the capacity for greater innovation. *How* they do that is less clear and will always remain a unique feature of each alliance.

2.4.3 Some hidden tensions within technology partnerships

There is little doubt that firms engaging in technology partnerships can and do learn from each other. However, there is still concern in the literature about one the inconsistencies in the logic between partnering and innovation. In essence, innovation is a 'chaotic' process combining creativity and risk, Quinn (1986). Thus the greater uncertainty of outcomes in new product innovation groups (when compared to other business activities) should logically lead to more adjustable and flexible management processes. In fact, innovation is often described by managers as an improvised, often unsystematic process. The importance given to the 'champion' and other roles supports the notion that innovation depends on autonomous decision-making and a continuous adaptation of plans to account for changes in project timing and in the business environment.

On the other hand, the logic of partnering emphasises clarity and explicitness. The formation and management of co-operative agreements are nearly always presented as a process which should be based on a clear definition of goals, Lorange and Roos, (1992). Partners seek explicit plans and forecasts so that each party can agree on how to share costs and benefits. Any departure from the initial plan has thus to be negotiated either to restore the agreed upon balance or to find a new, mutually acceptable equilibrium.

Consequently, the logic of partnering is foreign to the dynamics of innovation. On the one hand, a collaborative arrangement should be as specific as possible, while on the other, we can characterise innovation management as a non-linear process. This issue will be returned to in chapter nine.

Another tension relates to the dangers of opportunism by the partners. One argument is that instead of technology partnering arrangements being used as a vehicle for small and large firms to invade new markets, and generally harness new technologies, the widespread temporary nature of such arrangements in the offshore and motor components industries can only lead them to be endangered by lack of trust and power games. Indeed, the transient nature of the partnerships highlighted earlier where uncontrolled communication channels only serve to compound the uncertainty for the suppliers particularly in regard to the level of long term commitment between the parties. The entire disjointed and *ad hoc* process leads to a series of destructive partnerships and wasted effort. The following section considers these aspects in relation to the managerial issues of trust and power balances in a relationship.

One of the practical concerns for firms looking for ways to trigger their own partnering arrangements must revolve around maintaining good working relationships. Clearly, this calls for a managerial attitude and commitment that implicitly attracts other firms and make them *feel* that they could work together successfully. Indeed, much has been said about 'commitment' throughout the literature with respect to partnering, but little about what it means and how it can be demonstrated. The long term commitment to a particular purchaser relationship is a resource that can be communicated through personal contacts. The personal contacts are themselves often a manifestation of commitment, regardless of the overt purpose or message being exchanged. This is primarily due to the fact that every *personal contact* represents the allocation of a *scarce resource* (especially during a national recession) in favour of the particular supplier or purchaser. The more frequent the contact and the more senior the staff involved, the *greater the demonstration of commitment.*

2.5 The potential for power imbalances

An imbalance of power in the partnership can quickly lead to a short lived alliance; the small supplier will loose interest and fail to stretch themselves in terms of improving quality and technology and revert back to the traditional mode of working. Macbeth (1994) argues that in a adversarial relationship, purchasing power is used explicitly and often in a threatening manner by the purchaser - subjugating the supplier in an effort to cut costs in the short term - while the supplier uses the threat of disrupted supply as a bargaining ploy. In a collaborative relationship, power is recognised as 'two-edged' and is residing in both partners and not used or even threatened: it is not seen as a solution to most problems.

What strengthens or weakens a partner's power base and which may impact on the technology alliance? Cunningham and Homse (1984) note that is possible for a company's (either supplier or purchaser) 'resources' to be transferred into bases of power by making the other party aware of how those resources could be used either to reward or punish certain kinds of behaviour. (Buchanan and Huczynski [1985] also note the individual managerial theories of power in relation to punishments and rewards.) A multitude of aspects fall under Cunningham's heading of resources. From the supplier's point of view, resources are everything he has to offer that helps the purchaser solve a particular need or problem, including: product, technical expertise, application knowledge, ability and willingness to make product adaptations, price, credit, guarantees, ability to deliver on time, assurance of priority in the event of shortages, willingness to provide special stocks, etc. The main purchaser's resource is clearly purchasing power, yet others include: loyalty, the possibility of greater levels of purchases in future, commercial, technical or market information, technical ability to evaluate and suggest improvements in the supplier's product, flexibility on commercial terms, etc.

The need to recognise the influence of power differences within supply chain relationships and the implications arising may represent one of the most significant barriers to effective technology partnership, ie the values that are associated with partnering are likely to conflict with those that exist in a relationship that has unequal power relations at its heart.

To complicate the picture, companies' perceptions of power, whether their own or that of their trading partners, are often wildly inaccurate. Neither size nor position on the supply chain is a good guide. Although some may not realise it, small and quick-witted supplier firms have powerful means of compensating for apparent disparities through innovation and service focus. To illustrate, a small offshore engineering pipeline consultancy firm employing some 100 people pride themselves in their ability to react quickly to changing events and appreciate their position of power in relation to the purchaser. The purchasing director within the oil operator suggested that this supplier, despite its size, has the ability to deliver innovative ideas thus constantly improving performance which can make a considerable impact on reducing costs. Consequently, the purchaser ranks the supplier in high regard and aims to continuously blend their technical know how in their project teams. Indeed, the purchaser was the driving force behind ensuring that a Technology Committee become established between the partners; some of which were multi-national organisations. The small firm was appointed a full partner in the alliance to help scan for new technologies emerging from the offshore supplies sector.

Several relevant research studies on the development and implications of partnerships have been completed and the results recently published. In particular, a cross industry survey of 300 firms (CBI [1994]) reported that nearly three quarters of purchasers and 61 per cent of suppliers use the practice. The study found:

- 85 per cent said that partnership sourcing had enabled them to cut costs;
- 81 per cent said they could improve the service they gave their customers; and
- 78 per cent said they had improved product quality.
- 67 per cent said that they had been able to improve delivery times;

The CBI study concluded that in spite of growing awareness of an idea which has already become popular in information technology and electronics, companies had found that adopting partnership sourcing was *more time-consuming and difficult than anticipated*. Indeed, 41 per cent said that *co-operation with the other party was a key difficulty*.

These views are further supported by a cross-industry study carried out by the School of Management, and consultants A.T. Kearney (UMIST [1994]). They argue that the term 'partnership' is being devalued by overuse and abuse, while in practice it is difficult to define and execute. Interestingly, they also note the practical difficulties to partnership, eg the interactions between firms can take place at different levels and in different functions (virtually ensuring problem of consistency across the organisation); individual firms can be more or less skillful at managing the inter-actions; and most firms are part of not one but many different supply chains, often cutting industry boundaries. Furthermore, managing partnerships demands huge amounts of information to bolster the necessary trust. Integrating with more than a chosen few purchasers and suppliers is thus virtually impossible from a resource point of view - as well as posing capital strategic questions.

All of these findings suggest that aspects of **power** undoubtedly plays a formative part in how companies in the supply chain link with each other. Power, whatever its source, isn't made any less because a firm chooses to form closer relationships with trading partners. Contrary to easy talk of 'open-book accounting' in the business press, the reality is that firms do not, on the whole, trust purchasers with cost information, and suppliers dislike their purchasers trying to reduce their costs. In other words, whatever the cozy discourse, power matters, and imbalances of power are a serious barrier to effective partnerships.

2.6 The need to understand what factors influence good technology partnering performance:

One of the main points which emerged during this review was that small firms may enhance their technical knowledge base by maintaining informal alliances. It was highlighted that collaboration with other firms, HEIs, RTOs, may extend a firm's options in innovation. The importance for management to be 'outward looking' was also emphasised. In addition, the importance of learning as well as 'unlearning' was considered in relation to a partnership. A review of the role of networks to support innovation within the context of partnering highlighted some underlying problems of balancing cooperation with competition.

However, there was little emphasis in the literature on the managerial attitude and behavioural factors towards alliances although Doz (1988) provides an important contribution. The author conducted a study of technology partnerships between large and small firms and summarised three critical issues: (i) Convergence of purpose, (ii) Consistency of position within the large firm, (iii) Interface, and concluded that partnerships fail because of *managerial rather than technical reasons*. Three areas are highlighted below that may doom partnerships:

'(1) The initial analysis and the initial agreements emphasise strategic complementarity as a source of value for the partnership, but take subsequent strategic convergence as given. Cultural distance, uncertainties and misunderstandings as well as hidden agendas make such convergence difficult unless it is truly desired by the top management of both partners and unless it is actively managed.

(2) Managers in the larger partner do not develop a joint coordinated approach to the partner. On the contrary, they use the partnership as a tool to further their own interest in the bureaucratic and political games that take place within large organisations, and they see the partnership from the standpoint of their own parochial interest. While this is unavoidable, awareness of these problems by the top management of the larger partner can help limit the risk of internal politics and enhance its ability to manage a partnership with small entrepreneurial company.

(3) The operating interfaces between the two partners can not be left to chance and to ad hoc adjustment. They must be designed as a whole, recognising the various issues and the corresponding levels in the hierarchy of the bigger firm as well as the nature of the interdependences between the partners.'

While Doz highlights some practical managerial difficulties involved in maintaining partnerships such as cultural distance, uncertainties, misunderstandings, hidden agendas as well as political games and the importance of the managing the partnership interface, little has been researched into drawing distinctions between different *role* of technological alliance and the factors which lead to their success. What can be learnt from those that perform better at partnering? What are the important determinants of a small firm's ability to make technology partnering work for them? What factors represent best practice? What is the future outlook for partnering?

Consequently, the research aims which are shown next interweave these points and help to focus the area of research.

2.7 Research Aims:

The general aim of this study is about contributing a better understanding of the extent to which technology partnering has developed between purchasers and suppliers in manufacturing and process industries. Given this overriding theme, the objectives of this study include:

1. To evaluate under what general or idiosyncratic conditions (micro and macro) is technology partnering a good practice, and under what conditions is it inappropriate.

- The purpose of this evaluation is twofold:

[i] To assess where (historical) partnering arrangements have been successful: To question if it can be argued that one industry is homogeneous, ie that partnering has worked across the sector, or whether there are heterogeneous elements which make one group/network of firms more adept at forming alliances than another. What lessons may be learned from the successful

groupings? Can those principles be transferred to other industries? This assessment will also help to capture the likely future direction of partnering, predominantly within the oil and gas and motor industries.

[ii] To explore by what processes *vertical supply chain technology partnerships* operate with particular reference to small firms. This implies an indepth understanding of that continuously changing interactive process and will result in an assessment of the measurable (and immeasurable benefits) of partnering between firms. The purpose is to unequivocally state what are the precursors that need to be in place to move firms beyond partnership towards a position of continuous incremental improvement.

2. To evaluate the factors which influence managerial behaviour within and between firms, (influence of power) and how that behaviour affects the partnering arrangement. The purpose of this route is to:

[i] To provide a set of recommendations for industry sector organisations and government agencies which will detail how they can provide a better role to encourage partnering in the future. Partnering or alliance agreements are driven by management; a bland investigation of what makes a successful partnership will not help yet understanding what influential factors (internal or external politics) come into play which can then accelerate the progress of the contractual arrangement are clearly a key determinant to a successful partnership, (having defined what is meant by *success).*

[ii] To contribute and advance our conceptual understanding of the theories and influence of power within and between organisations which actively collaborate. For example, oil and gas companies developing and operating in the North Sea are currently shifting the prescriptive power in the services and products to be used to the contracting firms (design houses, and fabricators). One plausible line of enquiry would be to evaluate *how* that transition is being managed and what are the alliance characteristics which determine the balance of power. In addition, to explore the degree to which over-management (ie retaining power and meticulous control) can inhibit or encourage the progress of an otherwise veritable partnership.

This chapter considered the merits of technology partnerships, their various forms and focus were considered as well as the motivation for small and large firms to become involved in a collaborative venture. In addition, it highlighted the research need to recognise the influence of power differences within supply chain relationships and the implications arising may represent one of the most significant barriers to effective technology partnership, ie the values that are associated with partnering are likely to conflict with those that exist in a relationship that has unequal power relations at its heart. The next chapter draws together these points and presents the research propositions and questions.

Chapter Three: Research propositions and questions: the role of knowledge transfer

3.1 Introduction:

The previous chapter brought the concept of technology partnering to the fore stating that it is concerned with building the capabilities within firms in a long-term time framework. It provides a means for receptive SMEs to complement and supplement their own in-house efforts. Collaboration provides firms with the opportunity of not only of learning about new technologies, but learning about methods of creating future technologies and of the ways those technologies might affect existing business.

The point of view emerging from the first two chapters is that suppliers can expect to improve their in-house knowledge of process, product and materials technologies if they genuinely believe in the partnering concept and are prepared to devote considerable time and energy to making it happen. The last chapter showed that small firms in both mature industries continue to encounter some difficulties of technology association/assimilation, ie they have some difficulty in assimilating and adopting new technologies through their 'floating' partners. A plausible reason may rotate around their lack of an internal base of know how which *per se* limits their external knowledge accumulation. ie they lack the in-house capability and time to transfer and mould ideas into their own business. Angell et al (1984) suggested that a SME's ability to access external know-how is conditioned by its in-house employment of qualified scientists and technologists, (QSE). Rothwell and Beesley (1989) note how the lack of QSEs can inhibit the SME's ability to disseminate and further develop technological know-how, even when it does succeed in acquiring it from external sources.

One can easily argue that firms which have an innovative pedigree and the resource base, eg technical personnel to spare the time to participate in activities outside their routine duties, to experiment with technology partnering are more likely to risk sharing know how with other firms. On face value, this proposition appears reasonable yet it is a sweeping generalisation which over simplifies the internal mechanisms of the firms concerned and their attitudes towards technology partnering. It is an intuitive argument which fails to identify the potential targets for information gathering.

The aim of this chapter is to avoid generalisations and convey a set of five research propositions and related questions. Section two considers the development of the five propositions used in this study. Section three explains the information needed to address these questions. The application of these instruments is discussed in section four.

3.2 Development of research propositions and questions

3.2.1 Proposition One: Good external linkages are an important part of successful technology transfer

For small firms, their effectiveness in communicating with large purchasers can vary considerably. A major determining factor appears to centre on the time and effort which senior management within large firms devote to establishing linkages with small firms. Indeed, as Segal, Quince Wicksteed (1988) argue, 'few large firms have thought seriously about their links with small firms in the sense that they have a definite policy, established at top level and made known to concerned individuals throughout the organisation.' This, the authors contend, is a major shortcoming as a strategic relationship is necessary if the small firm is to play a role in product development and/or provide the large firm with a significant input of technology. The way in which the majority of small firm linkages were found not to derive from formal corporate planning processes had three main consequences. First, it meant that any partnership was inevitably peripheral and failed to command widespread support throughout the company. Second, it was critically dependent on being championed by individuals, and was likely to collapse if they were to move. Third, the partnership was narrowly based; it would, for example, be a link only between technical personnel, and would preclude links with the marketing function so valued by many small firms. These points equally refer to the third proposition below.

Related Research Questions to this Proposition:

1. To what extent do external communication channels vary from one vertical supply chain to another?

2. Is it possible to identify 'boundary spanning individuals'?

3. What impact have they made on the progress of the technology partnership?

3.2.2 Proposition Two: Similarly, good internal communication channels are important for knowledge transfer

In practice, poor internal communication processes inevitably result in difficulties in the adoption of and subsequent advancement of partnering-type relationships. Whilst the partnering concept appears to improve the awareness of technology development opportunities to prospective participants, it does relatively little to assist in the essential aspects of internal assimilation and adoption.

Related Research Questions to this Proposition:

4. Do supplier firms with good external linkages with 'committed' purchasers (above) have a better awareness of technology opportunities and do they see clear associations between their business needs and those technology opportunities?

5. Do small firms in particular find difficulty in assimilating and adopting new technologies through their partners because of a lack of internal base of technological know-how which can per se limit its external knowledge accumulation? ie they lack the in-house capability to transfer and mould ideas into their own business.

The discussion relating to the next two propositions is merged because of the close inter-relationships.

3.2.3 Proposition Three: Progressive technology partnering arrangements depend on the degree to which management possess the 'right' attitude towards sharing knowledge

3.2.4 Proposition Four: Good partnering arrangements ensure that committed individuals become involved in the partnership and champion its cause.

The establishment of an appropriate contact within the business who is able to appreciate the nature of the research as well as its value to the company, is very helpful, not least to overcome problems arising from cultural differences. Regular contact minimises the possibility for misunderstanding about the direction and results of the research. Such contact can be with the business organisation's research staff or with an individual who had a keen personal interest in the project - leading to a close working relationship, (Trott, Seaton and Cordey-Hayes (1994).

Macbeth (1994) considers the purchasing function's role in a partnering relationship and notes first that the purchaser should act as 'champion' to ensure that the supplier be given the opportunity to develop and support new technical capabilities. Second, the purchasing function's role as 'protector' is to recognise that the trust built up over extended time-scales is too valuable, and the benefits of technology partnering too important, to be put at risk by rash attempts to score 'quick points'. The 'protector' ie the purchaser's senior management, must therefore ensure that the partnership structures and procedures are constructed in order to prevent such short-term adversarial behaviour.

At the very least, the author contends, this means the 'protector' must understand the inter-relationships between the internal reward structure and its impact on the supply base and more generally the motives of purchasing/procurement personnel. It means resources must be directed towards reorienting personnel involved in the purchaser-supplier interface and, where appropriate, retraining. At the extreme, it may mean redeployment or replacement of existing staff - already noted in some large firms in the motor and oil and gas industry, where key purchasing individuals are hand-picked to manage relationships with critical suppliers.

The interpretation is that small firms face the task of building relationships with assembler/operator procurement personnel who may change their job, *and* may not share the same vision of senior management who, incidentally, change roles less frequently.

People are promoted in organisations because they 'provide a fit to the requirement'. Given the present set of new requirements for purchasing professionals, it is perhaps of no surprise to still find a mismatch between antagonistic and 'new' attitudes amongst middle management. Their role has changed totally from traditional purchasing to partnership behaviour - even treating the supplier as a 'friend'. However, a 'new' breed of purchasing professional is emerging. Briggs (1994) notes in a vendor assessment case study on Crosfield Electronics Limited that the purchaser's new role required 'a different set of skills and a much higher competence level. While some skills may be developed through training, it was felt that others had to be bought in anew.' This links with research by Cousins (1993) who noted the trend towards a higher percentage of degree qualifications in purchasing staff.

The above points would be particularly interesting to examine further in relation to possible 'distortions' in the mechanism/process. To recap, partnering is effectively a process through which technology can pass from one firm to another. However, the characteristics of the channel, (eg the number of supply levels), nature of the product, (eg innovative or standard), and the managerial attitude and behaviour towards partnering relationships appears to vary in degrees of strength from one firm to another.

Distortion may occur in the messages being processed externally (ie to/from the purchaser) and internally (ie from senior management at board level to the rank and file). In many situations, such distortions appear common and even expected due to the newness of the idea and the uncertainty of the outcome. For example, partnering has progressed at various speeds in different industries; dependent on the maturity of the industry and the influence of major customers, eg the concept gathered momentum in the motor industry during the early 1980s driven further by the full operation of Nissan UK in 1986 and then Toyota UK in 1992, whilst the North Sea oil and gas industry recently claimed alliance-type agreements as an innovation in contracting philosophy and it receives the 'full' support of major oil operators, eg BP. However, 'distortions' in the assembler's internal communication channels are still occurring given that small suppliers do not share the vision of senior purchasing management.

It is argued here that the potential for distortions in the internal communication channels in large purchaser organisations which can hinder the development of technology partnering between those firms and smaller suppliers <u>will be greater</u> where:

i] There is a preponderance of people who have responsibility for steering a partnering arrangement yet have infrequent interaction with the supplier and have a project-orientated career history; often suggesting that they have little appreciation or interest in the myriad of innovative ideas coming from small firms.

ii] There is a group of disorientated purchasing professionals who do not see their role as exerting pressure on the selected suppliers for innovation: avoiding the process of technology search and competitive benchmarking. (See reference to Macbeth earlier and the new role for the purchasing function).

iii] There are few people left in the large purchasing organisations left, following the singeing recession and accompanying redundancy programmes, who are 'product champions' and understand the suppliers' products and can push advances in technology, (relates to [ii] above). Having outsourced technical capability, and without a competitive tendering process to introduce new technology options (given established partnerships in the motor industry), it becomes crucial to identify potential threats and opportunities created outside the bounds of the partnering relationship.

iv] An external communication system which is inefficient in providing the supplier timely feedback on the performance of the product, ie feedback that is regular and expected as against reactionary and sporadic problem/crisis feedback. (also relates to three above).

v] There is no group of individuals who take *responsibility* for ensuring the supply relationships are understood, managed and improved. Personnel who move jobs frequently (commonly referred to as 'management churn') only disenchant the supplier causing them to build new relationships with people who bring 'a different set of baggage/ideals/beliefs' with them. This is surely no basis for long term partnering. It can only reinforce supplier skepticism of partnering borne out of organisational structural changes within the purchaser.

Related Research Questions to this Proposition three:

Purchaser related:

6. What is causing large purchaser middle management to react slowly to the new contracting philosophy?

7. What evidence is there to suggest that management are instinctively protecting their personal interests?

8. Is this a common human reaction to change or are there other more complex reasons which may specifically relate to mature industries, ie motor and oil and gas?

9. Are there any other contrasting distinctions in managerial attitude between those people in the motor components and oil and gas sectors?

Supplier related:

10. What influences suppliers to pursue particular strategies with different purchasers and how exactly do existing inter-organisational personal contacts influence and assist their achievement?

Related Research Questions to Proposition Four:

11. Are there consistent features which are displayed between a particular purchaser which increase the potential for greater distortion in the messages being sent and acted upon?

12. Within the purchasers which have a greater propensity to send and receive distorted signals (how ever measured), is a 'champion' lacking?

Aside: The literature referring to the adoption of technology is dominated by references to 'champions', either product or business. While such key people are necessary to promote and push the idea internally through to final exploitation, they are not sufficient on their own. Schon (1963) first identified the role of a champion and 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. 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). See glossary for definitions of various key individual roles within an organisation.

3.2.5 Proposition 5: Good partnering arrangements depend on the stable balance of power between the partners:

Related Research Questions to this Proposition:

13. To what extent does the influence of power in the 'overall' relationship inhibit the smooth progression of a technology alliance?

14. Is the notion of 'trust' seen as one of subservience (or overdependence) in many firms, but they consider that they have no alternative due to the power exerted by the main purchaser?

15. How do purchasers aim to balance the delicate issue of power between themselves and the supplier?

To summarise, these five propositions collectively argue that there are a cluster of attributes or conditions that should be in place within or between potential partners. The 'preconditions' centre around the participant's internal and external linkage mechanism, its process of acquiring and assimilating external know how and, its managerial attitude and receptivity towards partnering. If these are in place, then a partnering arrangement resembling best practice may emerge. These themes effectively set the scene for the remainder of the thesis.

With these propositions in mind, the information needed to address them is considered. The following section presents the three 'information sets' that help analyse the data and test the propositions.

3.3 Information needed to address these propositions

3.3.1 Information sets

One of the main aims at this stage of the research is to elicit information which can test these propositions and ultimately contribute towards a better understanding of technology partnering. Consequently, three main sets of information need to be gathered:

1. External knowledge acquisition.

2. Internal and external communication channels.

3. Managerial attitudes towards technology partnering.

Briefly, the **first set** aims to elicit sufficient data about how management respond to partnering in order to understand what influential factors (internal or external politics) come into play which can then accelerate the progress of the arrangement.

The **second set** refers in some depth to the continual process of communicating ideas within and outside the firm. For example, to assess if there are significant variations in internal communications between firms. Again, the value is to see if any patterns consistently emerge and whether it is possible to identify scanners, networkers, and boundary spanning individuals.

The **third set** of investigation will aim to enquire about firms' current approach to acquiring know how and measure the added value from closer collaboration. For example, it will aim to question the reality of the argument that firms can improve their in-house capabilities through partnering.

Table 3.1 summarises these information sets with the research propositions.

Table 3.1

	Information Set	Research Propositions	Research Questions
1	Managerial attitudes towards technology partnering:	3.	6, 7, 8, 9, 10.
2.	Internal and external communication channels:	2, 5.	4, 5, 11, 12, 14, 15.
3.	External knowledge acquisition:	1, 4.	1, 2, 3, 13.

While the research questions above aim to discern what makes partnering happen, they must be re-written in a form that is less daunting to a manager in an interview setting and which can be addressed quickly. The following section presents a summary of the semi-structured interview questions applied during the phase one of the research.

3.3.2 Summary of the semi-structured interview questions applied during Phase One

The first phase questionnaire, which may be found within Appendix A, covered four main sections. The selected responses are considered in chapters six and seven. Briefly, the main sections were:

(i) Relations with the customer and communication channels (Relates to Information Set One, Three and Four)

The emphasis within this section was threefold: (a) the characteristics that can sustain successful partnerships, (b) the impact of winning and subsequently supplying to the Japanese transplants, and (c) the suppliers' perceptions of how committed the assemblers, particularly the Japanese transplants, were to developing the technological capability of their supply base. This emerged as a result of the differing approaches and philosophy to between the Japanese and European based vehicle manufacturers and their suppliers.

(ii) Technologies (Relates to Information Set Two and Four)

The emphasis within this section of the questionnaire was sub-divided into nine areas which included: Technology motivation, scanning, frequency of changes, and method of assessment.

(iii) Research and Development (Relates to Information Set Two)

The objective within this section was to establish the level of the SME's R & D capability and their perception of the customer's research and development requirements. In addition, the source of financing such activity was explored.

(iv) Staff training (Relates to Information Set Two and Three)

The research questions focused on the level of in-house and external customer-lead structured training programmes and the approach the SME uses to identify skill gaps.

3.3.3 Summary of the semi-structured interview questions applied during Phase Two

The underlying aim of this phase was to assess and draw conclusions on the current and foreseeable problems and the management attitudes that intrinsically camouflage those problems in order to evoke what has, and will, hinder cost reduction in the wake of changing industry relationships. Consequently, the semi-structured questionnaire to elicit this information centred chiefly around identifying management responses to date. It was initially tested on a pilot basis to check whether the questionnaire a) was feasible, b) could elicit reliable qualitative information, and c) should be modified in the light of these preliminary interviews.

The first phase study was broad and divided into several stages. Briefly, the first stage equated to a series of exploratory interviews designed to uncover what managers believed were the key issues involved in partnering. The second and third stages focused the attention onto specific areas detailed above. This questionnaire applied in the second followed a similar process yet the question content focused on the central issues emerging in the first phase encompassing corporate strategy horizons with regard to partnering (implicitly examining managerial attitude), and the development of technology alliances. To illustrate the two main sections:

1. Suppliers' priorities and strategies in the new era

This section aims to ease the discussion into a broad overview in order to get a flavour of the firm and their attitude and response to the latest industry changes in contractual arrangements. Although the questions appear to ask for some highly confidential information, it was anticipated that answers would be vague. However, even limited information can aid the interpretation of how advanced the company is in terms of developing new technology, particularly through partnering arrangements.

The second research aim (section 2.7) involved exploring the managerial attitudes and motivational factors towards partnering in order to clarify some best practice features and attributes. Clearly, there are many reasons why a firm may wish to participate. Both organisationally internal and external factors will play a part in creating the desire. Combining this with traditional macro indicators (below) such as company size or ownership, will allow for examination of specific types of company such as small independent niche market supplier or a small company which is part of an international group.

2. Technology Alliances

The first proposition suggested that one of the prerequisites to establishing successful partnerships with other firms is to first good external communications. Consequently, the questions within this section aim to either specifically ask or shed some light on the strength of the firm's communication processes in view of other known facts and test whether the proposition is reasonable. Fundamentally, all of the questions here were aimed at revealing how the alliance had performed and the benefits arising. All four information sets were covered.

3.3.4 Routes to gather the right information Discussion

At this stage, it is worth reiterating one of the research objectives and attempt to define the actual information needs, (section 2.7):

> **'To evaluate under what general or idiosyncratic *conditions* (*micro* and *macro*) is technology partnering a good practice, and under what conditions is it inappropriate.'**

In attempting to analyse these 'conditions', it is important to enquire how and why companies, that have already adopted technology partnering, have shown themselves to be successful in the innovation process. In its broadest sense, technology transfer is an innovation process and therefore lessons can be learnt from companies which have shown adeptness at this process in the past. At this stage, there appears two routes to the problem:

Route A. To examine the '**macro**' indicators of successful partnering arrangements and individual firms within that alliance to see whether any patterns consistently emerge. By macro indicators it is meant measures of company characteristics which can be made externally or with the most cursory internal examination. These indicators would include: company size measured by either number of employees or turnover, industrial sectors covered, market position, frequency of incorporation of new technology into products and processes gained through the alliance - perhaps measured by 'patent intensity' (referred to within chapter 5).

Whilst it is relatively easy to measure and document these indicators, the internal structure, managerial attitude and culture of a firm or group of firms remains hidden from view. It is these areas which this research is *beginning to suggest* determines the success or failure of partnering between firms. Through identifying the internal workings of a firm; exploring its attitudes towards partnering then some contribution can be made towards meeting the first objective. The principal is aim to establish what are the preconditions to make technology partnering happen. What lessons may be learned from the successful technology alliances? Can those principles be transferred to other industries? This entire research process implicitly leads to the idea of continually developing and assigning *concepts* to observed situations. Through observing and noting the managerial behaviour and attitudes of specific firms, some striking differences may reveal themselves where the firms are 'living' under the same conditions; Research Propositions 1, 2 & 3.

The Influence of Purchasing Management on the Partnership

Proposition 4 argued that while medium size component/offshore equipment suppliers interface with senior purchasing management, smaller firms communicate on a daily basis with middle procurement management who [i] may not be 'sold' on the idea of partnering with the smaller firm; instinctively protecting their personal interest, (the concept may be seen as a threat by some middle managers - they may prefer to maintain the historical balance of power in the relationship - see below), and [ii] move into other roles given the 'flat' organisational structure. In this context, it is interesting to note Williamson's (1975) remarks about the changing nature of the purchasing function as it moves from adversarial relations to partnership. From being the enemy in the win-lose negotiation the purchasing professional's role becomes one of friend to the supplier. As such the purchaser will have to act as the 'champion' of the supplier partner, supporting involvement in new product opportunities. Sako (1992) also observed the friendship connotation adding that 'trust (between the partners) is based upon the assumption that the other party (purchaser or supplier) will offer assistance without concern about recompense, as not only is the relationship viewed as a reciprocal process, but also it is recognised that any short term inconvenience or loss is countered by benefits later. It is natural to make allowances for the vagaries of friends, and to work with them, helping them to recover to acceptable levels of performance. A partner should be a friend in these terms.' Indeed, the myth of the purely rational and economically motivated buyer has long since been rejected. Turnbull and Cunningham (1981) observed during a study of attitudes amongst European marketing and purchasing executives that the 'social bonding' objective of personal contacts is generally much stronger amongst suppliers and customers, '... the attitude of purchasing staff was generally that social relationships were easy to establish ... (whereas) supplie. executives often found it difficult to establish close social relationships with buyers. Although the two parties to a particular social relationship may not have the same opinion about its closeness and friendliness, the discrepancy in attitudes is more likely due to purchasers often being satisfied with an arms length relationship.'

Route B. This approach aims to make some attempt at measuring the internal or '**micro**' parameters of the firm and identify the organisational factors which can trigger successful technology alliances. Again, such factors might include *measures of internal communications, innovation strategies, planning and management, the quality and skills of management, technical personnel and workforce, the impact of the alliance on managerial behaviour, the role of key personnel such as 'boundary spanning individuals'*, and a myriad of other organisational, technical and personnel related issues. The difficulty with this approach is that it requires an indepth internal study of organisations whilst the actual time spent during a typical company interview is one hour. To conduct a proper investigation of this type is clearly time consuming and costly and would limit the number of companies open to investigation. However, phase one of the research involved several visits to some firms (see table 4.1) enabling a 'file' of information to be collated where the internal parameters of individual firms may be measured in greater detail.

3.4 Application of research instruments

The fieldwork for this study was undertaken over a period of three years where over 150 face-to-face interviews were conducted. The aim was not to achieve statistical significance in terms of sample size, but to interview a wide spectrum of people in order to gain a richness and quality of understanding of the process of technology partnering.

3.4.1 Semi-structured interviews

The method of conducting the fieldwork throughout this study has been through the use of semi-structured interviews. The unparalleled benefit of undertaking the fieldwork interviews meant that it was possible to gain an insight into how management think: their motives and attitude towards new contracting philosophies. Indeed, the initial background interviews with 15 managers within SMEs conducted during the first three months of the study reinforced the view that the most appropriate and effective type of interview was a form of directed or semi-structured interview. This allowed the participants the freedom to reflect and talk around the subject whilst containing the content to specific areas. The analysis of the early background interviews resulted in a number of themes which were used as a basis around which to structure the remaining interviews in Phase One. The five common themes were:

1. Shortage of technical skills
2. Sources of information
3. Lack of design, development and testing facilities
4. Restricted co-operation with the supply chain
5. Lack of linkages between business and technology plans

Briefly, bearing in mind that during these background interviews, the UK was in its 10th successive quarter of economic recession and given the high unemployment levels nationwide, it may be surprising that firms complained about a shortage of technical skills. In some cases, this shortage refers more to the suitability of labour and in other cases it refers more to the level of skill. This was succinctly illustrated by a managing director during one of the background interviews,

"This is the biggest problem we have got. It is the current problem and always is going to be the problem. To resolve it we try to look to somebody else who we know has a good man and we try to nick him. That's the bluntness of it."

These themes will be returned to in the chapter six when analysing the data.

3.4.2 Selection of the participants

Given the research aims to establish the factors which cause good practice partnering and the factors which influence managerial behaviour, senior purchaser and SME management were targeted.

In terms of Phase One, it should be borne in mind that all the component firms visited were selected by the assemblers in response to a request for firms who are 'receptive participants in partnering arrangements'. The sample is therefore not random, nor necessarily statistically representative of the UK industry as a whole. Furthermore, as will be shown, not all firms' visited turned out to be 'receptive' despite interviewing more than one manager within the same firm hence the various levels of partnering presented in chapter five.

Table 3.3 indicates that in some firms several managers and directors were interviewed several times to provide a good understanding of various firms' approach to partnering. Figures 3.3 and 3.4 convey the managerial and organisational levels interviewed within the automotive components and offshore supplies industry respectively.

3.4.3 Supplier Profile: Phases One and Two

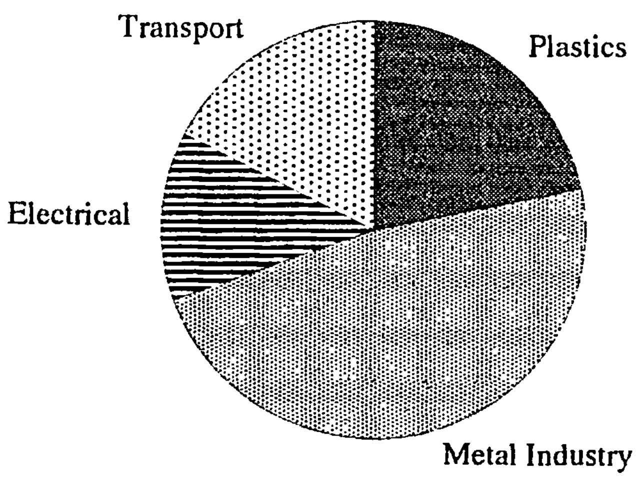
Broadly, two groups of component supplier were observed during Phase One:

The first group of companies were small firm manufacturers. They generally offered the customer local supply, flexible capacity and technical competence yet still needed to improve their use of technology and techniques, eg statistical process control (SPC). The second group constituted the majority of the UK components industry - the traditional volume suppliers of castings, forgings, tyres, etc. as well as electronic and plastic components.

Figure 3.1 conveys the phase one suppliers classified by industrial product groups.

Figure 3.1

Component Suppliers by Industrial Product Group



The offshore suppliers' interviewed during Phase Two broadly divided into three sectors: Subsea consultants, Consulting engineers, and Engineering design and manufacturers. Figure 3.2 conveys the division while table 3.2 depicts the proportion of 'small' firms (less than 50 employees).

Figure 3.2

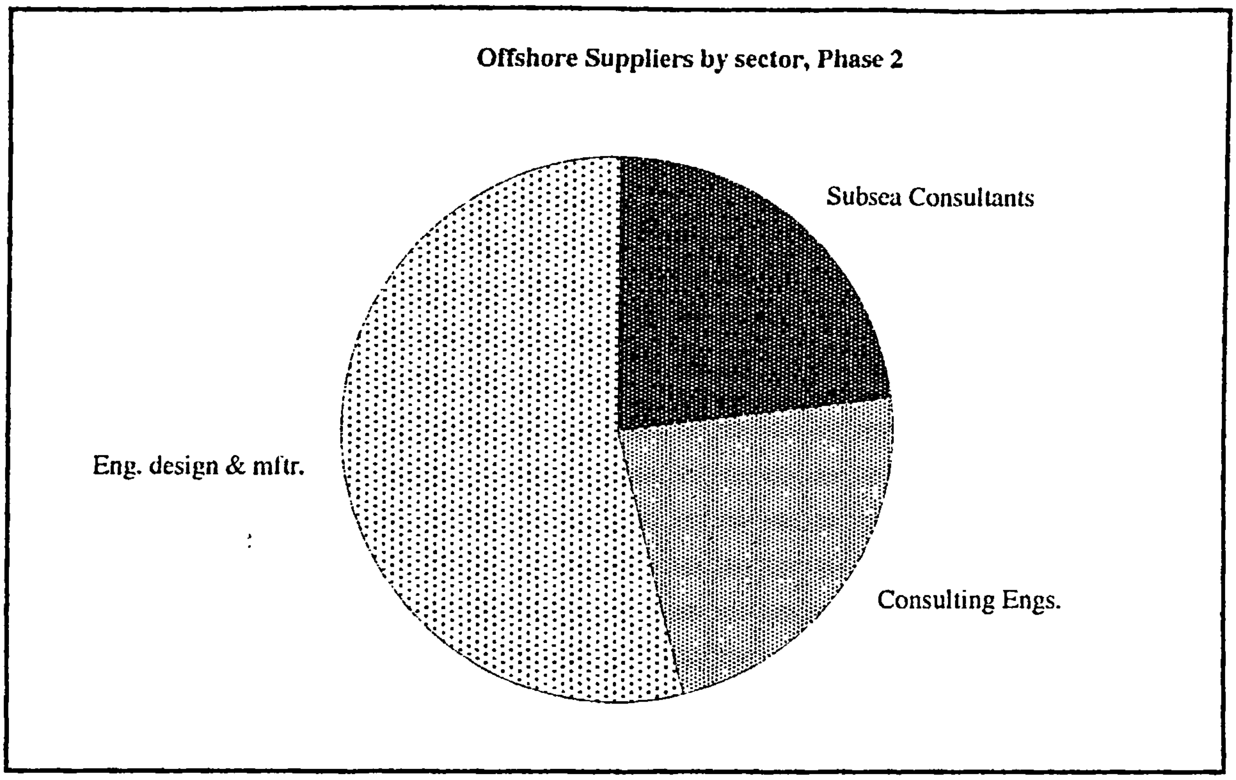


Table 3.2: Firm size and sector: Phase Two

Sector Group:	Category:	Employees <50	100 +	Independent Company	Group Owned
I	Subsea Consultants	5	-	3	2
II	Engineering design & mftr.	4	-	2	2
III	Specialised services	1	3	2	2
		10	3	7	6

3.4.4 Gaining access:

Potential management respondents in both phases of research were contacted on the telephone and/or letter. Fortunately, the success rate in terms of managers agreeing to an interview was 100 per cent - largely thanks to the credibility of the OSO, BHR Group and the academic flavour of the research project at Cranfield. In terms of the oil and gas project (Phase Two), the OSO and CALTEC were asked for companies who matched a criteria - similar to 'snowball sampling' where respondents fit a pre-characterised group. The process of telephoning managers proved time consuming; often up to six calls were made before speaking to the 'target' contact name. Nonetheless, a typical batch of ten Aberdeen interviews could be set up within two - three days and carried out in two days. The interviews lasted between one and one and a half hours. On the evidence of this study it can be said that the mention of 'partnering' or 'alliances' brings a positive response from most firms. However, small offshore firms were notably skeptical of the concept and would often reveal their standpoint on the telephone prior to the actual interview. This discussion was often useful in preparing for the interview and exploring a different angle. A list of all the interviewees in both phases is shown within tables 3.3 and 3.4 at the end of this chapter. This is supported by figures 3.3 and 3.4 which show the interviewees by organisational level in Phase One and Two respectively while figure 3.5 depicts Phase One firms by size.

Figure 3.3

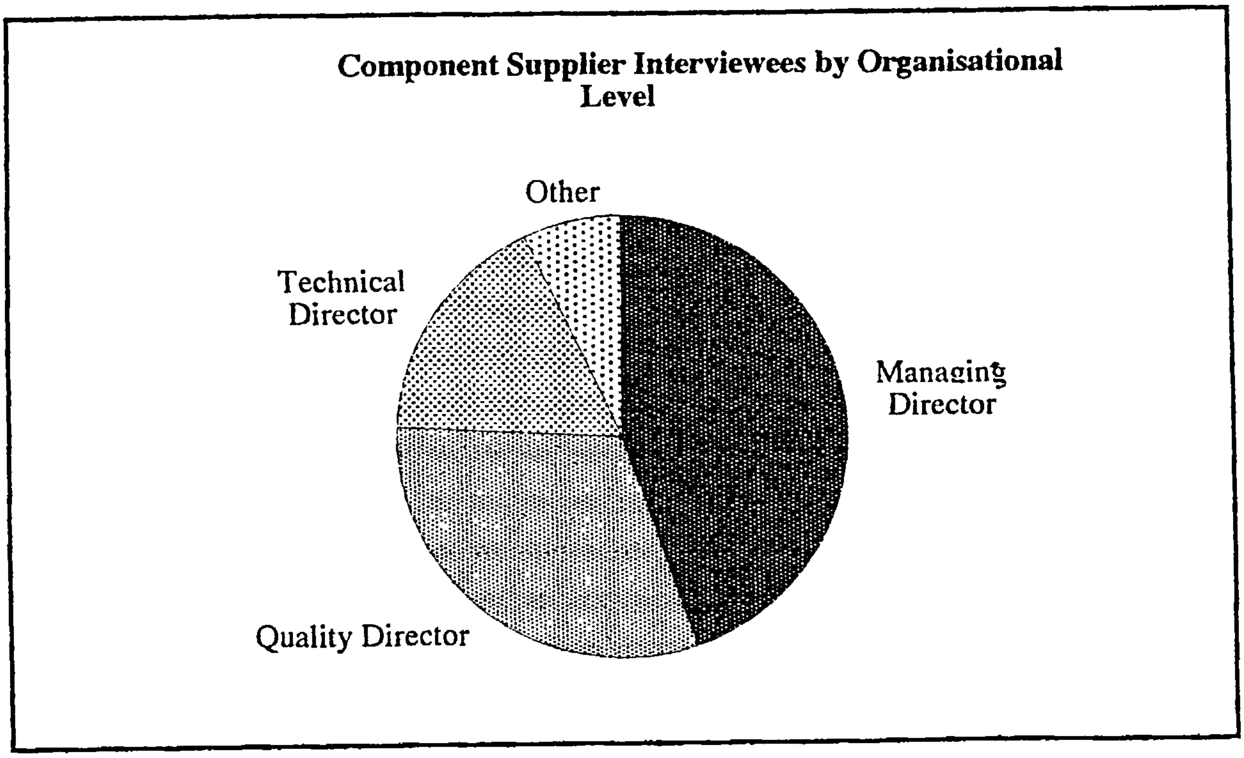


Figure 3.4

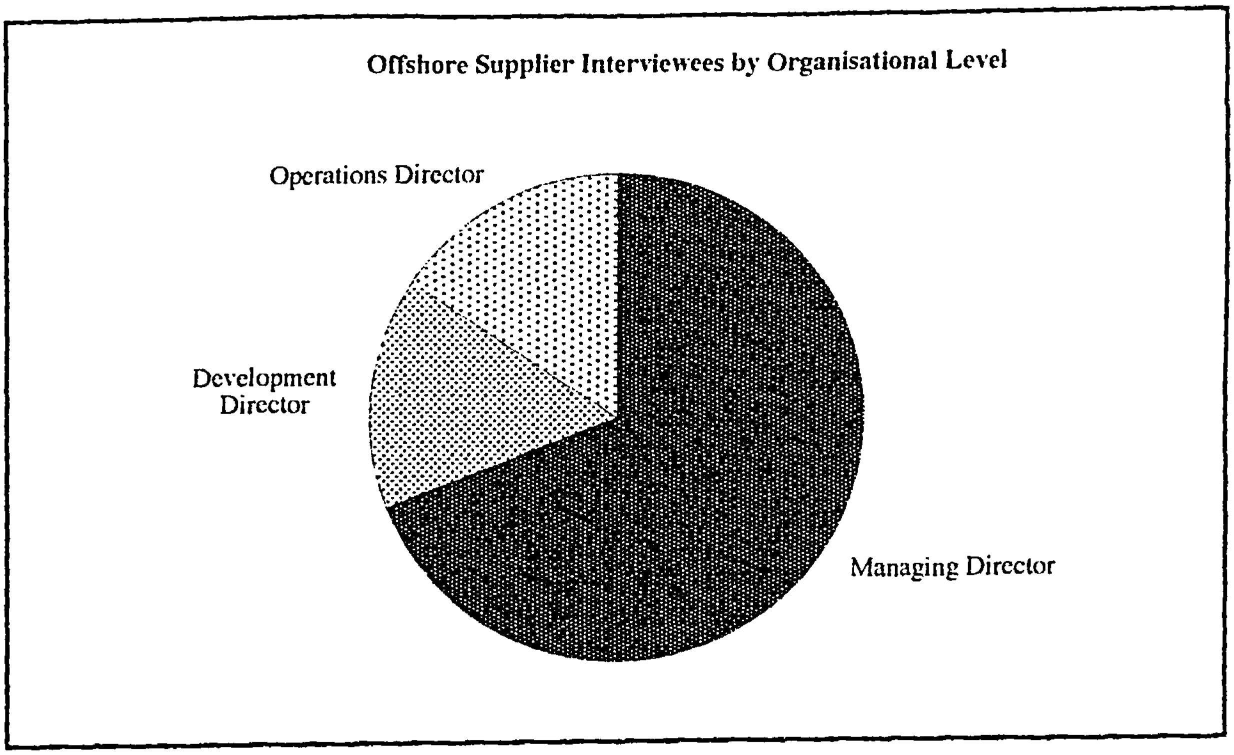
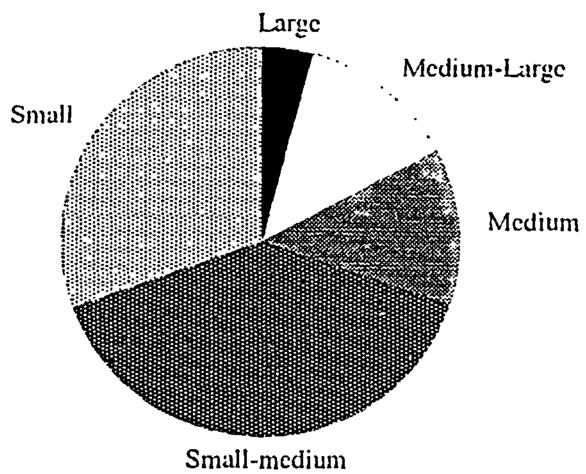


Figure 3.5

Component suppliers by size - sales turnover



Each respondent was sent a briefing note ahead of the interview date which aimed to present a structure to the research project and included the questionnaire. In addition, a detailed interviewer agenda served as a general reminder regarding the overall as well as specific aims of the interview since other staff members of CALTEC were in attendance during Phase Two research interviews.

Phase One interviews were arranged with the assistance of several assembler purchasing directors. The directors of Nissan, Toyota and Rover Group were asked to supply a list of component suppliers. The reason for asking these particular assemblers rested largely on reports within trade and technical journals about these assemblers' relationships with their supply base.

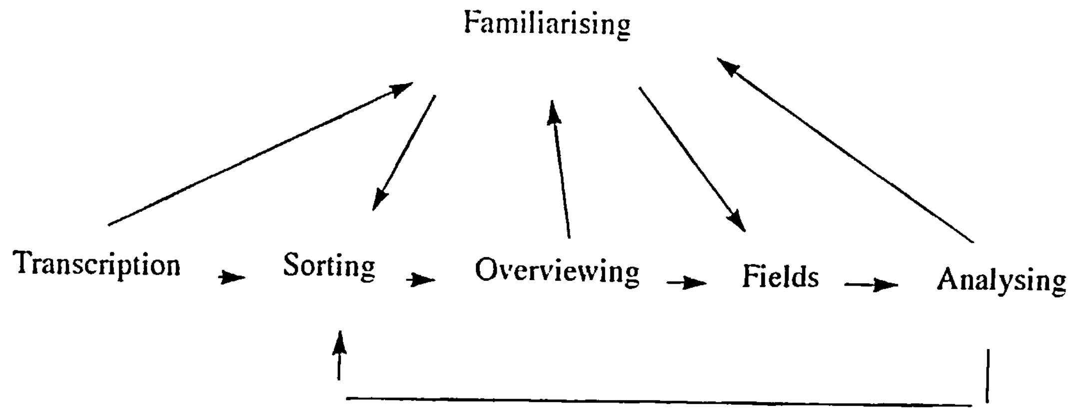
3.4.5 Sorting the interview data

Although the following chapters aim to encapsulate the main points heard during the interviews, some supplier management had a lot to say. On the whole, the interviews were refreshingly open and often culminated in a site tour. Indeed, some interviewees prearranged other members of management to participate. All interviewees were reassured at the beginning of the interview that their anonymity would be preserved, ie a code would be assigned to each firm and, where reference was made to that firm, the code would be used.

The majority of managers raised no objection to the interview being tape-recorded The need to be selective in transcribing each tape was essential because of the time required for transcription and analysis can be twelve times the length of an interview (Burgess et al, 1988). This is clearly an important consideration in the choice of an interviewing technique. The intention was not to transcribe each interview verbatim, rather that the transcript should provide a record and guide to content that removed the need for excessive and disruptive note taking. A notated outline of each interview was also made, to allow cross reference with the recordings - particularly in Phase One.

Clearly, the sheer volume of material which this type of research produces presents logistical and handling difficulties of its own. The approach to analysis which was taken consists of a number of phases, as illustrated in Figure 3.6.

Figure 3.6



Data Analysis Phases

Through continuous contact with the data this enabled greater familiarisation with the company being studied. This process undertaken was iterative, it included constantly checking the data, making sense of it, defining and refining the hidden meanings. Whilst a number of patterns and priorities began to establish themselves during the fieldwork process from which themes gradually emerged, a conscious effort was made not to allow these patterns to impose themselves but to retained awareness of them and seek them only when the fieldwork was complete, (Okley [1994]).

The process of classifying or arranging the data began immediately after transcription using the themes and patterns that had begun to emerge from early familiarisation. The practical problems to analysing the transcribed written interview notes (even accompanied by summary notes) often include trying to make sense of evaluating striking differences in opinion with no apparent consensus between the sample of respondents at any one time. One approach used was to draft brief conceptual maps that could convey the process of the partnering arrangement. However, this could only be applied to a select number of companies given the lack of data, ie some managers could not/would not refer to a clear partnering arrangement preferring to talk in general terms(!). Clearly, given the sheer amount of data some advantage will be gained from using a computer package to analyse the data. A spreadsheet which incorporated data base facilities appeared to be the best tool. Each interview transcript was then recorded onto a spreadsheet where each cell contained one (meaningful) interview sentence. The data was edited only to remove repetitive detail. This permitted a content analysis to be carried out using the data base functions to sort concepts and themes. The data could then be sorted in a multiplicity of ways by coding or by flagging and extracting entries of interest. This exercise formed part of the 'first run' through the data in order to become familiar with the data.

The data once in spreadsheets became much more accessible and from this it was possible to begin to develop an overview of the processes to technology partnering and a focussed step made to explore the development of emerging themes, concepts, and, as we shall see in chapter five, the distinct variables that exist in a successful technology partnering arrangement. While the data was coded using various categories the actual process is inevitably a time-consuming task, both in selection of categories and in distinguishing between the categories and applying these to the data - there are few short-cuts.

The information collected is qualitative in nature but its analysis might be both qualitative or quantitative, or incorporate both. The aim was to provide a balanced analysis, which combined specific attributes of both methods, the accuracy and representative nature of quantitative analysis together with the richness and breadth of qualitative analysis, which prompted the use of a quantitative approach to explore the relationship between technology partnering and a company's financial performance. As the next chapter five notes, several 'runs' of the data were undertaken thus ensuring familiarity.

3.5 Summary

This chapter has provided a tour through the development of five main research propositions and related questions that helped to guide the remainder of the fieldwork. It set out the three main sets of information that need to be gathered in view of the research questions. It highlighted the means to collecting that information, principally through semi-structured interviews and considered some of the detail about how and why the interviewees were selected. Use of spreadsheets to sort the data for eventual analysis was also discussed. The measures used to analyse the fieldwork data and the thinking behind each is considered in the following chapter. As we shall see in chapter five, the analysis measures fall broadly into three areas: Qualitative, Semi-Quantitative and Quantitative. A mixture of methods are applied with the pure qualitative area while the other two are dominated by one approach.

Table 3.3: List of Interviewees - Automotive Industry, Phase 1

Company Code (Product Group)		Interviews	No. of visits	Interviewee positions
Assemblers:				
A1 (Passenger car)		1	1	Director, Facilities and General Services Purchasing.
A2 (Passenger car)		1	1	UK Purchasing Director
A3 (Passenger car)		1	1	Purchasing Director
A4 (Passenger car)		1	1	Supply Director
A5 (Passenger car)		1	1	Purchasing Agent
Component Suppliers:				
AS1	(Electronics)	1	2	Technical Director
AS2	(Metals)	1	1	Manufacturing Executive
AS3	(Metals)	2	3	Managing Director General Manager and Quality Director
AS4	(Electronics)	1	1	Quality Director
AS5	(Metals)	1	3	Managing Director
AS6	(Transport)	1	2	Technical Director
AS7	(Plastics)	2	2	Managing Director Works Manager
AS8	(Metals)	2	2	Managing Director Commercial Director
AS9	(Metals)	1	1	Quality Director
AS10	(Metals)	1	1	Managing Director
AS11	(Plastics)	1	2	Quality Assurance Manager
AS12	(Electronics)	1	1	Quality Director
AS13	(Plastics)	1	1	Operations Director
AS14	(Plastics)	1	1	Technical Director
AS15	(Metals)	1	1	Quality Manager
AS16	(Metals)	1	2	Managing Director
AS17	(Transport)	1	1	Quality Director
AS18	(Transport)	1	4	Quality Director
AS19	(Metals)	1	1	Managing Director
AS20	(Plastics)	1	1	Managing Director
AS21	(Electronics)	1	3	UK Purchasing Director
AS22	(Metals)	1	2	Quality Director
AS23	(Metals)	1	1	Quality Director
AS24	Metals)	1	1	Technical Director
AS25	(Metals)	1	1	Managing Director
AS26	(Metals)	1	2	Commercial Manager
AS27	(Transport)	1	2	Managing Director
AS28	(Electronics)	1	1	National Managing Director
AS29	(Transport)	1	1	Sales and Marketing Director

NB: Due to requests for confidentiality the names of companies and persons interviewed are not identified. The purchaser and supplier codes used in this table are used throughout the thesis.

'AS' - 'Automotive Supplier'.

Table 3.4: List of Interviewees - Offshore Supplies Industry, Phase 2

Company Code (Product Group)		Interviews	Interviewee positions
OS1	Subsea Consultants	1	MD
OS2	Subsea Consultants	2	MD & Technical Director
OS3	Subsea Consultants	1	MD
OS4	Engineering design and mftr.	2	MD & Sales Manager
OS5	Engineering design and mftr.	1	MD
OS6	Consulting Engineers	1	MD
OS7	Engineering design and mftr.	1	MD
OS8	Consulting Engineers	1	Business Devlopment Director
OS9	Consulting Engineers	1	Engineering Manager
OS10	Engineering design and mftr.	1	MD
OS11	Engineering design and mftr.	1	MD
OS12	Engineering design and mftr.	1	North Sea Operations Manager
OS13	Engineering design and mftr.	1	Business Devlopment Director

'OS' - 'Offshore Supplier'.

Chapter Four: Setting the research aims into context

4.1 Introduction

The principal aim of this research is to contribute a better understanding of the technology partnering process. In particular, the central focus has been on the extent to which SMEs can improve their in-house knowledge of process, product and materials technologies through collaboration with their customers (vertical alliances). To stimulate that focal point, supplier-customer relations *per se* have been explored.

A review of the literature confirmed the importance for firms to have the internal capacity to assimilate and absorb new technology, to have in place good internal communication processes and external linkages with a number of key individuals and organisations. They should also demonstrate a positive managerial attitude towards partnering; they should genuinely want to participate and regard it as value for time spent.

The propositions pursued these themes and argued that there are a cluster of attributes or conditions that should be in place within or between potential partners before a technology partnership begins.

This chapter considers the industry setting in which the field research was conducted. Two UK industry sectors were chosen: the automotive components and offshore supply sectors. Section 4.2 considers the reasons for selecting motor industry while section 4.3 relates to the offshore supply sector.

4.2 The automotive components sector study: Phase One

4.2.1 Why the motor industry?

Within the UK, the automotive sector is the largest and single most important manufacturing activity, accounting for almost one in six of all manufacturing jobs within large companies such as GKN, Lucas and T & N, and at least 1,500 smaller companies who make everything from semiconductors to interior trim. One of the most striking features of the UK motor industry is that well over 50 per cent in value of the average 'British' car is bought from outside suppliers. Assemblers confine their manufacturing activities largely to sub-assembly and final assembly work, including body-building and the machining of engines and other major mechanical components such as gearboxes. In Western Europe there are an estimated 6,000 component suppliers, of which 1,500 are of significant size. The Economist (1993) estimated that about 400 of these firms account for 75 - 80 per cent of total business in the components sector.

Given the myriad of technological advancements following consumer demand and, more recently, environmental pressure, there has been rapid growth in the number of components each motor car has contained within it. For example, Rhys (1972) noted that the average car comprises about 3,000 parts. The author also noted that, in 1967, BMC (a major UK car assembler) sourced from over 4,000 suppliers although the total number supplying the car industry as a whole was somewhat greater. This sharply contrasts today where the average family saloon car contains some 20,000 separate items on a vehicle of 2,000 to 3,000 different types, only a few of which assemblers choose to produce in-house.

With so many different components inextricably linked and the trend towards 'system' assembly then surely the potential for technological collaboration between component suppliers in a vertical chain has never been greater. This was one of the main reasons for selecting this industry. We would expect to find a larger number of firms collaborating in product and materials development than in any other UK mature industry. Indeed, it has been widely recognised that the prevalence of inter-firm linkages and supply relationships within the automotive industry provide one of main strengths of the West Midland economy. Car assembly in the West Midlands is represented by the Rover Group (car and engine assembly at Longbridge, Birmingham and Land Rover, Solihull), Peugeot-Talbot (car assembly at Ryton-upon-Dunsmore, near Coventry and engine assembly in Coventry) and Jaguar (car and engine assembly at Coventry and body panels at Castle Bromwich, Birmingham) while commercial vehicles are produced by Daf Trucks (Birmingham).

The West Midlands Enterprise Board estimates that over 30 per cent of total UK components output is produced within the region. No other area has such a high concentration of manufacturers and component suppliers one third of all employment in the UK car industry is West Midland based.

Figure 4.1

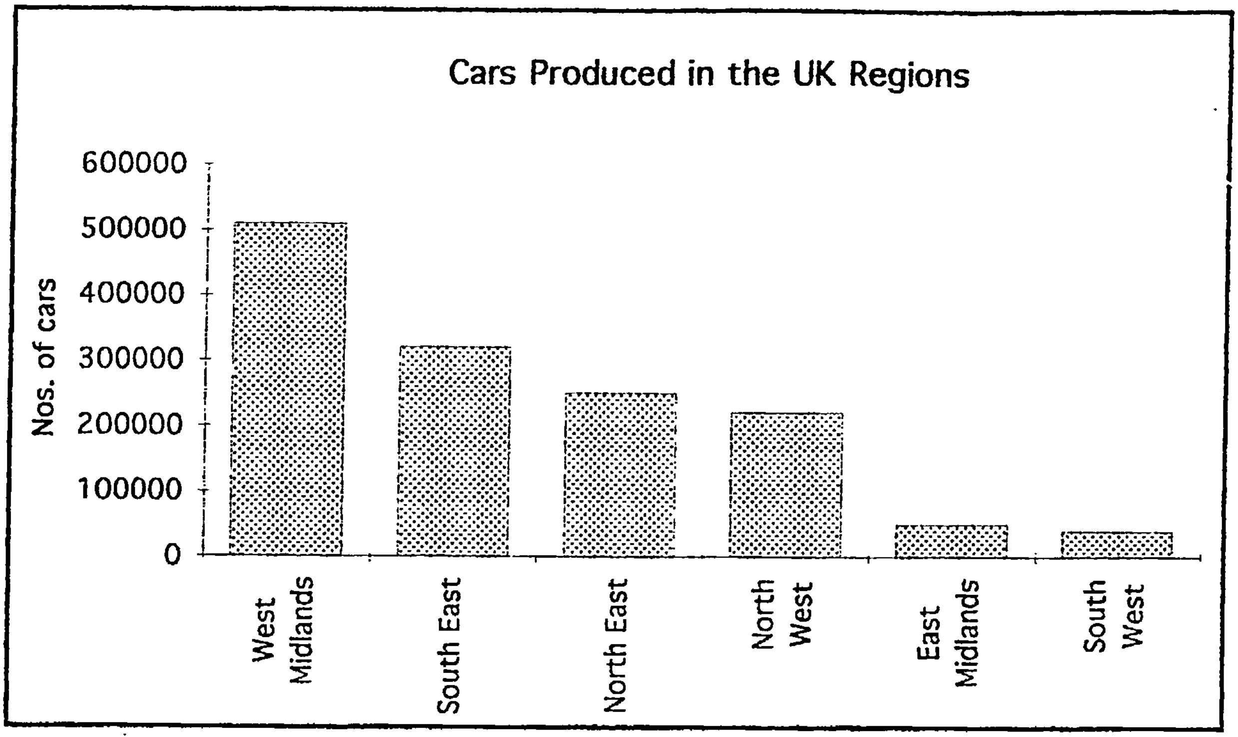
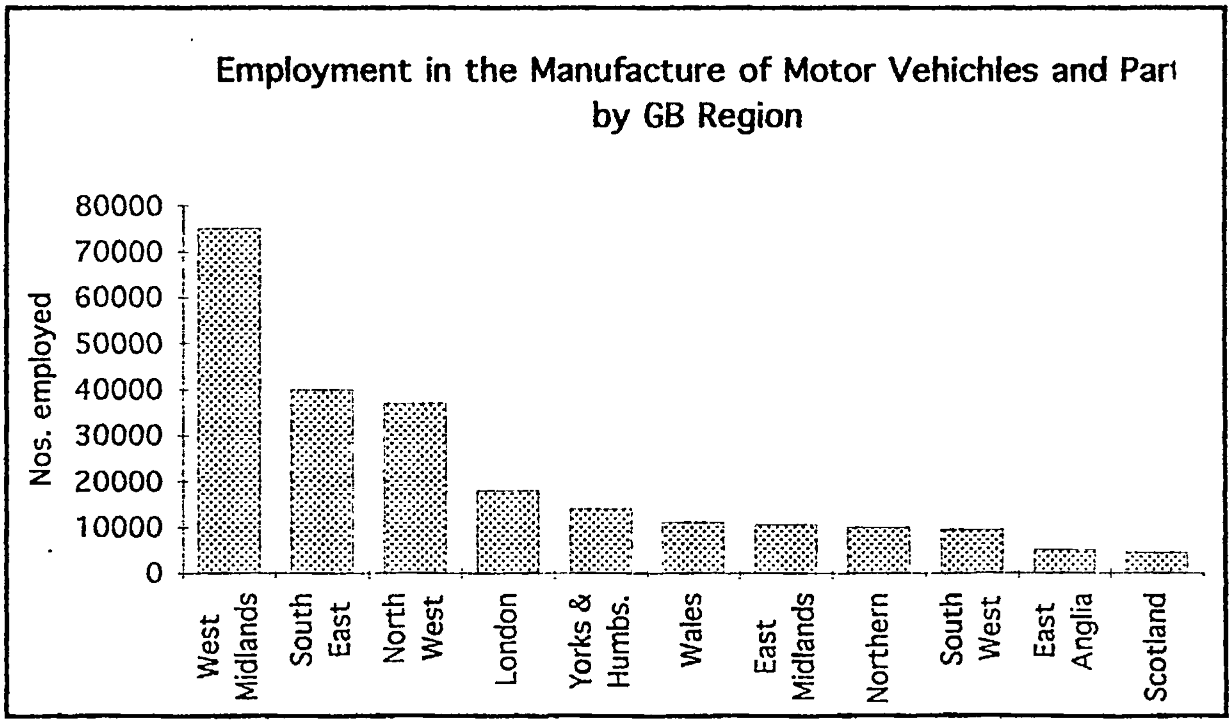


Figure 4.2



The results of this phase will therefore reflect the character of the region. Much of components supply in the West Midlands is process rather than product orientated. In particular, the region is especially well represented in the manufacture of castings, forgings, pressings and stampings. In the foundry industry, for example, it is estimated that the Birmingham-Black Country conurbation accounts for almost 50 per cent of UK automotive castings output. Indeed, within the Black Country's ten square area miles, more than 33,800 employees in 150 companies are directly engaged in component manufacture. Locally produced automotive components include vehicle chassis, door frames, bumpers, cylinder blocks, crank shafts, pistons, filter caps, handbrake assemblies, brakes and tyres.

In an effort to capitalise on its central location, superior transportation links and the engineering heritage of the area, the 'Black Country Corporation' has invested in setting-up an Automotive Component Park. The aim is to '... act as the catalyst to improved performance by promoting mutually beneficial long term relationships and co-operation amongst component manufacturers on a site with the inherent advantages of a Black Country location.' The Park is situated eight miles north west of Birmingham city centre. The Park will be one hour's HGV drive to assembly plants operated by Jaguar, Rover, Toyota and Peugeot and two hour's drive to additional Rover, Toyota, Ford, General Motors and Honda plants. The following section aims to place technology partnering into context in the 1990s.

4.2.2 Motor industry revisited

Phase One of the research was divided in two: The first stage involved interviewing some 30 managers within component manufacturers in 1993 - some were interviewed more than once. In order to contribute to an understanding of whether management views have changed over time, six companies were re-visited. The follow-up interviews with the same people offered the interviewees with an opportunity to reflect on their earlier perceptions of how partnering was working in the motor industry and to comment about what had changed in the industry and the impact on their business, for example, since the BMW take-over of Rover in early 1994.

While it was not the aim of this second stage to undertake a formal longitudinal study, it is worth noting the three main types of longitudinal study and then relate this back to the particular aims of this stage of the project.

There are three main types of longitudinal study: the trend study, cohort analysis, and panel study, [Caplovitz (1983)]. Briefly, a *trend* study measures the same variables at different points in time, and the researcher is able to document trends in these variables over time. A *cohort* study focuses on groups whose members share the same time frame and follows these groups over time. A *panel* study is one in which the same people are interviewed at different points in time. The critical difference between a trend study and a panel study is that in a trend study different sets of people are sampled from the same population at different points in time, whereas in a panel study the same people are reinterviewed at different points in time. A cohort study is comparable to a trend study of a particular cohort or age group. As in a trend study, the people sampled from the cohort may vary from one time period to the next.

In relation to this study, a 'panel study' was conducted during Winter, 1994/5. The main advantage of the panel study derived from evaluating the change in managerial behaviour and productivity processes in two years given the backcloth of partnering in the motor industry. The panel study attempted to assess partly the managerial attitude changes in specific assembler-supplier relationships, ie those highlighted during the first visit as well as distil some 'hard' examples of where either a process, product or materials technology improvement has been reached through customer collaboration.

A mixture of measures were used to analyse this data and are considered in more detail within chapter five.

4.3 The offshore supply sector study: Phase Two

4.3.1 Introduction

The second phase of the research was sponsored by the Oil and Gas Projects and Supplies Office, (OSO), Glasgow. It was highlighted by the general observation that the offshore oil and gas industry are having to become more innovative and flexible in the way they exploit the predominantly small and dispersed second generation North Sea oil fields. (CRINE (1993)) The new challenges and opportunities that all firms are facing mean that they require new skills and, above all, a new management attitude and approach that can embrace partnering.

While partnering is not a new concept in business, the application to the North Sea oil and gas services industry is a live issue promoting some important discussions. However, from an early review of the trade press it became apparent that the majority of these discussions were focusing on the economic features and benefits of partnering and alliances, and were tending to ignore the importance adjunct that these benefits derive wholly from different *managerial behaviours and attitudes* by the participants - a focus gaining strength at the interim stage of this study. For example, the third and fourth research propositions (section 3.2) raise the issue of potential barriers to otherwise progressive partnering arrangements and assert that for small firms determined to maintain close working relationships with the operators then middle operator management may block their path for two reasons: (i) they may not be 'sold' on the idea of partnering - instinctively protecting their personal interest and maintaining the historical balance of power in the relationship, and (ii) move into other roles given the flat organisational that most operators appear to share.The reality is that small firm entrepreneurs quickly lose the will to rebuild relationships with project orientated operator staff who may not share the same vision.

Thus, there were several reasons why this industry sector was selected to study in relation to partnering: (i) To follow the early or novelty development stages of partnering and, where possible, evaluate the managerial attitudes of those involved; (ii) To compare and contrast this sector with the motor industry, again taking into account the time lag given that partnering in the motor industry began to gather momentum during the early 1980s; (iii) In order to contribute to an understanding of what makes technology partnering happen in an industry where little research has been undertaken.

The main conclusions of this work were published within two offshore industry journals, (Beecham, [1995a], [1995b]).

Oil output in the North Sea province peaked in 1986. The level of activity and production is expected to last at least another 25 years while over 90 new fields will be developed in that time, 41 of which in the next seven years in the Northern sector. However, in a climate of low oil prices, many of these new fields will be on the fringe of economic viability. To develop them will call for important changes in oil companies' working practices to cut costs - which includes a shift towards partnering. While prior to 1986, the focus had been on technology which would ensure early production and cashflow, the economic pressure in the late 1980s has forced attention towards reducing operations costs. The UK fields to be developed are, in general, of relatively small value when considered individually, but can be very significant when tied back to existing facilities or developed individually. In order to achieve this, new contracting approaches are having to be considered between contractors, financiers, operators and suppliers. *The accent is on collaborative relationships.*

The earliest references to collaborative relationships in the oil and gas industry emerged during 1984; the Construction Industry Institute notes a partnering relationship for engineering services in the USA between Shell Oil and SIP Engineering Inc. (CII [1989]). During the late 1980s , Britoil introduced the 'integrated engineering' concept whereby one engineering company was involved in the Clyde oil field development from the early design stages to commissioning.

Other early examples of 'partnering-type' arrangements include BP's partnering with contractor Brown and Root and Shell's 'WIN '90s' innovative relationship with drilling contractors.

Since 1990, many relationships labelled 'partnering' or 'alliance' have been formed between operators and contractors. Green (1994) estimates that between 200 and 300 such relationships exist in the UK.

The emphasis in this phase is on exploring first the outlook for small firms to develop their own partnering relationships and win a place on the operators' preferred supplier listing and second the likelihood of developing technology with tangible support from the larger partners. However, the current opportunities for small firms revolve around the operators strategies. First, the relationship side: While the operators have a direct relationship with their contractors, they are one stage removed from the suppliers. One emerging trend arising from this is that operators are reducing their responsibility to push for new technologies and to manage the supply base to the major contractors. Second, the combination of 'downsizing' and concentration on core activities by the operators has resulted in a reduction of the amount of R & D funds supporting speculative and pre-competitive innovation. Some operators are making it clear to their contractors that they should be supporting the development of new technology and that oil industry support will flow from subsequent use/purchase. However, the contractors are still not inclined to allocate significant R & D budgets and this curtails the scope for smaller firms to make a contribution.

Thus, the principal aim of Phase Two was to establish the small firms' view of the changing contractual scene and how it influences the future delivery of innovative engineering solutions.

4.3.2 Research aims and work programme

The more specific research aims and timetable of Phase Two are set out below.

(i) To judge the strength of existing technology partnerships between oil companies, major contractors, and small suppliers, and

(ii) To identify where those partnerships have contributed to the development of new or existing technologies.

Phase Two was divided into four quarterly stages: The first stage involved visiting ten oil companies to establish their past and future strategies regarding technology partnering. The questions aimed to determine their current technological requirements from the service sector, how they see their supply base responding to meet the challenges presented to them in the new era and what opportunities exist now and in the near future to establish closer integrated links with service sector companies.

The second stage meant distilling the operators' opinions and using them as foundation blocks to judge, through further interviews with a select number of contractors, the depth of existing technology partnering between sector firms. The nature of the questioning focused around the contractors' opinion of the operator, their own technology capabilities as well as their perception of the outlook for small firms to integrate with the contracting sector.

The aims in the third stage involved completing the interviews and characterising the response of a group of small firms in order to grasp an understanding of their approach to technology alliances and long term partnering with other firms. It was anticipated that this process would ultimately support an informed assessment of the future of partnering and the inherent problems such arrangements may present. The fourth stage involved drafting a series of case studies depicting situations where suppliers have become involved in technology alliances with varying degrees of success.

4.4 Summary

This chapter aimed to set the research aims into context by considering the two field research settings and the very different stages of partnering development in each. Because of their exposure to the Japanese challenge, European motor vehicle assemblers have been working longer than most other European firms to adopt the style of close supplier relationships used by their Asian rivals. The extreme complexity and long lead times of motor manufacturing, and the assemblers' use of an acutely adversarial supplier relations strategy in the past, have made the transition to new methods more painful for them than for most. Thus the motor industry case throws into high relief the benefits and problems of moving toward long-term supplier relationships. Some conclusions of this phase were published in an automotive trade journal, (Beecham, [1995c]).

The offshore industry study presents some similarities as well as differences. While some broad principles and approaches to partnering and relationships may be directly transferable from one industry to another, others are less so. The 'lean supply' model (Lamming (1994)), so successful within the mainstream of the motor industry may not be entirely appropriate within the oil and gas industry. Bower and Keogh (1995) note the transfer difficulties in relation to oil companies current drive to impose the lean supply model on all aspects of their relationships, remarking, 'the problems ... may be due to a failure to appreciate that where continuous innovation is central to the firm's success, a different approach can be employed for handling different types of relationships.'

Nevertheless, the offshore industry case also presents a good opportunity to specifically address the research propositions by exploring the managerial attitudes and behaviour aspects amongst operators, contractors and small firms in particular. The widespread skepticism of the practice was anticipated given the infancy of such partnering arrangements.

The following chapter explains the three main measures of data analysis used in both phases of the research project.

Chapter Five: Measures used to analyse the data

5.1 Introduction

The thesis so far has considered the literature on the development of partnering and the perceived need for firms to collaborate to develop new materials, products, and processes given, amongst other pressures, competition from abroad. It then set out the research aims and placed them into context. The propositions guided the field research questions and determined what information would be needed and how it was going to be gathered.

This chapter completes the research design and methodology part of the thesis and explains the development and application of the measures used to analyse the data.

Section 5.2 considers the qualitative approach used during the first run through of the data which sets the scene for the next chapter. Section 5.3 explains a method used to measure each firm's level of technology partnering. It introduces a type of performance index that incorporates seven input variables that, if they are a strength within the supplier firm, could support a technology partnering arrangement - this analysis is referred to as 'semi-quantitative' measure or, as will be shown later, the 'TPPI' measure. Section 5.4 considers the financial performance of the firms' visited - the quantitative measure. Section 5.5 draws the presentation to a close and re-introduces some recent research presented in the organisational learning and alliance literature.

5.2 Qualitative measures of data analysis

5.2.1 Some 'levels' of technology partnering relationships

The following four levels of partnering provided some indications of the type of technology partnering arrangements found and their *role*. The initial research exercise, discussed within section 3.4, helped to distil some views about the causal factors to successful technology partnerships. They included: good supplier-customer working relationships, a proactive supplier design and development team with a good customer interface, parent company (of supplier) support of the partnership, clearly defined project where technological complementarity exists, and a high level of inter-firm trust. In addition, prior experience of working collaboratively appears to have a favourable impact on the partnership helping to ensure a smoother path.

The next section considers the four distinct 'levels' of technology partnering in more detail.

5.2.2. 'Soft' level

A supplier operating at this level of partnering would typically develop all or most of its product, materials or process technology requirements in-house. The supplier would invest in various technology development programmes in the confidence that their main customer will provide a ready market for the final product. The 'confidence factor' appears to be a key cornerstone in this type of arrangement where a customer-supplier relationship building exercise encompassing a rich flow of information flows informally and freely between the two firms.

Formally, in the context of our propositions technology partnering at this level may be summed-up as *informal knowledge exchange.*

5.2.3 'Medium' level

A medium level of partnering may resemble an arrangement whereby the partners have organised themselves into a grouping in order to develop a better engineering solution to satisfy an industrial need.

For example, firms undertaking partnering at this level may have earned the confidence of the customer through many years of relationship building yet understand that they will lose business unless they partner with other firms to present a more attractive product or engineering package. One of the features which set the partnering players at this level apart is in their continual recourse to a global network of technical experts.

Technology partnering at this level may be summed-up as Formal/Organised Knowledge and Technical Exchange.

5.2.4 'Hard' level

The focus and aims of this type of collaboration generally appear to alter during the life of the technology development cycle time and post launch period. Managers interviewed operating at this level were quick to refer to the success factors of the collaboration as revolving around complementary technology and trust, respect and good communication between the partners. Also important were management factors, both in project management and with regard to the strategic nature and issues of R & D collaboration.

Partnering at this level is more about meeting the company's strategic long term concerns than tactical short term considerations. A key feature of this type is multi-disciplined team from all partners will often be at the centre of the product's development.

Technology partnering at this level may be summed-up as Planned Collaboration/Shared Risk.

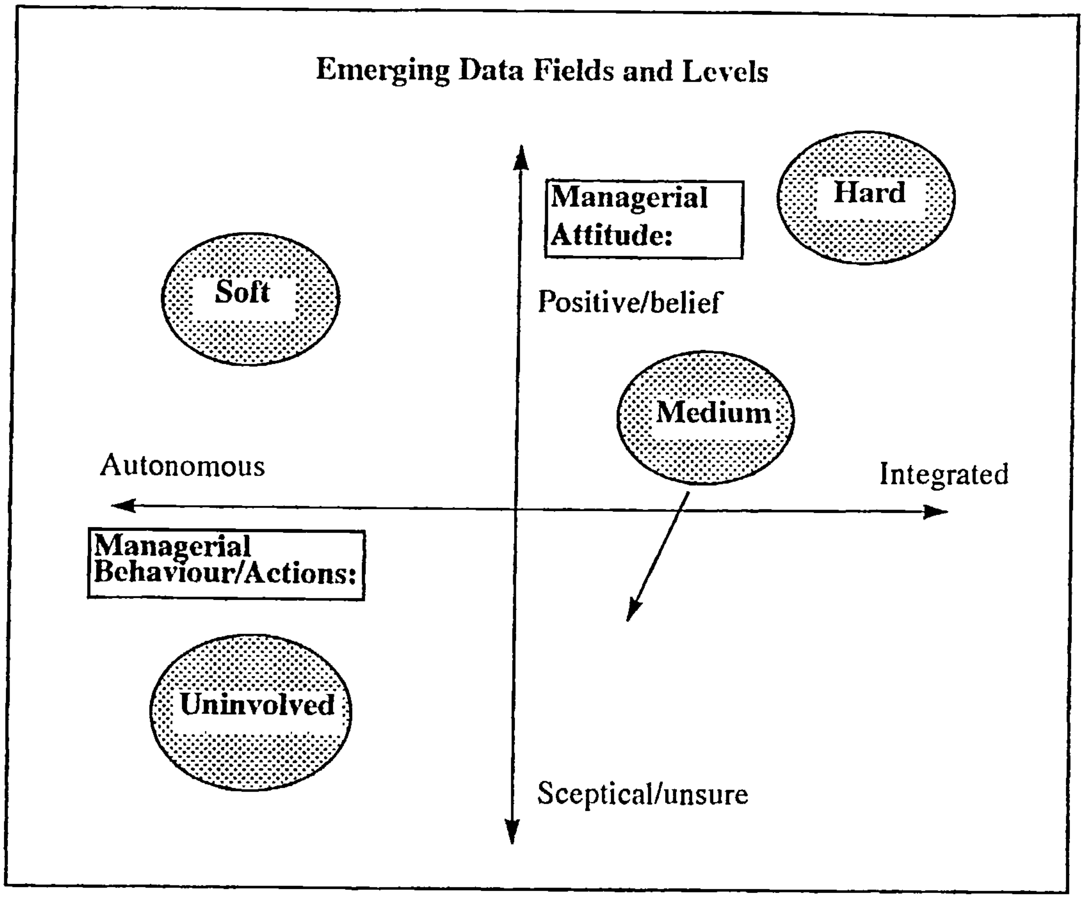
5.2.5 'Uninvolved' level

A supplier at this level makes little effort to develop technology in a consortium arrangement. Their management perceive few benefits to working in partnership and considers that such arrangements are often riddled with problems. They generally consider that the management effort required to make it work is far greater than the rewards.

Figure 5.1 summarises the partnering levels and related fields. The managerial attitude/behavioural fields simply aim to help distinguish and conceptualise the level of integration each firm appears to adopt with regard to its partnering activities. To illustrate, a firm which ranks as having a 'positive/belief' attitude indicates that their management genuinely believe in the partnership principles and understand what is required to make it happen, whereas a 'skeptical/unsure' attitude reflects the opposite - a hesitating and mistrustful management team that regards partnering as a 'passing fad'. The second dimension concerns the extent to which management behave towards partnering - as shown by their past and current actions. In other words, they may act in line with company and industry norms yet harbour doubts about what they are doing is better practice. An 'autonomous' behavioural characteristic resembles a management team which is perhaps insular in its approach to sharing information and know how and generally lacks experience in technology alliances. Conversely, an 'integrated' behavioural characteristic epitomises a management team which has spent considerable effort in aligning itself with particular partners and enjoys the close involvement of working in multi-disciplinary partnership teams.

In summary, three main activity levels have been highlighted with regard to technology partnering, namely, informal knowledge exchange, formal/organised knowledge and technical exchange, and planned collaboration with a clear element of shared risk and reward. The 'soft' level mainly relates to the issues surrounding the importance of Prior Knowledge while it has some interplay with Relationship Strategy. The relationships build in a linear fashion until the 'hard' level suggests, albeit at an early tentative stage, that has inherent factors from all three propositions.

Figure 5.1



The case studies presented in chapter seven and eight provide examples of each level of partnering arrangement. However, given that explanations of what makes good technology partnering practice are difficult to provide on the basis of case study data alone, there needs to be further evidence from other perspectives. To this end, evidence in addition to the qualitative data and the TPPI measure is provided in chapter seven in the form of authoritative opinions from a selection of purchasing managers, (section 7.3).

The following section aims to widen the analysis by applying a formalised measure to gauge each firm's technology partnering performance using the TPPI.

5.3 Semi-quantitative measure of data analysis:

5.3.1 Technology Partnering Performance Indices (TPPI)

Table 5.1 shows the matrix developed to measure each firms' level of technology partnering activity using seven key input variables. The TPPI aims to establish a dividing line between 'better' and 'weaker' partnering firms in phase one and two. An index score (see scoring process - 5.3.6 later) was attributed to each variable from 0 to 5. At one end of the scale, a supplier whose score is entirely 5s would be a strong advocate of technology partnering and their activities would, on the whole, resemble better practice. At the other end of the scale, suppliers' scoring all 1s prefer the insular approach to improving their materials, process or product technologies. Where a '0' is assigned implies that no evidence or not enough evidence was available to enable a score to be recorded. Interestingly, Carter and Williams (1957) undertook a similar approach yet listed the perceived characteristics to technically progressive firms and then assigned scores (0 - 10). Although their company data was more extensive, the authors conceded that they had not always asked the questions which would elicit information on all the characteristics or the information was vague and of doubtful reliability. Consequently, they used a weighting system: a zero weight, ie the mark was ignored or not given if the information was inadequate or the characteristic quite irrelevant; a weight of one for full information about a relevant characteristic; and intermediate weights of 0.25, 0.50, and 0.75 for intermediate degrees of relevance or information.

Consideration was given as to imposing a weighting system on the TPPI. It was thought that the addition of weights would introduce a unnecessary and misleading subjective element into the analysis. In addition, the 'weighting idea' was abandoned for two reasons:

(i) Imposing weights on the scores was considered to dilute the validity of the results.

Table 5.1

Matrix to score levels of technology partnering

	Input Variables to Technology Partnering	1	2	3	4	5
1	**Prior knowledge:**					
A	Degree and depth of technology scanning	Poor				Good
B	Number of professional engineers	Few				Many
2	**Internal and External linkages**					
C	Alliance organisation and structure	Nebulous				Clear
D	Range of external organisations consulted	Few				Many
3	**Relationship Strategy**					
E	Frequency of technical personnel exchange with purchasers	Rare				Often
F	Frequency of multi-disciplinary inter-firm meetings	Few				Many
G	Receptivity toward partnering	Poor				Good
4	**Overall Impression of the supplier's ......**					
H	… strategy with regard to partnering	Poor				Good
	… managerial attitude toward partnering	Poor				Good

(ii) Imposing independent weights on the variables themselves would be inappropriate given that most are dependent on each other. For example, a firm needs to have a prior knowledge before it can develop its external linkages.

In the light of the five propositions presented within chapter three, the variables in the TPPI were categorised into three groups and a fourth 'overall impression' group used as a control or check variable. The aim was to shed some light on the internal capabilities and managerial attitude and behaviour of each company.

Group One:	Prior Knowledge
Group Two:	Internal and External Linkages
Group Three.	Relationship Strategy
Group Four:	Overall Impression

As will be discussed within the next three chapters, all of the major purchasers in this study (assemblers and oil operators) select their suppliers on quality, price and delivery record and manufacturing or other facilities but then quickly move on to evaluate the attitude of the supplier management. As Toyota's Purchasing Director remarked,

"We are subjectively objective here. Something which is often underestimated is the supplier management attitude. We are looking for suppliers who are not satisfied with where they are, and are looking to, and demonstrating that they can move forward. We are looking to a supplier's ability to improve rather than its actual level of performance."

Thus, the 'overall impression' group was scored on the basis of, for example, the opinions formed during a site tour, ie witnessing a near-empty store room as a result of the company achieving a better stock management system itself resulting from better planning information from the purchaser/partner.

In order to assign scores to each company, the input variables had to be clearly defined, measurable and, more importantly justified, ie why a low score would be assigned to a company that displayed a particular characteristic.

During the second run through of the data, seventeen input variables were defined and included in the matrix. The point of the variables is to minimise, as far as possible, the subjectivity of each and filter each company through using practical measures. However, it became clear that the 'measurability' factor presented some difficulties when applied to some of the seventeen variables. To illustrate, the first draft included the input variable: 'Relative geographical proximity of partners' where a distant factor would achieve a low score and vice versa. The assumption is that in a technology partnering arrangement where the partners are located within easy reach of each other, then the process of management interaction at all levels is made easier. However, with the advent of video conferences and the now commonplace Electronic Mail procedures to communicate as well as Electronic Data Interchange, this argument wears thin. Consequently, this variable was excluded along with others while several new variables were developed and included.

Finally, following a series of internal research discussions seven input variables were selected. The process was further accelerated with the help of an independent expert who assessed the matrix and appropriateness of the input variables and provided guidance before the actual scoring process commenced.

To sharpen the relationships between the research propositions and groups, figure 5.2 presents the input variables with the research proposition core themes.

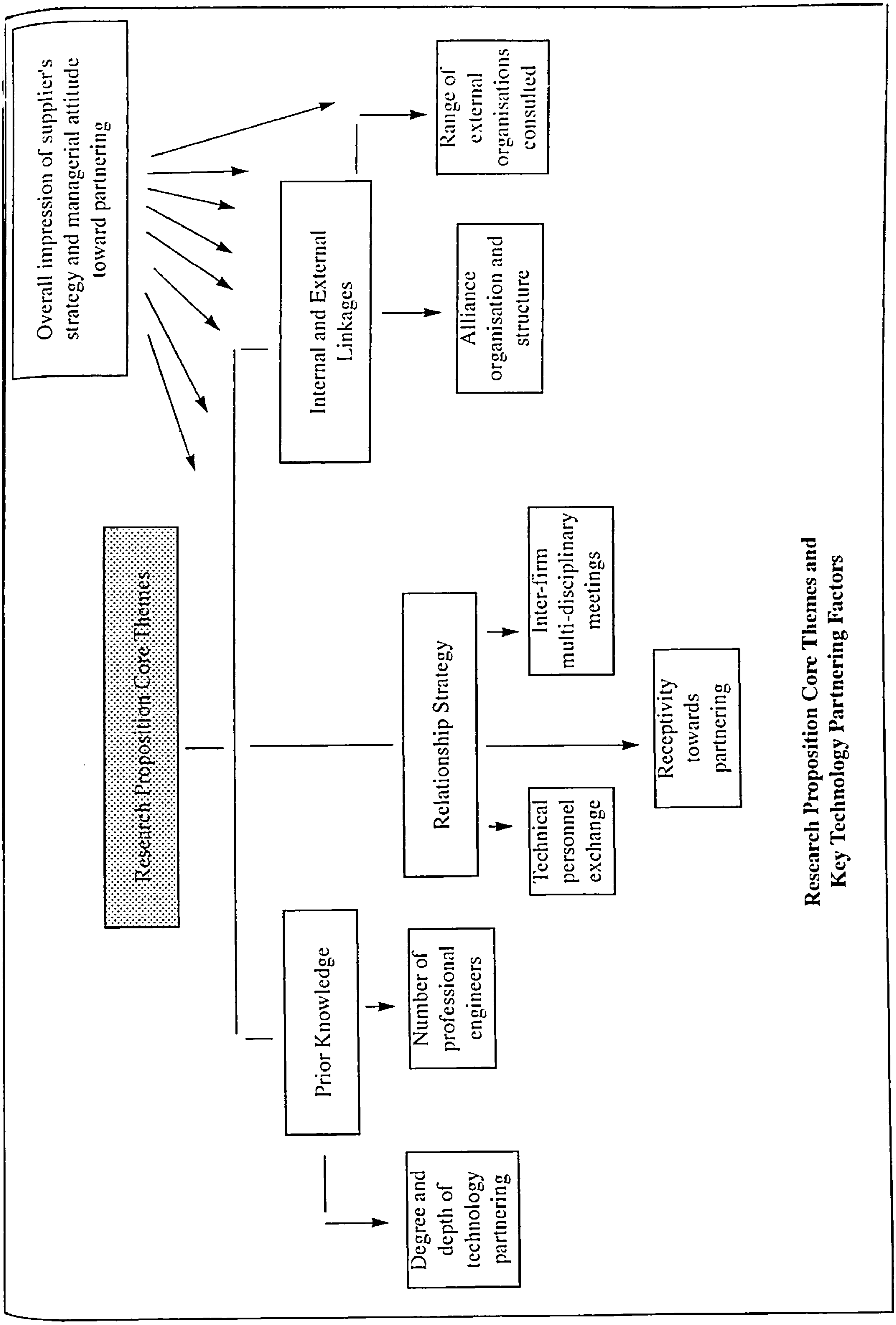
Next, each group and variable is considered in turn and the scoring process defined.

5.3.2 Group One: Prior knowledge:

As chapter two highlighted, Cohen and Levinthal (1990) argued that organisations need prior related knowledge in order to assimilate and use new knowledge. The author's suggested with reference to learning as a skill that the progressive improvement in the performance of learning tasks is a form of 'knowledge transfer' and referred to earlier as 'learning to learn'. These points guided the first research proposition (chapter 3, section 3.2.1) to asserting that 'good external linkages are an important part of successful technology transfer'.

However, in order for a firm to learn about new technologies, it must have within it the capabilities to learn. It has long been established that a key characteristic of technically progressive firms is their high quality of incoming information. In 1959, Carter and 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 (1971) confirmed the need for high quality external linkages; CEST (1990). Furthermore, earlier research shows that industrial companies who conduct their own R & D are better able to access externally available information, (Allen (1977); Mowery (1983); Trott (1993).

Figure 5.2



Research Proposition Core Themes and Key Technology Partnering Factors

It seems clear then that small firms must have the ability to scan in relation to learning about new technologies. Consequently, the first input variable aims to gauge their ability and discern where small firms' obtain technology ideas. Are they internal to the firm? Do they derive from the recruitment of good doctorate engineers, metallurgists, physicians, etc? Do they trawl for technology across the world? Do they have outward looking management? Rothwell and Beesley (1989) argue that the most significant factor in determining an SME's propensity for and ability to access external technology is internal to the firm; most notably "the employment of qualified scientists and engineers and the outward-lookingness of managers". In other words, the lack of internal technological know-how can inhibit external know-how accumulation and a firm's receptivity to externally developed technology. However, in the opinion of Segal Quince Wicksteed (in Rothwell and Beesley (1989)), access to external technological know how and advice is definitely not a barrier to growth in either traditional or technology-based SMEs wishing to develop, improve, and extend existing products and product ranges. Nor is access to new technology as a basis for major new product development for growth an important problem for SMEs. In the latter case the major constraint is the strategic perceptions and abilities of management, not identification of or access to technology *per se*. In the great majority of cases, however, the employment of QSEs is essential for facilitating both SMEs' external contacts and for the assimilation of new technology.

5.3.2.1 Degree and depth of technology scanning:

This variable divides into three parts: (i) Frequency, (ii) Awareness, and (iii) Importance. Each interview transcript was scrutinised to establish the *degree* of these sub-sets to technology scanning and scored individually between zero and five. The scoring of each set was as follows:

Frequency: a low score would indicate that the firm hardly ever engages in a particular activity whereas a high score means they do.

Awareness and Importance: a low score indicates no or minimal evidence was recorded to support that particular view, whereas a high score would indicate the opposite.

(i) Frequency:

	SCORE		
	Often	Occasionally	Rare
1. How often do they attend conferences and exhibitions?	2	1	0
2. How often do technical managers attend specialist seminars?	2	1	0
3. How often do managers consult the local or trade association library?	2	1	0
4. How often do managers visit other suppliers?	2	1	0
5. How often are outside consultants' used?	2	1	0
	Many		Few
6. How many subscriptions to trade magazines and journals does the company have?	2	1	0

(ii) Awareness:	**Yes**	**No**
1. Are there managers referred to that actively scan for technology?	2	0

(iii) Importance:	**Yes**	**No**
1. Does the firm appear to recognise the importance and value of external information for successful innovation?	2	0

[Adapted from Trott (1993)]

Score system:

Points:		Range:		
1	-	0	-	3
2	-	4	-	7
3	-	8	-	11
4	-	12	-	15
5	-	16	-	18

Returning to Carter and Williams (1959), they undertook a pioneering study of technically progressive firms and revealed 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. Where applicable, the letter in bold print references refer to the close alignment to the input variable used in this matrix.

- High quality of incoming communication; **(A)**
- A readiness to look outside the firm; **(A)**
- A willingness to share knowledge; **(D & G)**
- A willingness to take on new knowledge, to licence and to enter joint ventures; **(C & G)**
- Effective internal communication and coordination mechanisms; **(C)**
- A deliberate survey of potential ideas; **(A)**
- 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; **(B)**
- High status of science and technology on the board of directors; **(C)**
- High quality chief executives; **(B)**
- A high rate of expansion. -

Godkin's classification is, incidentally, 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.

Thus far, it has been argued that if a firm is to succeed in a technology partnering arrangement, they should display an ability to continuously scan for emerging technologies.

Another related factor which has been argued throughout the literature as being capable of supporting a firm's scanning as well as research and development activities is the employment of Qualified Scientists and Engineers ('QSE' - used above), (Rothwell and Beeseley (1989)). The second variable supports this view and refers to 'professional engineers' to include: Graduate engineers with chartered status, and/or Science Doctorates with experience in, say metals and various other materials and processes, chemistry, physics, etc.

5.3.2.2 Number of professional engineers:

In order to score each firm, it was considered that ratios (rather than absolute figures) of Professional Engineers to other staff ought to be used. There would be little point in assigning a high score to a firm with ten PhDs yet the total workforce is over 100 and a low score to a small firm employing 10 staff including one Doctorate.

Ratio of QSE to other staff	Score
No information available	0
1 : 10 (10%)	1
3 : 20 (15%)	2
6 : 30 (20%)	3
10 : 40 (25%)	4
15 : 50 (30%)	5

Although the 'prior knowledge' of a firm means much more than technology scanning and the numbers of professional engineers employed, these two variables in particular present aspects that may be directly measured from the fieldwork data. This point equally relates to subsequent groups. Chapter six presents some broader contributory factors to successful technology partnering arrangements' that are not easily measurable but figure significantly in this research, (section 6.2).

The following group of variables highlights the importance of maintaining internal and external linkages to support the innovation process.

5.3.3 Group Two: Internal and External linkages:

The first and second research propositions argued that successful innovation requires firms to have an *external orientation*. Indeed, a common feature of the studies undertaken from the

1950s into successful innovation is the extent of external inputs - from customers, suppliers and academia - into internal innovative activities (Carter and Williams [1957]; Rothwell et al [1974]; Maidique and Zirger [1985]). In Gibbons and Johnston's (1974) study it was argued that external information inputs are as, if not more, important to innovative activities. Successful innovation depends on effective interactions between organisations (Lundvall [1988]).

There is little doubt in the literature that for large firms, partnerships with suppliers can provide privileged access to state-of-the-art components. Dodgson [1993] notes that strong links with important customers facilitate effective feedback on market requirements and product performance. One best practice feature between firms that demonstrate a high level of collaboration is a communication channel which embraces the suppliers' ability to plan longer term work schedules and investments with greater certainty. Another key feature relates to how supplier firms interface with one responsible group of purchaser personnel committed to the alliance/partnering concept which can provide timely feedback to the supplier on product performance, (referred to as 'facilitators' at AT & T, Dundee). Large firms, such as AT and T, have set up supplier support teams who assist the supplier on an ongoing basis in making improvements to their operations. Such firms conduct monthly meetings (not problem driven) held alternatively at the purchaser's and supplier's premises. (IIR (1994)).

The two variables within this group refer to the alliance organisation and structure (supporting the strength of the internal links) and the range of external organisations consulted. Chapter eight notes how many offshore contractors and oil operators have established large integrated teams incorporating as many as 50 key personnel. For example, the contractors, H & G Kavearner have been working in partnership with the oil operator Phillips Petroleum on the development of the Judy/Joanne Block in the North Sea for several years. (Appendix H conveys the mix of staff at various managerial and technical levels.)

5.3.3.1 Alliance organisation and structure:

The intention here is to suggest that a firm may better alleviate the managerial difficulties and effort associated with partnerships by establishing from the outset a good communications and project management structure. The fourth research proposition asserted that 'good partnering arrangements ensure that committed individuals become involved in the partnership and champion its cause.' In other words, the establishment of an appropriate contact within the business who is able to appreciate the nature of the research as well as its value to the company, is very helpful, not least to overcome problems arising from cultural differences.

As far as the scoring process is concerned, a good score would indicate that a particular firm is highly structured perhaps characterised by a risk/reward sharing agreement, an integrated team where key members meet regularly an centrally coordinated by an alliance office. The case studies which follow in chapter seven and eight exemplify the meaning of alliance organisation.

5.3.3.2 Range of external organisations consulted:

The assumption is that the a firm may enhance its technological capability through wide technical consultation with experts. Consequently, all suppliers were asked about the extent to which they consult with other organisations, (Appendix A, section 2, and Appendix B, section 2). The following table lists the main sources of outside help open to such firms derived mainly from the innovation literature review and internal research discussions. It is supplemented with the various membership of industry initiatives, such as the SMMT Industry Forum or the Scottish Oil and Gas Innovation Forum which are both useful sources of ideas and platforms allowing firms to understand each others' capabilities, (considered in chapter seven eight respectively).

External Organisations:

1. Purchasers/OEMs
2. Own suppliers
3. Other component suppliers
4. Companies in other markets/industries
5. Universities (Res. lab, testing etc. Not specifically for graduates)
6. Research and Technology Organisation
7. Local technical and further education colleges
8. Business Link
9. TECs
10. Independent specialist technical consultants
11. Regional Technology Centres
12. Technology Transfer Agents
13. Parent Company (albeit inter-co.)

For the purposes of the process of scoring, all sources will be ranked equally. To illustrate, AS7 referred to ten sources therefore it is assigned 4 points.

Number of sources	Score
No information available	0
1 - 2	1
3 - 5	2
6 - 8	3
9 - 11	4
12 - 13	5

So far it has been argued that the technological position of the firm may be defined as a combination of its internal resources (eg preponderance of qualified and experienced professional engineers) and its access via inter-firm relationships, to the required external technical resources. In order to manage the external resources effectively, the firm needs to develop and implement a strategic approach to its supplier relationships, in which technology circumstances are integrated. Ford et al (1992) refers to this as a *relationship strategy* which can guide the firm in assessing what type of relationship are appropriate given the characteristics of the technologies. The third group considers the importance of this aspect in relation to partnering.

5.3.4 Group Three: Relationship Strategy:

While not discounting the relevance of using collaboration to access a piece of knowledge or technology for immediate, tactical reasons, collaboration can also assist the development of core competence and technological diversification; both central strategic issues. For example, AS8 (Case study in chapter seven) used technology collaboration with Toyota and a machine spinning firm in Germany to develop a new one piece pulley. Technological collaboration then provides an opportunity for firms to learn about new opportunities and ways of doing things. While the actual outcome of the arrangement may be different from that the partners' originally expected, the *process* of collaboration allows companies to learn and develop *new capabilities*. These outcomes can then be put to use in new markets and products. It is through the development of new capabilities that the strategic implications of collaboration become apparent.

This third group highlights three aspects. First, the extent to which supplier personnel are exchanged with customer personnel - regarded here as being a key indicator of how strategic the partnership is between the parties. Clearly, we would not expect to find a strong indication of a strategic partnership forming within all of the motor component suppliers visited. It is neither possible nor desirable for an assembler to construct partnership relationships with all suppliers. For example, strategic partnerships may be necessary for the development of advanced technology components and systems, or those requiring sophisticated logistics management, whereas less crucial products, where the rate of technical change is lower, might be best procured via an 'arm's length' process. Second, the group highlights the frequency of inter-firm multi-disciplinary meetings categorised into three types as another indicator of the strategic nature of the partnership. Third, the group brings to the fore a measure of the firm's *receptivity towards partnering* - effectively reinforcing the importance of supplier management having the 'right' attitude. It ought to be noted that receptivity in the context of technology partnering does not simply refer to whether the decision makers in a company are willing to contemplate technological and organisational change, it refers to a set of organisational attributes ranging from current usage of technology, to relationships between that organisation and its component or material supplier and to human factors and management decision making. The emphasis here is not to measure a firm's receptivity to partnering given a technological development focus - which suggests a short term opportunistic flavour - but to assess its managerial receptivity to sharing information and learning from others firms. It is about identifying which firms have a genuine interest in partnering and understand the implications and potential drawbacks. While this implies an managerial attitude of mind - their attitude will inevitably be partly directed by the demands placed on them by customers and the industry contractual changes creating new norms of behaviour. In other words, modern managers will react quickly to such changes in their genuine positive belief that partnering is the way forward.

5.3.4.1 Frequency of technical personnel exchange with customers:

The ultimate aim of encouraging firms to group together and share technical expertise and experiences is to provide the end-customer with a product that is cheaper and better. The practice of frequently exchanging personnel between the partners aims to help firms forge closer ties with each other. Closer ties which go beyond the annual, seemingly ritual, supplier symposium and infrequent supplier assessment but which establish more frequent contact based on an open style of management and an informal, long-term commitment to one another.

The best way to transfer knowledge from one firm to another is through people. In the motor industry, for example, the momentum for guest engineers is gathering pace, albeit slowly. Lamming (1994) in a review of the relationships between assemblers and suppliers noted from a survey of 77 UK component supply firms that they conduct learning in an introspective manner: for example, only 27 per cent of suppliers have employees who spend prolonged periods working in customers' plants.

In order to measure each firm with regard to technical personnel exchange, this variable is sub-divided into two, viz.

		Score				
		1	2	3	4	5
	Visit *to* the purchaser					
1.	Frequency of the engineer's visit	Rare				Often
2.	Nature of work	Trouble-shooting				Defined project

5.3.4.2 Frequency of inter-firm multi-disciplinary meetings:

These types of meeting generally fall into three groups and are defined, for the purposes of this discussion, as:

1. Supplier-Assembler multi-disciplined meetings:

A multi-disciplined team is one where the group comprises assembler and supplier representatives from engineering, design, manufacturing, purchasing, etc albeit often at different levels and where the supplier is out-numbered. The meetings appear to be at periodic intervals, ie six months and equate to an intensive 2 - 3 day visit by the assembler. The aim is often to focus and improve some manufacturing process in the supplier's facility (eg Rover Groups multi-disciplined teams as part of the RG2000)

2. Supplier-Assembler technical meetings:

For example, a group of design engineers from the assembler meet with the supplier to discuss a new or redesigned component perhaps with a representative of the materials supplier. The meetings are held when necessary and reconvene when there is something to report.

3. <u>Supplier-Supplier technical meeting:</u>

This may be vertical or horizontal collaboration. The latter, however, appears to be a rare event in the motor components industry especially amongst SMEs. The vertical arrangement is where representatives from the first and second tier suppliers would meet, eg a door lock system supplier meeting with a plastics firm which supplies the housing for the lock. In some situations, the raw material supplier may be invited to attend.

The most common type of meeting that management referred to were technical meetings between themselves and the assembler (2 above). For reasons discussed later, component suppliers were not inclined to meet with other suppliers, (unless they were members of a Supplier Association).

5.3.4.3 Receptivity towards partnering:

This variable has been scored taking into consideration the following two main areas:

1. Each supplier's involvement in industry specific initiatives such as Engineers to Japan, Learning from Japan, Supplier Association, as well as general participation in Business Enterprise initiatives and CBI membership. These are considered in detail within chapter seven (section 7.4). The premise is that the more initiatives the supplier is involved in, the more prone it is towards making useful contacts, learning from others' experiences and understanding each others' capabilities. The wider the participation the stronger the supplier's genuine willingness to collaborate.

2. Another area supporting the above is whether they have earned any supplier service awards from the purchaser that specifically takes into account the management response and attitude with regard to collaboration and building partnerships. For example, the Rover Group's Supplier Excellence Awards - considered within chapter seven.

5.3.5 Group Four: Overall impression of supplier's strategy and managerial attitude towards partnering:

The third research proposition highlighted the importance of the 'right' managerial attitude to lead the partnership. Consequently, the factors being assessed within this final group surround the supplier's managerial attitude toward technology partnering which implicitly came across during the individual interviews. For example, the extent to which the manager showed any signs of inwardly harbouring concerns of the customer's motives to partnership - perhaps revealing the supplier's instinctive mistrust about the customers's *vision* of longer term partnerships. Indeed, the remarks made by the purchasing director at Toyota confirm the importance of managerial attitudes (section 5.3.1). Other factors would include any clues to gauge their attitude towards open-book accounting or their continual reticence to conceal cost information from their purchaser, and so on.

Inevitably, one of the problems of trying to make an independent assessment of each firm's ability in a particular area is that 'other' factors cloud ones judgment - especially if the scoring process is undertaken within a short period. With this in mind, a fresh look back at each company was undertaken after a one - two month break from scoring each firm and an overall score was assigned with regard to its enthusiasm or dynamism for becoming actively involved in technology partnering.

5.3.6 The Scoring process:

The process of assigning scores (0 - 5) to each variable involved evaluating each firm in the light of the sub-variables to each variable. One of the underlying reasons for using the matrix was, as far as possible, to reduce the subjectivity element. In other words, to first identify firms that instinctively appeared good technology partnering players, and second to test those assumptions by developing a set of specific characteristics or attributes noted during the literature review and from internal research discussions at Cranfield which were thought important to any successful technology partnership.

Appendix I provides an example of how the input variable: 'Range of external organisations consulted' was scored for each firm in the offshore and motor industries. To reduce the subjectivity noted above, the scores were assigned according to the number of outside sources of technical help the manager referred to - both voluntarily and in response to specific questions.

To summarise, two data analysis measures have so far been considered. The first considered how four levels of partnering were identified during a first run through the data. This area will be returned to in chapter six. The second measure introduced the reasoning behind the technology partnering performance matrix and its overall purpose. While using these two measures alone would give some signals about which companies were better at technology partnering than others in the sample and, more importantly, why they are, ie the factors which lead to successful technology partnering arrangements, they are still too subjective.

With this last point in mind, it was considered that the research information needs should swing towards collating an independent data evidence. The aim was to check the validity of the early views centred on mainly qualitative data by examining independent quantitative data. For example, the number of patents each firm had been assigned as a measure of innovation, partnering activity, and its impact on the company's balance sheet. The main customer of every firm visited were also asked for a view on these suppliers in terms of their overall performance. (See chapter six and seven for a full discussion, eg Rover Group's Supplier Excellence Awards). However, the main set of quantifiable data inevitably related to key financial indicators on every firm interviewed. The following section describes the steps involved in collating and analysing this data set.

5.4 Quantitative measures of data analysis:

This set was collated principally on the underlying assumption that firms enter into such arrangements with the clear anticipation of improving their financial performance. The central question then becomes:

To what extent does technology partnering affect company performance?

5.4.1 Methodology:

In gathering the financial data required to answer this research question, the following steps were taken:

Step 1. The principal source of company information were the four annual Kompass directories, (Company Information, Financial, Product and Parent company). The information recorded from these directories included: Company name, number of employees, parent company and origin, the year the firm was established, and the product groups. The financial account headings were recorded, namely, sales turnover, profit before tax, fixed assets, current assets, current liabilities, shareholders funds, capital employed return on capital employed (ROCE) and return on sales. This information enabled the Researcher to establish which family of key financial ratios could be used. For every firm, financial records for four years ((1989 - 1992) was recorded and subsequently averaged to provide an overall financial performance score.

Step 2. The product groups were subsequently sorted to establish precisely which industry sector each firm was in. This exercise also revealed several competitor groups within the sample. For example, it became clear that (AS3 and AS5), (AS16 and AS24) as well as (AS9, AS14 and AS20) shared almost identical product portfolios. Thus, by using an independent source of reference, other information came to light that was not clear or forthcoming during the actual interview.

Step 3. Organised the above information, viz.

i Recorded each firm by industrial group and financial ratios: Return on Capital Employed, Sales Margin, Utilisation Ratio, and Sales Growth.

ii Ranked each firm by industrial group by its overall profitability, ie Best of Class.

iii Ranked the overall profitability of each firm against every firm in the sample irrespective of industrial group.

Two further financial data sets were gathered:

(i) Financial data on a select group of firms for a ten year period: 1982 - 1992. The firms included those to be compared against each other and those identified as the 'best performers' within each research phase. However, it is recognised that there are many other factors which influence a company's performance and a blinkered inspection of the financial accounts of an individual company will not reveal the causes.

An attempt was made to present a ten year financial history of all suppliers. However, some problems were encountered here. Most libraries only keep trade directories, such as Kompass for two or even three years. Company information that relates to earlier years may be accessed by other on-line routes, eg Datastream, or paying for commercial market information searches, eg Science Reference Information Services, City Business Library, or the DTI's Business Information Research Service. Given the time and budget constraints, the Researcher contacted the company secretary and/or finance managers within these companies that were able of being compared. Despite the latest financial information being easy to access, managers still felt wary of releasing such 'confidential' information. Again, this is perhaps further indicative evidence, albeit indirect, of some 'less receptive' firms to sharing information... knowledge ... ideas ... willingness to participate.

Again, all these aspects will be referred to again in later chapters.

(ii) Financial data on other component suppliers competing in the same industrial group, of similar size and located in the West Midlands (given over 80 per cent of those firms' interviewed were located in this region). This aspect is considered further in chapter six.

Step 4 The competitors' financial information was recorded. The size of this sample was the same as the original sample, ie for every firm interviewed in the plastics sector, one firm would be selected using the above criteria. The point of this exercise was to partly establish the credibility of the data, ie original profitability rank of some 30 companies. The same sorting process was carried out on this data and the two groups finally merged to give an overall profitability rank of some 60 companies supplying mainly to the automotive industry.

5.4.2 Choice of key financial ratios:

Several key ratios were either presented in the directories themselves or could be calculated using the information available. During the early stages of this exercise, four ratios were calculated for each firm: Return on Capital Employed, (ROCE), Liquidity, Sales Growth, Utilisation Ratio.

A company's ROCE is often interpreted as the primary measure of profitability as it can be roughly regarded as the sum the business yields for the money invested in it. It is calculated by dividing pre-tax profit by capital employed and expressing the result as a percentage. For example, for every £1 of long term capital invested in the company, the management of AS7 generated 18 pence in net profit before interest in 1992. One of the financial measures used initially to rank each supplier in the sample was overall profitability given the financial records available in the business directories.

Liquidity, on the other hand, is concerned with the organisation's current financial position, and in particular with its capacity to pay its debts as they arise in the short term. If an organisation has a liquidity problem, there is an increased risk of its failing to generate *any* future cash flows.

Sales Growth was calculated because it often provides a good indicator of a company's future prospects. However, like all financial account headings, they should not be looked at in isolation.

Given the financial information available, the only other ratio that initially appeared to be worthwhile was the Utilisation Ratio. This was calculated in order to provide some information as to how intensively resources have been utilised. For example, if two companies in the same industry own identical assets and set the same price for their product, the company utilising the assets more intensively will generate the higher sales revenue. One limitation of the utilisation ratio is its use of a figure (for long term capital) from the balance sheet which may be untypical of the capital employed throughout the rest of the year. One way of reducing this problem is to use an average of the opening an closing balances.

On review of these indicators, it was considered that ROCE and Sales Growth should be used in the analysis. While valid to some degree, it was anticipated that liquidity and measures of resource utilisation have limited linkages with any partnering activities, ie there seemed little point in making the analysis more complex by introducing a liquidity measure. The profitability indicator is more directly tuned to its customer base and its products than any internal cash management measure.

5.4.3 Patent Data

The patent data was gathered via an on-line system direct to the Patent Library, Cardiff. Initially, the aim was to gather data on every firm (offshore and motor component) under study that related to the number of patents they were assigned between 1987 and 1991. The principal reason being that all the financial performance data gathered related to the period 1989 to 1992, hence, we might expect to see some impact of the patents.

However, this type of on-line search is very expensive. The search was therefore modified to glean the *total number of patents assigned since the company was incorporated.* No other data was called for.

It was decided that the best way to present this information was to set it against the number of years each company has been trading in order to determine a 'patent intensity measure'. Another method is to use the firm's average turnover. However, given our search did not cover a specific period but each firm's lifetime, then this ratio is inappropriate.

This measure may now be used as a further variable to correlate against several others. Chapter six (section 6.1) considers the use of the patent data further and the evolvement of two hypotheses that are subsequently tested using the statistical package, SPSS.

5.5 Interrelationship with the literature: discussion

The following considers the background to and the reasons for analysing the fieldwork data using three distinct measures described above.

The actual approach to analysing the fieldwork data will vary from one research study to the next. The viewpoint carried at the interim stage of this research project suggested that while technology partnerships may bring significant benefits to the receptive participants, they are not a universal solution to every industry sector. The benefits may simply be that the longevity of a business relationship may be enhanced and maintained as well as some financial reward commensurate with the effort. The picture that emerged was that there were islands or archipelagoes of technology partnering success. These islands have varying life cycles. The duration and collaborative focus of each island appears to depend on the nature and complexity of the product or project. A small firm's propensity to collaborate varies according to (a) the stage of technological development and (b) its managerial attitude towards collaboration.

With this viewpoint in mind, the aim was to establish the characteristics of those islands of relative success in technology partnering with a view to eventually establishing a guide to best practice technology partnering. A first run through of the entire interview transcripts provided some indications of the attitudes and beliefs of the managers interviewed. The four distinct levels of technology partnering were identified during this stage which were positioned along two dimensions characterised by a supplier's managerial attitude and behaviour towards partnering.

In order to gain a better conceptual understanding of what the four levels mean and why they exist, a second run through of the data served to help develop a technology partnering performance indices (TPPI). The aim of this indices was to provide a less subjective measure of each firms' level of technology partnering activity.

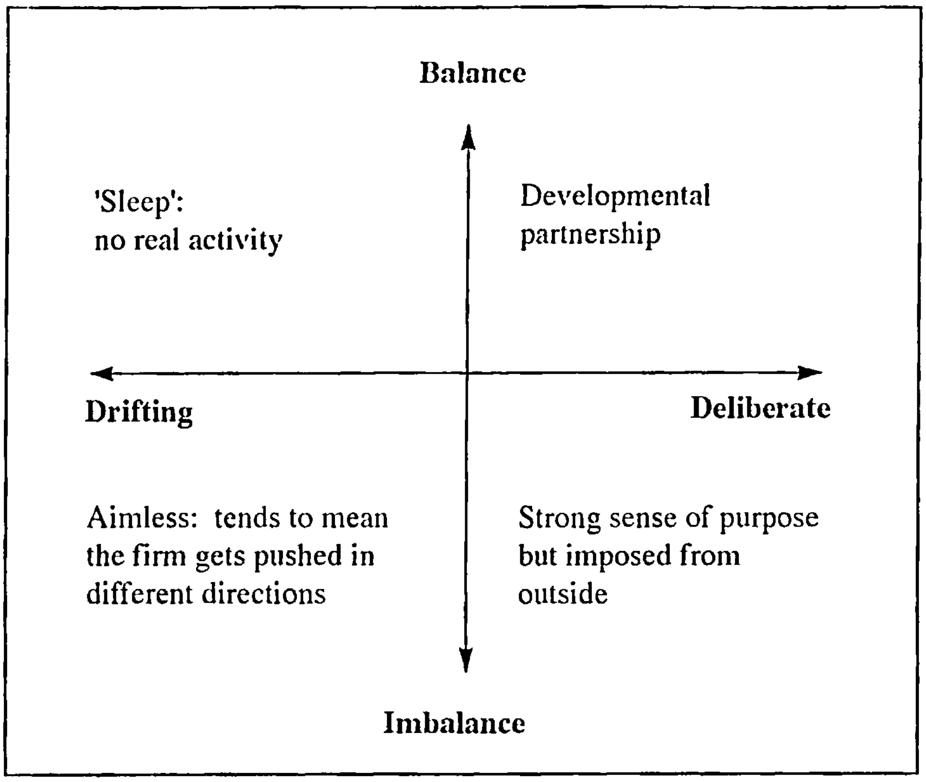
The four partnering levels presented here may almost be transposed into the vertical/pre-competitive quadrant. Although Nueno and Oosterveld (1988) made distinctions between technology alliances from a competitive position and supply chain point of view, the point here is to establish if this work may be extended and introduce other qualitative differences or aspects that can determine the relative position of such alliances. The aspects identified in this research broadly relate to:

(i) Managerial attitude and behaviour.
(ii) How and where small firms develop technology.
(iii) Technology alliance organisation and structure.

In addition, a number of contributory factors were identified, (see chapter six). As well as a close overlap between some of Nueno and Oosterveld's eight aspects and those identified here, mainly corresponding to 'Technology alliance organisation and structure', there are others that do not appear to have been explored in this context. For example, the impact of managerial attitude and behaviour on the alliance.

It is also interesting to note the close alignment of the partnering fields and levels presented in figure 5.1 above to the work of Bessant et al (1994b). The authors review some general characteristics that might be associated with Total Quality relationships in the supply chain. They characterised inter-firm relationships along two dimensions. See figure 5.3.

Figure 5.3



'Potential relationship states in interfirm networks (Bessant et al (1994))

The authors describe balanced relationships as 'those in which the parties operate as near equals, at least as far as their transactions are concerned, whereas imbalanced relationships are those in which there is considerable distance between them: for example, in the case of a big powerful buyer and a weak small supplier. The second dimension concerns the degree to which a deliberate policy for developing and managing the relationship is in place, as distinct from an aimless and reactive approach to inter-firm transactions.'

Bessant's 'relationship states' correspond closely to the 'partnering fields' and 'levels' presented above. To illustrate, the 'hard' level of partnering depicts the most formal and advanced type of collaboration found which resembles the 'developmental partnership' described by Bessant as a balanced and deliberate partnership relationship (in terms of strategy; boundary definition; monitoring and measuring performance; developing and managing the culture within the relationship; people and structures; processes and coordination; and continuous improvement). Similarly, the other three quadrants relate closely to 'soft' ('Sleep'), 'medium' ('Strong sense of purpose but imposed from outside'), 'uninvolved' ("Aimless').

Finally, the third phase of the data analysis described earlier concerned collating and correlating some independent evidence of each firm interviewed, namely, financial performance data. This involved gathering and sorting the main financial performance indicators for every company interviewed. The underlying reason for this exercise was to establish what, if any, impact a technology partnership has on a company's overall financial performance.

5.5 Summary:

This chapter considered how a mixture of qualitative, semi-quantitative, and quantitative data analysis measures forms the basis to explaining the results from two phases of research. The first run through the data resulted in the identification two dimensions, namely, managerial attitude and behaviour. The four distinct levels of partnering, namely soft, medium, hard, and uninvolved were then positioned within these dimensions. The second run through the data resulted in the development of a performance measure to advance the fields and levels yet reduce the subjectivity of the analysis. A Technology Partnering Performance Indices was developed. The emphasis then switched to collating independent data, such as financial performance related information, to establish any correlations. The next chapter applies the TPPI to the motor industry data and aims to advance the conceptual development of the partnering levels and managerial attitude/behavioural fields.

Chapter Six: Results and preliminary analysis of the study of the evolvement of partnering in the UK automotive components sector: Phase One of the research

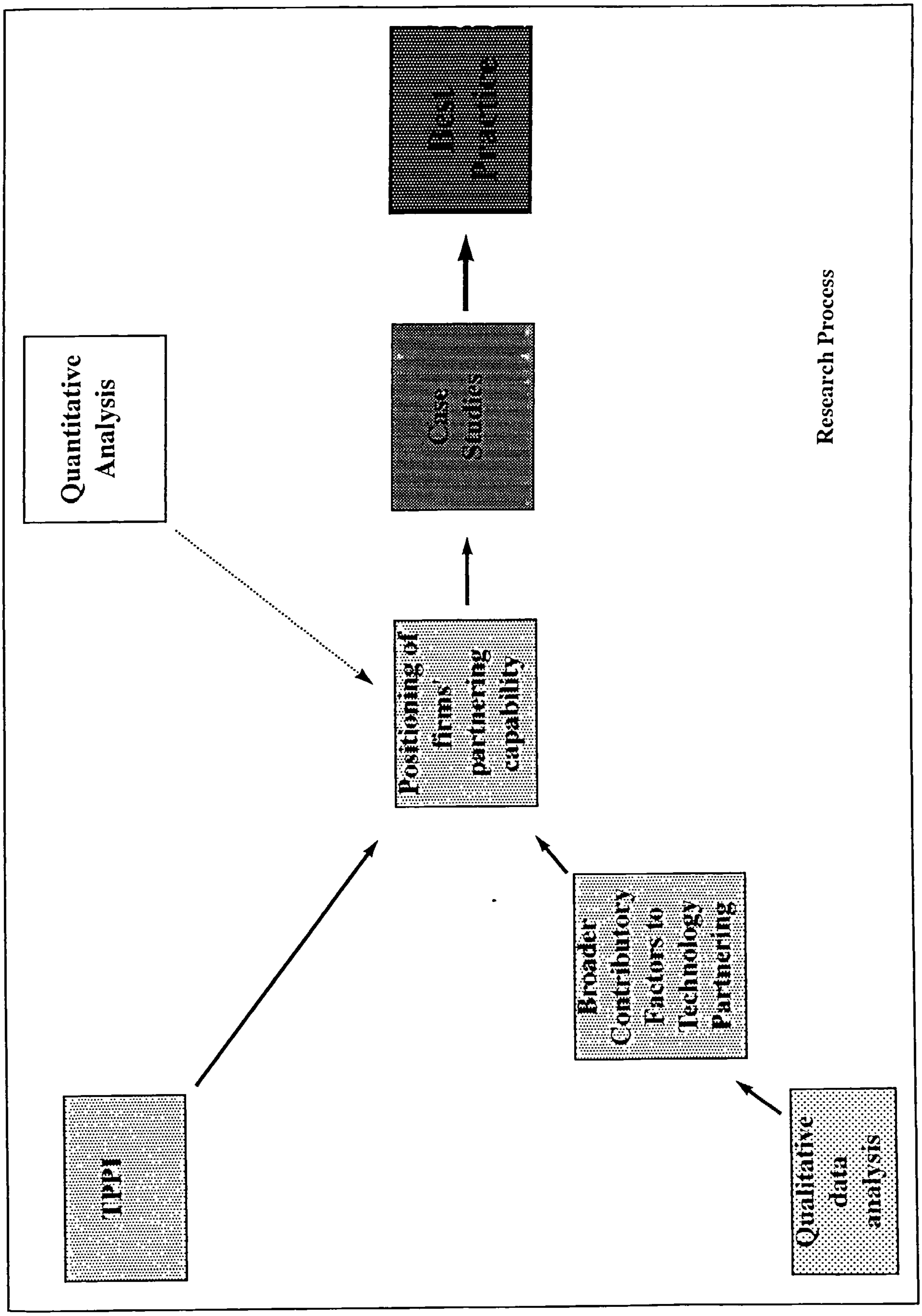
6.1 Introduction:

The previous three chapters described the aims of the research and how and where the fieldwork was conducted and the data subsequently analysed. Technology partnering was defined as *a relationship between a supplier and customer that encourages the development of technology to meet the customer's requirements.* Chapter three highlighted the research propositions and questions which guided the subsequent fieldwork. It then considered what information would be needed to test those propositions. Chapter four considered where and how to get the data and how it could be analysed. It placed the research aims and propositions into context by considering the industry setting, namely, the automotive components and offshore supply industries. With the propositions, questions, and information needs clearly defined and the means to collating that information and within each industry stated, chapter five suggested an iterative process to analysing the data thus ensuring increasing familiarity of the data would be the best approach. It then reasoned how the data would be analysed using three main measures of analysis, namely, qualitative, semi-quantitative and quantitative.

In a discussion of the qualitative area of data evidence, four distinct levels of technology partnering relationships were identified. The semi-quantitative measure principally represented the Technology Partnering Performance Indices (TPPI), while the quantitative measure equated to the financial performance indicators of each firm visited and included patent application data. Figure 6.1 summarises this process. It shows that these three measures of analysis serve to position each firm as far as their partnering capability is concerned. As it will be considered later in section 6.4, the quantitative measure proved to have less impact than the other two measures.

In a sense, the thesis so far has been largely about the 'inputs' and the structure of the research. Here, we begin to analyse the fieldwork data in detail and present an evolving picture of the research output. Chapter six and seven collectively present an analysis of phase one - the motor industry - while chapter eight explores the offshore industry. The preliminary research conclusions are then set out in chapter nine, while the wider implications for different players in the technology partnering process as well as the contribution to industry and academia are given in chapter ten.

Figure 6.1



Research Process

This chapter aims to apply the three measures of data analysis to the automotive components study in order to test some of the propositions first set out in chapter three. Section 6.2 uses the TPPI measure to highlight some differences in partnering capability between the firms' interviewed. Section 6.3 re-introduces the discussion about 'levels' of partnering and 'fields' of relationships and presents some broader contributory factors to technology partnering. While the 'contributory factors' and the 'TPPI' factors were both identified during the literature review and subsequent interviews as being significant in a good partnering arrangement, the main difference between them is that the TPPI factors are more readily measurable than the contributory factors and, therefore, are treated in a performance measurement index. Chapter nine considers how the three measures are merged. Section 6.4 considers the third measure of analysis by exploring each firm's financial performance as well as some inter-relationships between the data. Some inconsistencies are revealed in terms of the the financial performance with its TPPI score, ie some good technology partnering players yet poor financial performance history.

To recap, chapter three first highlighted two possible routes to examine the technology partnering process. It considered the importance to enquire how and why companies, that have already adopted technology partnering, have shown themselves to be successful in the innovation process. The first route (A) set out to examine the 'macro' indicators of successful partnering arrangements to see whether any patterns consistently emerge. By macro indicators it is meant measures of company characteristics which can be made externally or with the most cursory internal examination. These indicators would include: *company size* measured by either number of employees or turnover, *industrial sectors covered, market position, frequency of incorporation of new technology into products and processes gained through the alliance - perhaps measured by 'patent intensity'*.

The second route (B) aimed to make some attempt at measuring the internal or 'micro' parameters of the firm and identify the organisational factors which can trigger successful technology alliances. For example, these factors may include *measures of internal communications, innovation strategies, planning and management, the quality and skills of management, technical personnel and workforce, the impact of the alliance on managerial behaviour, the role of key personnel such as 'boundary spanning individuals'*, and a myriad of other organisational, technical and personnel related issues. Both of these routes are considered within the next two sections.

6.2 Establishing the TPPI Index in practice: Semi-quantitative analysis of the data

Table 6.1 shows the TPPI scores assigned to each firm. Figure 6.2 shows the ranked order of motor component suppliers in terms of the overall TPPI results. Several groups of firms are beginning to emerge that display differential ability with regard to partnering. Again, while only a limited reliance can be placed on this particular measure, especially in isolation, some distinctions are emerging.

Figure 6.2 shows seven firms positioned in the top quartile (far left) which demonstrate the more able partnering players. These firms are given further consideration later in the thesis, namely, AS16: Chapter seven; AS8 - 'Example of 'soft' level': Chapter seven; AS26 - 'Example of 'medium' level: and AS18 - 'Example of 'hard' level': Chapter seven; and Chapter seven; AS3 - 'Motor Industry Comparison A' - Chapter nine.

The bottom quartile shows eight firms (far right) less prone towards partnering activity and include AS5 - a firm highlighted later ('Motor Industry Comparison A' - Chapter nine.). AS2 were, incidentally, liquidated in early 1995.

While this information in isolation is limiting it does provide an indication of which companies are the better partnering players. Again, this Performance Index provides a key link to discerning the best practice guidelines in chapter nine.

Despite the subjective nature of the TPPI, some firm conclusions may be made on the basis of it. For example, the sources of technical advice and assistance which the firms' interviewed could have used to overcome their technology related problems may be explored. The results show that those seven firms within the top quartile of the TPPI are likely to have contacted a much wider range of organisations than those within the bottom quartile. This analysis showed that these top performers' contacted on average 9.6 organisations, compared with an average of 4 for the 'uninvolved' group of firms. This suggests that the best practice companies are much more closely linked to the formal local business network. Overall, the most popular source of external advice was 'purchasers' (100 per cent) followed by 'own suppliers' (93 per cent) whereas the least contacted organisation was Regional Technology Centres and Technology Transfer Agents. These findings do not necessarily imply that purchasers are the best or most useful source of reference but simply illustrates the inextricable vertical links prevalent in the motor industry. They also indicate that given the RTCs and Technology Transfer Agents generally don't sell their own technologies but act as intermediaries then their perceived use is less direct than firms in the same market or supplying to the same industry. Clearly, if companies want technology they know, can understand, is already developed and has been

Table 6.1

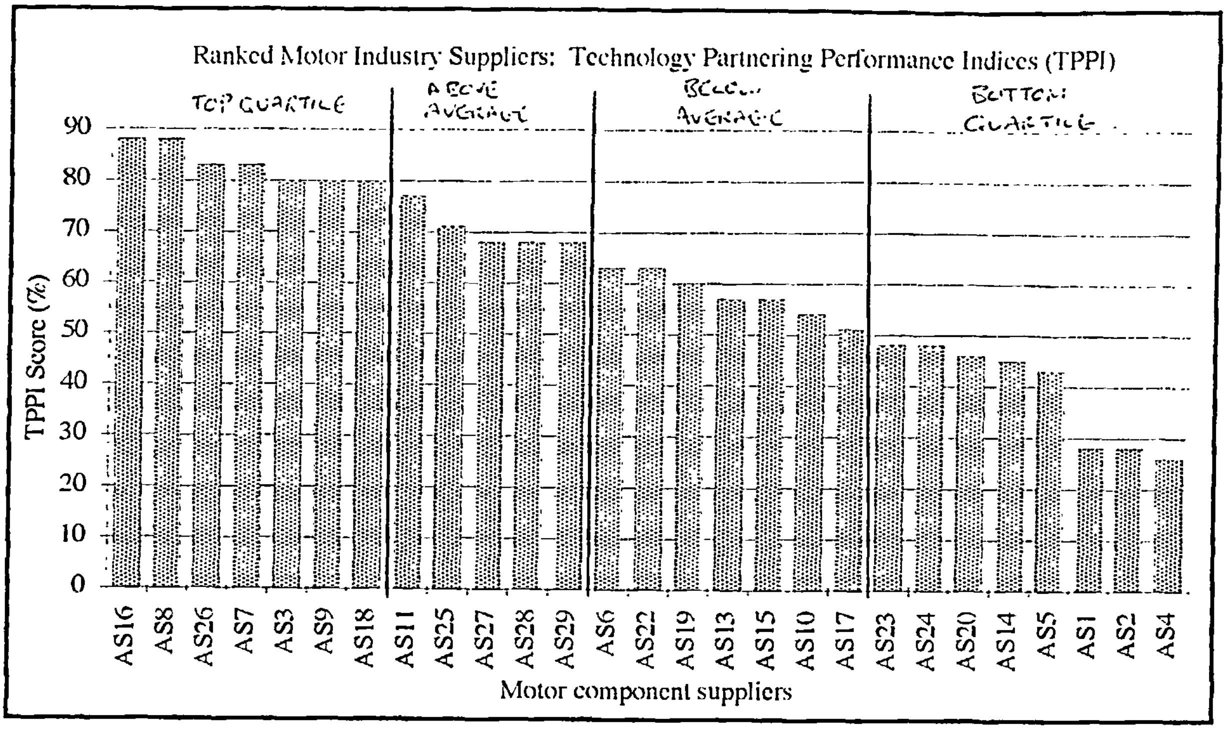
Technology Partnering Indices:
Motor Industry Supplier Scores

Automotive	Group 1			Group 2			Group 3						4
	A	B	%	C	D	%	E	F	G	%	Score	%	H
AS1	2	1	30	1	2	30	1	2	1	33	10	28	20
AS2	2	1	30	1	2	30	1	2	1	33	10	28	25
AS3	4	3	70	4	4	80	4	4	5	86	28	80	80
AS4	1	1	20	1	2	30	1	2	1	33	9	26	20
AS5	2	1	30	2	3	50	3	2	2	46	15	43	45
AS6	4	3	70	4	3	70	3	2	3	53	22	63	65
AS7	4	3	70	4	4	80	5	5	4	93	29	83	75
AS8	4	4	80	4	4	80	5	5	5	100	31	88	80
AS9	4	3	70	4	3	70	5	5	4	93	28	80	80
AS10	2	2	40	2	2	40	4	4	3	73	19	54	50
AS11	4	3	70	2	4	60	5	5	4	93	27	77	70
AS12	4	2	60	2	3	50	2	3	2	46	18	51	40
AS13	2	2	40	2	3	50	3	5	3	73	20	57	55
AS14	3	2	50	2	2	40	2	3	2	46	16	45	45
AS15	3	3	60	3	4	70	2	3	2	46	24	57	45
AS16	5	3	80	4	4	80	5	5	5	100	31	88	85
AS17	3	2	50	2	3	50	2	3	3	53	18	51	65
AS18	4	3	70	3	4	70	5	5	4	93	28	80	80
AS19	4	3	70	2	3	50	2	3	4	60	21	60	75
AS20	3	2	50	1	3	40	2	3	2	46	16	46	35
AS21	3	1	40	2	3	50	2	5	2	60	18	51	35
AS22	3	2	50	3	4	70	2	5	3	66	22	63	50
AS23	3	1	40	1	3	40	2	5	2	60	17	48	40
AS24	3	2	50	1	3	40	2	5	1	53	17	48	30
AS25	4	2	60	3	4	70	3	5	4	80	25	71	70
AS26	4	2	60	4	4	80	5	5	5	100	29	83	80
AS27	3	2	50	3	4	70	3	5	4	80	24	68	65
AS28	4	2	60	3	4	70	3	5	3	73	24	68	50
AS29	4	2	60	3	4	70	3	5	3	73	24	68	50

Key:

A	Degree and depth of technology scanning
B	Number of professional engineers
C	Alliance organisation and structure
D	Range of external organisations consulted
E	Frequency of technical personnel exchange with customers
F	Frequency of inter-firm multi-disciplinary meetings
G	Receptivity toward partnering
H	Overall impression of supplier's strategy and managerial attitude toward partnering

Figure 6.2



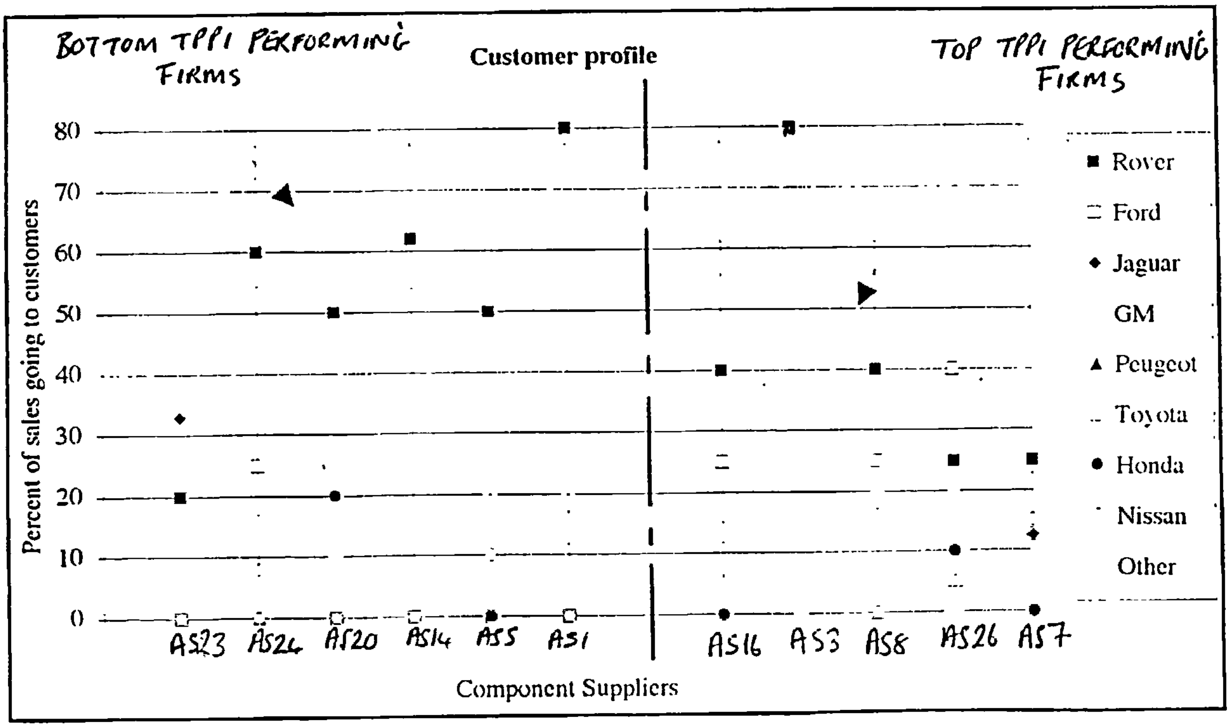
proven in the market place, the most obvious place to look for technology is companies operating around them. Lefever (1992) also found in a study of the role of intermediaries that 'component suppliers were the second favourite source with some 58.5 per cent of companies receiving technology from this source. ... The use of suppliers as technology sources implies a less active technology strategy based on reactive policies. However, in some subsections of various industrial sectors the requirement for change will be driven by the technology by companies higher up in the manufacturing chain.'

Chapter two (section 2.3) highlighted the importance of prior knowledge while the first two research propositions (chapter three) emphasised the importance of internal and external linkages. Trott (1993) undertook a study of the inward technology transfer process and in particular the notion of 'receptivity'. His findings helped 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 can facilitate the development of an organisation's receptivity to externally developed technology. The analysis of this field research, namely the TPPI using the second input variable 'Number of Professional Engineers', indicates that the top seven TPPI firms (above) employ a greater proportion of qualified scientists and engineers to other staff than the 'uninvolved' group. In fact, the top group of firms employ over 20 per cent (average score, 3.2) of QSE to other staff whereas firms located in the bottom quartile employ less than 10 per cent (average score, 1.0). The same input variable is applied to the offshore suppliers (phase two) yet these firms were much smaller in term of staff employed. Consequently, it ought to be noted that the TPPI scores for this variable were high, ie a engineering consultancy firm employed ten people would represent seven graduates, a secretary/receptionist, an office administrator and a part-time book-keeper.

The third measure of data analysis - quantitative - sets out to establish other relationships. For example, how much influence does the parent company have on each firm's technology partnering performance? Is the SME made more attractive because of its parent? Is there evidence to suggest that one type of parent group has structured itself in a way to support and promote such subsidiary partnerships?

Some tests on these relationships above were performed using a spreadsheet package. Some examples of such spreadsheets and their output are provided within Appendix E. The aim was to check visually on a graph for signs of any correlations. For example, checking the relationship, if any, between the TPPI score results and the proportion of annual sales to the supplier's largest customers. To investigate the issue of dependence, all firms were asked to indicate the proportion of their sales to all of their customers. Even though a firm may have a large number of customers it may still be effectively dependent upon either one or a very small number of customers. Figure 6.3 presents this relationships.

Figure 6.3



This test above implies: (i) The top seven TPPI performing firms (figure 6.2) generally display an even customer base. (ii) These firms tend to show a greater trading involvement with the Japanese transplants. (iii) The bottom quartile firms show a marked tendency to be more dependent on one assembler. However, in the interpretation of this last point it is very easy to overdramatise and focus on the particular assembler as the major influencing factor on the 'weak' suppliers. Extreme care should be taken here not to *tar the assemblers with the same brush*.

To back-track to the first run through the data when the spreadsheets described above were tested, it was at this point that an attempt was made to divide the sample of firms into four distinct groups. To illustrate, figure E1 (Appendix E) aims to extend figure 6.3 by first dividing the spreadsheet into four 'fields, and second highlighting a quotation about Rover Group from each component supplier, (given that every firm visited supplied Rover). An attempt was then made assign one term to each 'field' which best encapsulates the relationship between the supplier and Rover. For example, Field 1 was first described as 'Proactive', Field 2 'Insular', Field 3 'Controlled', and Field 4 'Reactive'. As the data analysis process continued, other concepts emerged as 'levels' and 'partnering fields' bounded by managerial attitude and behavioural characteristics.

Returning to the spreadsheet analysis, while this process provided some glimpses, it was considered that a statistical package such as SPSS may help the data analysis and provide a sharper insight. Consequently, various SPSS tests were undertaken to establish if any strong relationships between the TPPI results and independent variables existed. Some examples of SPSS tests are provided within Appendix F. These are discussed in section 6.4.

Before continuing, it is worth 'speculating' on the common characteristics between the top performing quartile of seven firms using the qualitative evidence available. These points will be returned to again in chapter nine. To reiterate the elite group, we are considering: AS16, AS8, AS26, AS7, AS3, AS9, and AS18. One of the main facets that binds this group of firms together in the context of partnering is that they all appear to have demonstrated their specialist technical resources to existing and potential customers and displayed their innate ability to outperform their nearest competitors in terms of cost, quality and lead time. These firms persisted to emulate their customer's style of management and technical lead in order to 'match' themselves to particular assemblers which would then stimulate initial negotiations. Their management demonstrated to potential customers their willingness and capabilities to keep abreast of new technologies through active participation in collaborative ventures with universities and research institutions, and membership of professional associations as well as maintaining contact with other suppliers. To illustrate, the management within AS16 are continually exchanging ideas with their opposite numbers within AS3. Similarly, AS3 have set up an exchange personnel arrangement with AS9. The MD of AS16 remarked during interview, *"The MDs (of AS3 of AS9) are forward thinking modern managers. A lot aren't. I have no hesitation in asking them if they are interested in participating in a project involving six other firms with say, Warwick University."*

To exemplify some of the idiosyncrasies, AS16 is owned by the German company Thyssen Umformtechnik. The German influence is carried further into training requiring their subsidiaries to develop a staff training strategy that is consistent and streamlined with their customer's. This particular firm has been acknowledged for its quality of on-going staff training and commitment to investing in people through two national awards: the first in 1988 related to training of their management team, with the emphasis on engineering and technical quality, and a greater sense of the benefits which could accrue from closer collaboration with the Japanese transplants. The second in 1991 which recognised the change in strategy from batch to JIT production and the introduction of a cellular manufacturing approach. Implementing flexible manufacturing cells led the company to adopt a multi-skilled programme for all staff which would allow the cells to function at their best. For example, skills in power press setting, spot weld and projection welding setting, and statistical process control. Furthermore, German-owned subsidiaries are encouraged, it seems, by their parent to annually recruit talented individuals from local technical colleges in order to undertake a structured apprenticeship training programme in addition to undergraduate engineering sponsorships. A strategy that approximates to the German Dual System which is based upon the traditional apprentice system and has evolved into a highly organised mass system of vocational education and training. The result is a focused effort to continually identify skill gaps, and promote staff from within who have reached a position to train and manage others.

AS9, another German controlled firm in the top performing group above regarded itself as a *Participation Company* where all its employees are given the opportunity to make a contribution through the firm's established Business Improvement Teams and Action Teams. The clear emphasis and importance which such German firms attach to securing an adequate supply of skilled manpower has also been witnessed in the Toolmaking industry. A comparative study of Toolmakers in West Germany and the UK (NEDO [1981]) concluded that there was, on average, a greater continuity in training programmes and more investment in training facilities (plant and personnel) in West Germany than in the UK.

6.3 Identifying the broader contributory factors: Qualitative analysis of the data:

6.3.1 Some emerging managerial behaviour/attitude fields:

Chapter five (section 5.1) noted that following an initial run through of the data, three activity levels of partnering had begun to emerge as well as an 'uninvolved' group of firms. These levels were positioned within four partnering fields bounded by two dimensional axis.

In the last chapter, figure 5.1 conveyed four partnering fields. The two axis scales show the managerial attitude and behavioural actions that each firm appears to adopt as far as partnering is concerned.

To recap, a supplier operating at the 'soft' level of partnering would display a generally positive attitude towards partnering, their behaviour is still insular, ie they still typically develop all or most of its product, materials or process technology requirements in-house. The supplier would invest in various technology development programmes in the confidence that their main customer will provide a ready market for the final product.

Technology partnering at this level may be summed-up as Informal Knowledge Exchange.

A medium level of partnering may resemble an arrangement whereby the partners have organised themselves into a grouping in order to develop a better engineering solution to satisfy an industrial need. The firms undertaking partnering at this level have earned the confidence of the customer through many years of relationship building yet understand that they will lose business unless they partner with other firms to present a more attractive product or engineering package. These firms will often continue to seek technical assistance using their global network of experts. Their managerial attitude reflects a positive stance coupled with an integrated approach. As the case study within section 7.4 will testify, there is some overlap with managers initially unsure of the partnering principles, what was expected, what could be expected to result from the arrangement, etc.

Technology partnering at this level may be summed-up as Formal/Organised Knowledge and Technical Exchange.

The focus and aims of the hard type of collaboration generally appear to alter during the life of the product development, ie early design stages through prototype to manufacture. Managers interviewed operating at this level were quick to refer to the success factors of the collaboration as revolving around complementary technology and trust, respect and good communication between the partners. Also important were management factors, both in project management and with regard to the strategic nature and issues of R & D collaboration.

At this higher level of technology partnering the actual focus of the collaboration will inevitably change over the product's development cycle time and post launch period. It is about strategic concerns, ie meeting the company's long-term objectives. A multi-disciplined team from all partners will often be at the centre of the product's development.

Technology partnering at this level may be summed-up as Planned Collaboration/Shared Risk.

Finally, the 'uninvolved' group reflect a stance that displays minimal receptivity toward partnering arrangements.

6.3.2 <u>Some broader contributory factors to the technology partnering process:</u>

While the TPPI attempts to draw together a collection of qualitative variables considered important to creating and maintaining a successful partnership, clearly many other contributory factors come into play. Here we present a set of seven broader contributory factors thought capable of influencing the progress of a technology partnership. While these factors were not directly included or measured in the TPPI they were identified from the interviews. To illustrate, the first three propositions stress the importance of internal and external linkages as well as managerial attitudes and behaviour toward partnering. Similarly the first three contributory factors attempt to encapsulate a best practice supplier approach to sharing information in a way that is truly compatible with the purchaser given their positive belief of the partnering concept. The trade and academic journals also provided a valuable input into this process, most notably, 'A Review of the Relationships Between Vehicle Manufacturers and Suppliers', Lamming (1994).

Table 6.2 divides each contributory factor into four levels which directly correspond with those considered in chapter five, namely, Managerial attitude: positive or unsure, Managerial behaviour: Autonomous or Integrated. The 'hidden linkage' between the propositions and contributory factors above relates to the research evidence making clear how each of these factors and the sub-levels emerged. Consequently, 28 'sub-factors' are characterised using the fieldwork evidence, ie quotations drawn from the interview transcripts.

The following defines what is meant by each of the attributes to technology partnering in table 6.2. A direct quote from a particular firm positioned in the relevant 'field' is given to help characterise the situation.

6.3.3 Open-Book Accounting and Cost transparency:

Open-book accounting is the name given to the negotiation technique in which the customer requires the supplier to share component cost information, as part of the process of improvement and cost reduction. Arguably, some of the problems which have prevented this practice from becoming widespread relate to a lack of respect and trust amongst the 'partners'. For example, the suppliers' interviewed often remarked how their customers require them to share all information - rather than just that which is relevant to the process. The customers would then provide little justification except the general claim that it is a necessary part of supply chain management.

Cost transparency is about the extent to which both the customer and the supplier share sensitive information. Coupled with compatible accounting systems, this aspect is clearly one of the major hallmarks of technology partnering as far as this research project is concerned. Some firms are using a variety of costing systems, eg Activity Based Costing (ABC), Total Acquisition Costing (TAC), Whole Life Costing, etc.

In cost transparency, there is a basic recognition that information must be shared, but the process is two-way, ie the supplier needs to know the way in which the component is used and combined with other components after the point of delivery, in order to develop ways (either in the process or the product) in which cost can be removed, quality improved, etc.

Broader Contributory Factors to Technology Partnering: Automotive components industry

Contributory factors influencing progress in the technology partnering relationship / *Relationship model/'field'*		Open-Book Accounting & Cost Transparency	EDI compatibility	R & D	Supplier stress level	Level of trust	Corporate culture	Balance of Power
Field 1.	Integrated	1. Two way	5. Good	9. Shared for cost reduction	13. Low/medium	17. Good	21. Greater alignment	25. Purchasing powe not used
Field 2.	Skeptical/Unsure	2. One way: Supp. opens books	6. Poor	10. One sided: minimum share	14. Very high	18. Non-existent	22. Traditional, internally focussed company	26. Purchasing powe explicit and visible
Field 3.	Positive/Belief	3. Two way: Knowledge of true costs	7. Excellent	11. Shared for development	15. Low	19. Strong	23. Customer-orientated	27. Power is two wa and hidden
Field 4.	Autonomous	4. Restricted: minimum necessary	8. Average	12. Minimum exchange: reliance on supplier parent	16. Medium	20. Medium	24. Continuously improve performance	28. Purch. power is rarely used.

Table 6.2

Examples of the characteristics in table 6.2:

1 . Two way:

"To us, the most effective partnership is where the customer volunteers something rather than us having to ask for it." (Reference AS3)

2 . One way: Supplier opens books:

"We are total open book with Rover yet they are, in many respects, still adversarial!" (Reference AS14)

"Whilst everything is open book with Rover, we are very wary of them releasing that information to our competitors." (Reference AS20)

3 . Two way: Knowledge of true costs:

"We are always 'in-the-know' which helps us to plan ahead." (Reference AS11)

4 . Restricted: Minimum necessary:

"We sometimes feel that it is a good partnership but the only trouble is that when we ask Rover to see their books, they refuse!" (Reference AS1)

"Our customers always tend to keep things close to their chest." (Reference AS23)

"If I ask my customers for their cost structures, then I get no reply ... probably because the people I'm talking to people who don't know the answers. Cost transparency only goes one way." (Reference ASOP)

The above reflects a collection of views that reflects a snapshot of how a selection of component supply manufacturers view the 'open-book' approach. Perhaps not surprisingly, this area appears to bring the most compassionate arguments to the fore. Given that the assemblers know the production costs involved in their components, margins can become increasingly squeezed for suppliers. The increasingly pervasive involvement of the assemblers has resulted in a definite change in the power relations between buyer and supplier. Paradoxically, while dual sourcing was a major cause of declining profitability in the late 1970s and early 1980s, single sourcing, with greater transparency of financial and production information, may produce the same effect. By squeezing marginal cost improvements from suppliers may prove counter-productive in the longer term if this impairs the ability of component suppliers to invest in new technology and research and development. Indeed, there should be some concern about the observation that component supplier profit levels are generally low (considered later).

In summary, the presence of open-book appears to vary in degrees from fairly mutual exchange of financial information which may present some implications regarding the imbalance of power (although the suppliers appear to be proving the most information) to the minimum exchange possible. This information alone provides some clear insights into the nature of each supplier-customer partnership. This information will be referred to again in this chapter and within chapter nine.

6.3.4 Electronic Data Interchange (EDI) compatibility:

EDI generally appears to be regarded as an integral part of the quick response strategies which are required by vehicle manufacturers and their component suppliers in order to derive competitive advantage. A management report from the FT (1995) labelled EDI as 'an integral element of many advanced production and business techniques including supply chain visibility, logistics management, lean production, just-in-time, CAD/CAM communications and geographical enlargement of the supply chain. In particular, the report notes that component suppliers utilised EDI at an early stage and concludes that this has helped to engender a spirit of partnership and co-operation between themselves and their customers.

More specifically, NEDO (1991) in a survey of Nissan's UK suppliers noted how EDI link are either in place or planned to be installed with many suppliers.

"This enables Nissan to communicate forecasts and detailed orders directly to suppliers, and in some cases allows suppliers to check Nissan stock levels for particular items. Where such links have been installed, the two parties still speak frequently on the telephone to ensure that the relationship does not become too impersonal."

EDI in use in the motor industry appears to involve the use of 'messages'. For example, there are four special 'national' messages for the Rover Group including messages used by suppliers which deliver to warehouses run by transporters. Another message, 'Synchro', enables Rover to broadcast a message to a supplier close to a plant on a two-hour delivery horizon. Two hours before Rover needs components from a local TRW United Carr factory a message is broadcast requesting delivery. TRW begins assembly and half an hour before they are required the parts are delivered straight off the truck on to the line in the order they are used.

The SMMT report that almost all the large automotive assemblers have implemented EDI in the UK often to support just-in-time and synchronised deliveries. Given this position, component suppliers are faced with the decision of whether to introduce a system into their own facility and, if so, choosing one which is capable of coping with the inconsistency of business information contained in the various systems.

In a survey of Welsh Automotive Component Suppliers, (Delbridge et al 1990) this showed that 45 per cent of firms were operating EDI, while 40 per cent of GM's suppliers were using EDI (Vauxhall, 1995). As far as this research is concerned, an almost even 51 per cent of the component suppliers' visited had invested in EDI systems. The division of investment may partly reflect their attitude to communicating and sharing information with their main customers. The following encapsulates their views.

Examples of the characteristics in table 6.2 :

5. <u>Good:</u>

(See 7, below)

6. <u>Poor:</u>

"Information is always being fed to us in an unstructured way." (Reference AS2)

7. <u>Excellent:</u>

"Customers occasionally pull us in to advise us of new developments and quality procedures ... especially on EDI procedures." (Reference AS16)

8. <u>Average:</u>

"The majority of our customers are of Japanese origin there for their technological advances are made known to us via specifications which often come in on our EDI system." (Reference AS12)

6.3.5 <u>Research and Development:</u>

Close involvement of suppliers in the development of the next model is a practice which assemblers claim to support. The systems approach to the design of vehicles also presents the need for suppliers to collaborate with each other on R & D, since the various component parts cannot be developed in isolation, and the assembler does not wish to become involved in the details of problem solving, etc. This requires one supplier to act as coordinator but usually without the remit to choose the others. For example, the system which allows the driver to have the seat, mirrors, steering column, pedals, etc. automatically set to personal dimensions, by the car's computer memory and controlled by a personalised key, involves four or five major components and several minor items. The assembler might supply the group of chosen suppliers with the spaces to be filled (black hole) and require them to collaborate on providing the finished items to be fitted to the vehicle. The assembler still retains the right to choose sub-contractors.

While the need to collaborate in R &D is at the heart of this study, the practical difficulties for both small and large firms are many, not least those related to internal politics and large firm policies towards such collaboration. The following quotations aim to characterise each field in relation to R & D activity.

Examples of the characteristics in table 6.2:

9. Shared for cost reduction:

"Some R & D is paid for from a development budget, which some customers pay for IF they can see a saving in costs and a short term payback period." (Reference AS11)

10. One sided: minimum share:

"We are quite self-contained here ... we have our own R & D department which deals with developments in exhaust, catalysts, petrol tanks, etc." (Reference AS15)

"I would agree that the assemblers are expecting us to take on more of the R & D work but they are not necessarily prepared to pay for it." (Reference AS20)

"We don't tend to have much interface with other component part suppliers. We don't know who, for instance, would manufacture the column, the cluster of instruments, etc." (Reference AS5)

11. Shared for development:

"We got some people from the customer and our own people to develop our product." (Reference AS7)

"We can use the customers' testing facilities to iron out small technicalities at no extra cost." (Reference AS9)

"The assemblers are moving to increase the supplier's design responsibility and in return are giving longer-term contracts. This means I can invest in new equipment, for instance, and they expect a share in the benefit. Likewise, there is a sharing of technical knowledge." (Reference AS28)

"We accepted that when we began to work with Nissan, we would have to do more development work but not the actual research." (Reference AS29)

12. Minimum exchange: reliance on supplier parent:

"All our R & D work is carried out in one of our German companies." (Reference AS1)

"It's not high technology but just a bit of innovation and design work. That innovation is all done through our in-house capabilities." (Reference AS24)

6.3.6 Supplier Management Stress level:

Lamming (1987) first argued that the stress level in the customer-supplier relationship may increase due, in part, to technological pressures, with the assembler urging favoured suppliers to invest and take advantage of the competitive advantages to be gained from new practices and plant. Another reason why the stress level may increase may be due almost entirely to the assembler threat of sourcing parts elsewhere as part of the assembler's supplier rationalisation process. Other reasons may typically include the pressure to reduce costs constantly.

Macbeth (1994) notes also how in an adversarial relationship stress is imposed by the customer, coupled with high levels of uncertainty about the future and the outcome of bids and negotiations. In a collaborative relationship stress is self-imposed. The drive is to avoid letting the partner down and to continue to develop and improve as fast as possible, to keep this link to the partner strong and healthy.

In the context of this research, the level of 'Supplier stress' reflects an overview of the firm in its partnership with the assembler. It takes account of Lamming's redirection of sourcing threats and continuous purchaser pressure to cut costs and/or squeeze profits as well as Macbeth's views.

Examples of the characteristics in table 6.2:

13. Low/medium:

"We are still trying to overcome the bad practices that have existed between us for decades." (Reference AS11)

14. Very high:

"The problem is that our European customers are all demanding that we reduce our prices by 5 per cent each year yet our suppliers are increasing their prices!" (Reference AS15)

"The systems they (the assemblers) put in place penalise suppliers who don't live up to expectations. The Ford system in particular is especially punitive. Poor quality or wrong quantity means you quickly lose your status and Ford come and crawl all over you."

15. Low:

"Despite their purchasing people moving around, we are still able to keep that relationship continuity. It doesn't matter that we may have to revisit some old issues with some new people - it helps to ensure that they understand our capabilities." (Reference AS8)

16. Medium:

"All we ask is that our achievements are recognised and they are put on record so that whoever takes over the purchasing job understands our capabilities ... but that never happens! Every time there is a change in buyers, we have to crawl along a new relationship curve." (Reference AS5)

6.3.7 Level of trust:

One of the most controversial aspects of a soundly based relationship between a manufacturer and supplier is the need for openness. Partnership Sourcing Limited (CBI (1991)) suggest that 'the essential ingredients of successful partnerships include: Genuine commitment from the top of both organisations; A firm understanding by both parties of what is expected; Capable people sufficiently trained to carry out the job; Sufficient resources to ensure success; Patience to tackle obstacles and teething problems; Open communication ... most of all, however, partnerships demand trust.' Indeed, chapter two referred to the importance of trust in a partnership, (section 2.5.2)

Clearly, the greater the level of trust between the partners, the faster the development progress. The following presents a set of views that positions some firms on a 'partnership trust scale'.

Examples of the characteristics in table 6.2:

17. Good:

"They are looking for suppliers like ourselves to take on more of the development phase, eg the drive train." (Reference AS19 - Competence trust)

18. Non-existent:

"We trust our suppliers considerably more than we trust our customers." (Reference AS4)

"One of my real worries is that you work with someone like Rover and two weeks later that Rover Team will be working with one of our competitors ... our meetings with Rover have to be very tactful." (Reference: AS20)

"If I had a choice, I wouldn't deal with General Motors - it's not a partnership." (Reference AS7)

"Bright ideas bounced off customers end up with competitors." (Reference AS20)

"Relations with customers seem to be characterised by a lack of trust." (Reference AS4)

"The idea that we can all work in collaboration in some 'matey' team is, in my mind, suspect. I am not about to help anyone!" (Reference AS20)

19. Strong:

"Our relationship is one of great depth - a one-to-one complex relationship." (Reference AS16)

20. Medium:

"Our Chief Engineer is an ex-Rover Product Developer" (Reference AS7 - Competence trust)

"True customer-supplier relationships are broken by the buyer sticking to their rules." (Reference AS24)

"We spoke to other suppliers because we had some doubts about the nebulous aspect of the relationship with Nissan regarding the trust element." (Reference AS29)

"The only disadvantage to partnering our customers is allowing them access to confidential information that may be released to our competitors." (Reference AS6)

6.3.8 Corporate culture:

One of the major reasons why firms working in partnership encounter difficulties and require a massive management effort to make it work relates to cultural differences between the two firms. As well as both firms having different aims, procedures and language, the parties will also bring to the partnership different working cultures. Consequently, they will approach tasks in different ways.

Briggs (1994) remarked on the importance of the supplier's corporate culture with regard to ensuring success or failure within a purchaser-supplier relationship,

"Culture is seen as the most important criterion in assessing the viability of a successful supplier partnership. It describes the underlying business methodology and operating values that will be the key to ensuring success or failure within the relationship."

To illustrate further, the Japanese vehicle assemblers select their preferred suppliers on the basis of assessments on the factory, plant, equipment and products, but then move quickly on to examine the management and their attitudes. It was clear that companies such as Toyota are more interested in the supplier's potential to change their technological processes and their instinctive attitude to talk to other firms, at least in their own locality. A senior member of Toyota's board of directors added,

"When assessing new suppliers, we look at supplier performance such as delivery, engineering capability, cost performance and their general attitude. We are 'subjectively objective' here ... the criteria that we measure against is not just the number of defects per million parts, but it is Toyota representative's individual assessment of what the supplier's research and development capability is. It's a general feeling. We also look very closely at the management team and their attitude. stability and capabilities ... these are, without doubt, the most important attributes. If the management don't possess the right qualities then most of the other areas can not progress. If they have a closed attitude to new concepts and regimes, and are unwilling to take on board constructive criticism then they are not thinking in a positive vein. They must be customer orientated."

The NEDO survey highlights Nissan's distinctive approach in selecting suppliers. It is interesting to note the similarities to Toyota, ie in a team-based, informal approach,

"Initially, the assessors looked at the factory, plant, equipment and products, but then moved on quickly to examine management and people and their attitudes. Most of the suppliers recognised that they did not fully meet Nissan's requirements, but that the assessors were more interested in their potential. When touring the factory, the Nissan assessors paid great attention to such details as cleanliness, age of shop workers, how busy they were, and how many machines were working."

In a case study of supplier relations, Dubreil et al (1993) also concluded that in a assembler-supplier partnership, shared values are more important than legal contracts.

"Renault Purchasing spent great effort up-front to qualify the supplier in terms of business soundness and 'values'. ... There were problems but they were often solved rapidly by direct telephone conversation."

The following factors draw distinctions between the aligned and non-aligned suppliers in terms of culture.

Examples of the characteristics in table 6.2:

21. Greater alignment:

"Our 'two triangle' philosophy shows that our customers are equally important to us and without that interdependence we can't achieve the best thing for our customer. The second triangle is saying that without quality you can't have training and you can't have profit ... we're talking about respect for everyone from everyone through trust and ability." (Reference AS3)

"Market intelligence, both from consultants but more crucially by staff getting out into the marketplace, testing the claims of the opposition, or looking for needs, is essential." (Reference AS3)

22. Traditional, internally focussed company:

"Rover are continually saying to us, 'you haven't got X', so we get it in." (Reference AS5)

"We could be dead in seven weeks time. It's no good talking strategy in this business or innovation." (Reference AS2)

23. Customer-orientated:

"We do very little R & D. We have an Engineering department which satisfies our customers' needs." (Reference AS8)

"You must get into the mind of the customer even when the customer doesn't know his own mind." (Reference AS7)

"I believe that we have to work together to provide the Japanese transplants with a service which will stop them bringing in their own suppliers." (Reference AS16)

24. Continuously improve performance:

"Some buyers can't buy into the concept of partnership intellectually. They are in a culture which can't do it, and they are unwilling to do it." (Reference AS23 referring to particular motor vehicle assemblers.)

6.3.9 Balance of power:

In addition to cultural differences, there will often be perceived power difference between the organisations, (UMIST (1994)). For example, when a large firm develops and markets a novel technological breakthrough provided by a small firm then the perceptions of where the balance of power lies may take priority. Problems with power differences may also extend beyond the organisational level to the individuals within the partnership team. Hardy, Turrell and Wistow (1992) note that collaborations work best if the individual members perceive themselves as being of approximately the same status. However, this can be difficult to achieve if the partner firms differ in size and have aims which make the alliance more important for one firm than another. Huxham (1991) makes the point that 'core groups often end up involving middle managers from large organisations and senior managers from smaller ones. Even if senior managers from large organisations get involved at the start, the pressure to delegate management of the collaboration to an operational manager is large. This means that there may be imbalances in the degree of autonomy to act that different core group members have, especially if the larger organisation is highly bureaucratic.' Dodgson (1994) notes the human-centred problems for scientists and engineers in different organisations working alongside each other with varying levels of technical competence, 'Specialist vocabulary may not be common, understanding of the latest research techniques or findings may not be shared. Unequal competences result in delays and diversion of efforts as the weaker partner is brought up to speed.'

Macbeth (1994) draws a comparison between adversarial and collaborative relationships using a common framework of categories, (cited earlier). One category relates to personal (managerial) attitudes and behaviour displayed by the players in each organisation. The author notes that in a collaborative relationship, 'power is recognised as two-edged and as residing in both sets of hands, so it is kept in the background and not used or even threatened: it is not seen as a solution to most problems. In an adversarial relationship purchasing power is used explicitly and often in a threatening manner by customers, while the supplier uses the threat of disrupted supply as a bargaining ploy.'

In many respects, the examples that follow reflect Macbeth's distinction in relation to power.

Examples of the characteristics in table 6.2:

27. Purchasing power is not used:

(See 28, below)

26. Purchasing power is explicit and visible:

"We have got situations with Rover where we are being played off other suppliers ... that's not a partnership." (Reference AS14)

"Unless you threaten to discontinue supply, they will not help you in any way." (Reference AS4)

27. Power is two way and hidden:

"Our relationship with Rover has been riddled with ultimatums." (Reference AS5)

28. Purchasing power is rarely used:

"We're only making partnerships together to try and enhance our own business situation. If the partner becomes uncompetitive, then unless they've built some good barriers to stop me moving, I'll move to another supplier". (Reference: AS24 referring to partnerships with their own suppliers)

"We offer them the option of being our sole suppliers, but they've got to give us a lower price to get that business. That's the only reason we're doing it. It's not that we want to be in partnership, we want to get the cost down." (Reference AS24)

"You have to know the people with the authority to take the most points off." (Reference AS23)

This last point completes the presentation of characterising the broader contributory factors. This evidence will be returned to in the next chapter when all the three measures of data analysis are merged. Figure 6.4 re-introduces the various partnering fields and levels from chapter five and transposes the 28 broader contributory factors.

To sum up, two measures of data analysis has been considered and applied: the qualitative evidence and the TPPI measure of evidence. Together, they help to distinguish the partnering capabilities of the firms' interviewed and place them in the context of the four levels of partnering identified. However, the subjectivity element of both measure is still too great to be ignored.

Consequently, some quantitative data was collected and later analysed in relation to the first two measures. It ought to be noted that despite considerable effort to collate all the records, some firms' financial records could not be traced hence only 23 from 29 records are summarised here.

6.4 Establishing the independent evidence: Quantitative analysis of the data

Table 6.3 below depicts the sample of firms and their overall rank in terms of profitability as well as liquidity over the four year period, 1989 through 1992. The industrial group that each firm generally falls under is given as well. Clearly, profit margins and liquidity positions will vary from the innovatory and growing electronics sector to the mature metal presswork sector.

Figure 6.4

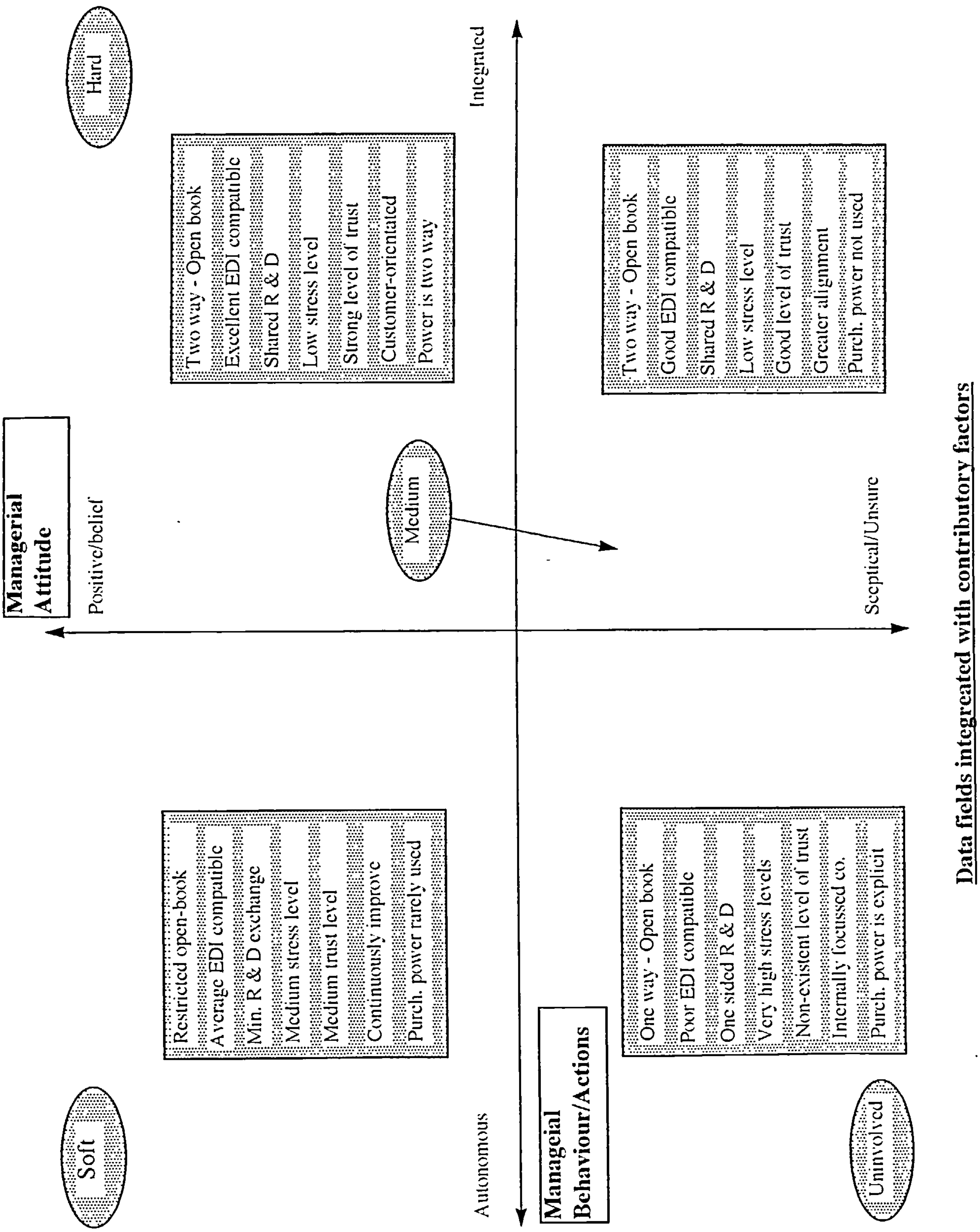

Managerial Attitude
Hard
Soft
Medium
Uninvolved
Integrated
Autonomous
Positive/belief
Sceptical/Unsure
Two way - Open book
Excellent EDI compatible
Shared R & D
Low stress level
Strong level of trust
Customer-orientated
Power is two way
Two way - Open book
Good EDI compatible
Shared R & D
Low stress level
Good level of trust
Greater alignment
Purch. power not used
Restricted open-book
Average EDI compatible
Min. R & D exchange
Medium stress level
Medium trust level
Continuously improve
Purch. power rarely used
One way - Open book
Poor EDI compatible
One sided R & D
Very high stress levels
Non-existent level of trust
Internally focussed co.
Purch. power is explicit
Manageial Behaviour/Actions
Data fields integreated with contributory factors

Table 6.3: Motor Component Suppliers: Overall Profitability and Liquidity Rank

Profitability Rank	Company Code	Industrial Group	Liquidity Rank	Company Code	Industrial Group
1st	AS6	Metal Industry	1st	AS19	Metal Industry
2nd	ASMP	Plastics	2nd	AS22	Metal Industry
3rd	AS16	Metal Industry	3rd	AS9	Metal Industry
4th	AS25	Metal Industry	4th	AS3	Metal Industry
5th	AS11	Plastics	5th	AS24	Metal Industry
6th	AS5	Metal Industry	6th	AS17	Transport Equip.
7th	AS7	Plastics	7th	AS8	Metal Industry
8th	AS20	Plastics	8th	AS4	Electronics
9th	AS12	Electronics	9th	ASMP	Plastics
10th	AS21	Electronics	10th	AS7	Plastics
11th	AS14	Plastics	11th	AS25	Metal Industry
12th	AS17	Transport Equip.	12th	AS5	Metal Industry
13th	AS19	Metal Industry	13th	AS12	Electronics
14th	AS8	Metal Industry	14th	AS18	Transport Equip.
15th	AS9	Metal Industry	15th	AS26	Metal Industry
16th	AS4	Electronics	16th	AS21	Electronics
17th	AS18	Transport Equip.	17th	AS27	Transport Equip.
18th	AS5	Metal Industry	18th	AS20	Plastics
19th	AS24	Metal Industry	19th	AS11	Plastics
20th	AS26	Metal Industry	20th	AS16	Metal Industry
21st	AS27	Transport Equip.	21st	AS14	Plastics
22nd	AS22	Metal Industry	22nd	AS6	Metal Industry
23rd	AS2	Metal Industry	23rd	AS2	Metal Industry

Perhaps not surprisingly, AS2 which ran into financial difficulties earlier this year ranks last on both counts. Some of the indicators above can perhaps be best explained by the influence of the parent group. For example, AS7 is owned by Eagle Pilcher, an American firm which demands all its subsidiaries to achieve above average profits while AS11 is owned by BTR which expects from its subsidiaries a consistent high return on assets.

A simple comparison between the top ten financial performers above in terms of profitability and the top seven TPPI performers highlighted above reveals that four firms appear in each category, namely, AS16, AS7, AS11, AS25. Again, these four firms will reappear in a later discussion when it comes to the important exercise of determining the characteristics of the best performing companies in terms of technology partnering.

At this stage of the analysis several points should be borne in mind. First, thirty companies were interviewed yet only twenty three firms' financial data was able to be collected. Because the sample size is small it was not considered appropriate to subject it to the full range of statistical analyses. The firms that ranked high in terms of profitability against the whole sample above were then matched, in terms of sector, age, geographical location and size, with twenty three other firms whose partnering performance was unknown. The point was to assess the financial strength of the known group - and, more importantly, the top performers - with other firms *regardless* of their partnering capabilities. The results are shown in Table 6.4.

Table 6.4

RANK	*PROFITABILITY SCOREBOARD*
1st	**AS6**
2nd	ABB Control
3rd	**AS16**
4th	**ASMP**
5th	**AS25**
6th	Control Techniques (Midlands)
7th	**AS7**
8th	**AS11**
9th	**AS3**
10th	Walsall Pressings
11th	Weston Body Hardware
12th	**AS20**
13th	**AS14**
14th	**AS12**
15th	Harlow Pressings
16th	Adamant Engineering
17th	Fern Plastic Products
18th	**AS17**
19th	Eldon Electric
20th	Carando Elliot
21st	Regent Eng (Walsall)
22nd	Kigass Engineering
23rd	**AS9**
24th	**AS21**
25th	**AS8**
26th	**AS19**
27th	Ravenscroft Plastics
28th	Silkmead Tubular
29th	Belsix Engineering
30th	Combined Optical Industries
31st	**AS4**
32nd	NFI Electrical
33rd	Cousins, Whitehouse & Co
34th	**AS24**
35th	**AS26**
36th	**AS18**
37th	**AS5**
38th	**AS2**
39th	NCJ Precision Pressings
40th	Supra Acoustics
41st	**AS27**
42nd	Birmingham Stopper
43rd	Luneside Eng Co
44th	J.L. Float
45th	Cooksons
46th	Arden Products (Kenilworth)

Again, this tabulation indicates that firms AS16, AS7, AS11, and AS25 are still the best financial performers amongst an even wider group. However, it indicates very little about the strength of their partnering capabilities.

So far in the quantitative analysis, the financial data relating to each company in terms of profitability has been recorded and organised. The reasons for selecting this indicator ahead of others was made clear in chapter five. Some simple comparisons between the semi-quantitative and the quantitative data analysis using spreadsheets were undertaken, (for examples of this work, see Appendix E). However, the nature of this relationship is still, at this stage, little more than coincidence. It is still too early and ambiguous to suggest that a good technology partnering outcome solely resulted in a good overall financial performance.

The next section considers some of the interrelationships between these two components as well as reintroducing the qualitative evidence. Here, some SPSS tests are performed to establish, statistically, if any relationships exist. In addition, it considers the assumptions about why firms set up technology partnering arrangements and question what can be realistically expected to follow. For example, it was noted in chapter one the many reasons why firms enter into technological collaborative arrangements. Thus, it can be reasonably assumed here that firms, on the whole, expect to see a positive economic result deriving from that arrangement. The central question here is: *To what extent does technology partnering affect company performance?*

6.5 Inter-relationships between the data: Discussion

To study the extent of this effect, the nature of the analysis involved looking at historical (3 - 4 year financial data of each firm visited) alongside the TPPI results.

A series of 'interrelationship tests' were performed and grouped into five classes:

Test Class One: The TPPI input variables in relation to each other,

ie Variable A: Degree and depth of technology scanning, in relation to variable F: Frequency of inter-firm multi-disciplinary meetings.

Test Class Two: The TPPI input variables in relation to the groups,

ie Variable A, in relation to group 2: Internal and External Linkages.

Test Class Three: The TPPI input variables in relation to the quantitative data,

ie Variable A, in relation to the patent intensity measure, ROCE, and sales growth.

Test Class Four: The individual groups in relation to other groups and quantitative data.

Test Class Five: The proportion of business that each supplier has with each of the major vehicle assemblers, in relation to each of the input variables, groups, and quantitative data,

Table 6.5 summarises the correlation coefficients.

Discussion of these results:

Test Class One and Two: The initial aim of these tests were to establish the variables with the strongest relationship to each other. The early tests in this class included over 12 input variables such as 'Duration of trade with main customer'. This exercise helped to narrow down the field. This test suggests, perhaps not surprisingly, that strong relationships exist between the TPPI variables. For example, a good relationship exists between Managerial Attitude and all other variables.

Test Class Three explores the relationship between the various TPPI input variables and the independent quantitative data collated, ie patent intensity, ROCE, and Sales Growth. The relationship is generally poor or non-existent. However, one trace of relationship is shown between Variable A: Degree and Depth of Technology Scanning with Sales Growth.

Test Class Four shows yet again a poor relationship. However, Group One (Prior Knowledge) appears to have a good relationship with Sales Growth.

Table 6.5: Correlation coefficients using SPSS

Correlation Coefficients using SPSS

Class/Group	A	B	C	D	E	F	G	H	GP 1	GP 2	GP 3	PAT	ROCE	SALES
AUTOMOTIVE														
A	1	0.7038	0.7063	0.7115	0.6255	0.5061	0.7254	0.7503	0.9335	0.7678	0.6823	-0.0166	0.396	0.5616
B		1	0.7092	0.5684	0.6838	0.3261	0.727	0.7839	0.9118	0.7064	0.6469	0.1294	0.388	0.4126
C			1	0.6923	0.7456	0.4282	0.8183	0.8193	0.7664	0.9477	0.7504	0.1187	0.2404	0.4596
D				1	0.5932	0.6601	0.7049	0.6593	0.6984	0.8864	0.7193	0.2134	0.0979	0.3155
E					1	0.5991	0.8383	0.8388	0.7068	0.7407	0.9274	0.1309	0.2548	0.3321
F						1	0.5688	0.4958	0.4573	0.5666	0.8011	0.174	-0.1767	0.1639
G							1	0.9615	0.7865	0.8368	0.9104	0.2813	0.3148	0.3774
H								1	0.8295	0.8172	0.8633	0.2254	0.3594	0.4164
GP 1									1	0.8005	0.7211	0.0557	0.4249	0.533
GP 2										1	0.7995	0.1705	0.1975	0.4344
GP 3											1	0.2258	0.1481	0.3191
PAT												1	-0.2061	-0.2256
ROCE													1	0.4599
SALES														1
FORD	0.164	0.0686	0.0492	0.0205	0.0436	0.2322	0.1778	0.2311	0.1236	0.0407	0.1664	-0.555	0.0228	0.1014
GM	0.3149	0.2478	0.2653	0.1207	0.4066	0.2819	0.3465	0.3792	0.3056	0.2241	0.3866	0.316	0.1814	0.032
HONDA	-0.2326	-0.1534	-0.1591	-0.1277	-0.1844	-0.1094	0.1348	-0.1542	-0.2108	-0.1587	-0.1369	0.1141	-0.0827	-0.1426
JAGUAR	-0.2042	-0.2737	-0.1702	-0.1312	-0.1991	-0.1218	-0.2381	-0.3103	-0.2553	-0.1674	-0.178	-0.0342	-0.2166	-0.2752
NISSAN	0.2032	-0.0777	-0.1654	-0.0508	-0.1701	-0.0423	-0.1791	-0.1277	0.0771	-0.129	-0.1768	-0.0587	0.0913	0.2114
PEUGEOT	-0.0071	-0.1142	-0.0515	0.0495	-0.2082	0.1033	-0.0201	-0.0573	-0.0618	-0.0115	-0.0647	0.292	-0.3703	0.0074
ROVER	-0.0344	-0.0425	0.0324	0.0114	-0.074	-0.351	-0.1299	-0.1091	-0.0412	0.0259	-0.2081	-0.3253	0.2805	0.2652
TOYOTA	-0.0566	-0.072	-0.1131	-0.2429	-0.1514	-0.1204	-0.2376	-0.23	-0.0688	-0.1795	-0.1983	0.0656	-0.1625	-0.1754
OTHER	-0.2092	-0.3156	-0.144	-0.1059	-0.0403	-0.1894	-0.1391	-0.1501	-0.2794	-0.1394	-0.1272	0.0131	-0.2061	-0.2256

Class/Group	Mean	Std Dev	Minimum	Maximum
AUTOMOTIVE				
A	3.28	0.92	1.00	5.00
B	2.17	0.98	1.00	4.00
C	2.52	1.09	1.00	4.00
D	3.28	0.75	2.00	4.00
E	3.00	1.36	1.00	5.00
F	4.00	1.22	2.00	5.00
G	3.00	1.28	1.00	5.00
H	55.34	20.00	20.00	85.00
GP 1	54.48	15.94	20.00	80.00
GP 2	57.93	16.98	30.00	80.00
GP 3	67.03	21.73	33.00	100.00
PAT	0.14	0.38	0.00	1.88
ROCE	9.57	21.41	-32.57	61.27
SALES	6.91	11.12	-9.00	32.50
FORD	14.09	16.52	0.00	42.00
GM	6.54	8.27	0.00	20.00
HONDA	2.14	4.63	0.00	20.00
JAGUAR	4.23	10.19	0.00	40.00
NISSAN	8.50	16.01	0.00	80.00
PEUGEOT	3.07	8.46	0.00	36.00
ROVER	37.07	23.81	0.00	85.00
TOYOTA	2.18	3.70	0.00	10.00
OTHER	14.50	13.26	0.00	47.00

Key:

Group 1	Technical Ability
Group 2	Internal and External Linkages
Group 3	Relationship Strategy
A	Degree and depth of technology scanning
B	Number of professional engineers
C	Alliance organisation and structure
D	Range of external organisations consulted
E	Frequency of technical personnel exchange with customers
F	Frequency of inter-firm multi-disciplinary meetings
G	Receptivity toward partnering
H	Overall impression of supplier with regard to its strategy and managerial attitude toward partnering
PAT	Patent Intensity
ROCE	Return on Capital Employed
SALES	Sales Growth

Test Class Five provides some interesting insights. Section 6.1 noted that when assemblers select suppliers with a view to partnership, they look for a compatible managerial attitude. This test examines the relationship between the level of business to the UK-based vehicle assemblers to the TPPI variables especially variable H 'Overall impression of supplier's strategy and managerial attitude toward partnering'. It was found that given the sample of some 30 companies, the Rover Group is the largest customer (the average proportion of business supplied to Rover is 37 per cent while the Ford Motor Company occupy second place with just 14 per cent). Overall, the relationships are very poor. In particular, there are three points to note:

- In this analysis, there is no relationship apparent between 'managerial attitude toward partnering' (Variable H) and the level of business supplied to each customer.

- The extent of a company's internal and external linkages has no bearing whatsoever on the level of business supplied to customers. There are many other factors involved.

- Similarly, a supplier's 'relationship strategy' as defined here has no impact on the level of business.

Given the magnitude of variables that come into play and affect such factors as how much business should a firm aim to supply to one customer and why, we should not be surprised that little or no relationships have emerged here.

In summary, the SPSS correlations coefficient results indicate, statistically instead of the visual use of basic spreadsheets, that in nearly every case of relating technology performance with financial performance, the trend is in the right direction. However, the actual gradient of the slope is too weak to be able to place any reasonable reliance on the result. *In other words, no statistical conclusion can be drawn from these findings.*

The counter-argument is that we can not expect to see a strong relationship between sales growth or return on capital employed and the technology partnering performance indices. The financial performance indicators can be influenced by many other variables, for example, a key member of staff joins/exits the firm, a new product is launched, extra production capacity is made available, etc.

The following considers some other expectations of the analysis, in particular, two areas exploring the direct effects of company size and its innovativeness on a company's technology partnering performance.

Briefly, as cited earlier in chapter three, (proposition one) large firms are often better able to 'spare' and direct human and capital resources towards a technology partnership or informal linkage with a small firm. Berg at al (1992) found that size of the firm has a positive effect on joint venture participation. This correlation can be explained by better and more opportunities to seek external linkages for instance through economies of scope. The author states that the size of companies and innovation a direct effect of size of firm is assumed and refers to a number of qualifications which are necessary for this effect. In the classical Schumpeterian and Galbraithian theory research output (patent intensity) increases more than proportionally with firm size. The classical counter-argument is provided by Bain (1956), who stated that small companies were more innovation-efficient, whereas larger firms suffer from 'creative backwardness'. Others, for instance Freeman (1982), mention industry-specific circumstances with a positive relationship between size and innovation in R & D intensive industries and/or industries where economies of scale are decisive, for example, pharmaceutical, and aerospace.

Widely accepted is the view by Scherer (1965) that both R & D input and output (patents) tend to rise less than proportionally once a threshold has been passed, which leads to an 'inverted U-shape' distribution of size and innovation. Empirical studies by Mansfield (1984), Philips (1971), and Mueller (1986a) support this view of non-linearity, usually with the exception of the chemical industry where a linear relationship is found

The finding in this research with respect to company size was mixed. (See Appendix E). The preliminary conclusion drawn at this stage was that small firms are either very good or very bad at technology partnering but large firms often occupy the middle-ground. In other words, small firms often display differential ability. Inevitably, for small firms attempting to work in partnership with larger firms with different strategies, structure, systems and cultures is a very difficult and time consuming process as well as tension ridden.

Figures E2, E3, E4, and E5 highlight the otherwise weak relationship between each firm's technology partnering performance score and its company size, (measured by annual sales turnover, number of staff employed and amount of capital employed in the business).

Another line of enquiry to establish how good or bad a firm was at technology partnering related to the number of patents it has applied for. This can be assessed by its *patent intensity*, ie measured by the total number of assigned patents set against the number of years each firm has been trading. The us of patents as a reliable metric of innovativeness of companies is widely accepted in the literature, (Patel and Pavitt (1991)). Unfortunately, due to lack of information, we can not apply an R & D intensity measure.

If it can be assumed that innovative firms attract partners to develop technology further, then one expectation is to see a higher patent intensity amongst innovative firms. Furthermore, the expectation of a high correlation between patent intensity and the intensity of technology alliances is based on a number of characteristics of inter-firm cooperation. Hagedoorn (1993) noted how technological complementarity of partners, concrete development of innovations and the need for technology monitoring are important motives for forming alliances. Therefore technologically capable firms are to achieve a higher degree of 'courtship' than less innovative firms. This assumption is supported by Hladik (1985) who found that positive effects on successful cooperation in joint ventures and the occurrence of cooperation are, amongst other things, related to *the similarity of partners with respect to technical assets.*

It may be expected that a high patent intensity to have a positive impact, albeit moderate, on the financial performance of the firm. Where a patent was assigned, say in 1987, then we might reasonable expect to see the benefits of that patent within the firm's financial statements in 1989 and/or 1990.

In summary, it may reasonably be expected that those firms with a high technology partnering performance indices score will also exhibit a higher than average patent intensity rate. It might also be anticipated that those firms with a higher than average patent intensity rate will demonstrate a similar return on capital employed and sales growth performance.

The results indicate, however, that there is only minimal correlation between patent intensity and the technology partnering performance indices and the financial measures. (for an example of an SPSS test, see Appendix F). The patent intensity 'test' was carried out for both motor and offshore industries. The mean r2 statistic for the motor industry suppliers was 0.14 while the mean correlation for the offshore suppliers was 0.25.

In theory, the degree of cooperation or at least its 'preparedness' should affect the innovativeness of firms that participate in technology partnering. If we use the patent data to measure a company's innovativeness, then it is still difficult to check the direct effect except where a clear partnership exists and the patent was submitted and approved during the period of the arrangement. Given the patent data relates to each firm's entire lifetime, then again we can not rely on such results. In this sample, it may be argued that because many things affect and radically change a firm's financial performance - even a small firm - then only where the company earns an annual sales turnover of less than £ 1m can a new innovation be expected to impact the accounts so strikingly. Overall, no proper conclusion can be made about the relationship here between a supplier's patent intensity or innovativeness and its financial performance.

6.6 Preliminary conclusions:

There were several findings/outputs resulting from the application of the three measures of data analyses. **The first finding** related to the fact that, overall, the strength of the interrelationships between the TPPI results and quantitative data was weak. The question initially posed in section 5.4 was: To what extent does technology partnering affect company performance? Through interrelating the TPPI and independent financial performance evidence using a statistical software package, the conclusion was that no statistical conclusion could be drawn from the analysis, presumably because of the many other factors affecting company performance.

Given this position, the effort switched back to exploring the qualitative and TPPI evidence. Here, a collection of broad contributory factors to technology partnering emerged while pursuing the lines of enquiry set within the propositions. These factors were each sub-divided to illustrate four different levels. For example, figure 6.1 suggested four distinct research and development activity levels as undertaken by the supplier or assembler and may be characterised by either (i) shared for the purposes of reducing costs; (ii) one sided and a minimum share arrangement; (iii) shared for development; or (iv) a minimum exchange where there is considerable reliance on the supplier's parent for innovative developments. Each characteristic equates to a 'managerial behaviour/attitude' field in the same way that was first described in the last chapter, (figure 5.1).

The second finding was the identification from the qualitative data of four distinct levels of partnering arrangements, bounded along two dimensional axis characterised by managerial behaviour and attitudes offered 'fields' of partnering activity. The TPPI results showed some divisions in the field sample. These results helped to position each firm within the fields.

The third finding was related to the TPPI measure of analysis and the importance for firms to network; an area already highlighted within the propositions. Chapter two considered the literature in relation to the role of networks to support the innovation process. It pointed towards the growing body of research which finds evidence of networking as a key factor to expansion. In particular, the TPPI analysis showed a clear division between the top seven performing companies and the bottom eight with regard to external sources of advice. Section 6.2 highlighted that the top partnering performers are much more closely linked to the local business network. In addition, the TPPI analysis showed that the top performers employ a greater proportion of qualified scientists and engineers to other staff than the bottom quartile group. In fact, the better firms employ over 20 per cent of QSE to other staff whereas firms ranking lower down the TPPI employ less than 10 per cent.

Overall, the two most important measures of data analysis are the qualitative and the TPPI sets. The quantitative proved insignificant in relation to this research project because the benefits of technology partnering arrangements on the firms are not always quantifiable and are generally long term. Consequently, this measure of analysis is not pursued within Phase Two.

Chapter Seven: Some factors associated with good technology partnering practice emerging through case studies

7.1 Introduction:

The previous chapter aimed to convey an evolving picture of the research output. It first presented three measures of data analysis, namely, qualitative, TPPI and quantitative. The interrelationships between these measures were then explored to help further identify any characteristics that may be present in successful technology partnering arrangements. The Technology Partnering Performance Indices (TPPI) was designed to provide a stepping stone between the research propositions and the important task of appraising what the characteristics of the best performing companies were in terms of technology partnering. Several findings were highlighted which arose from the development of the conceptual framework, ie identification of partnering fields and levels, as well as finer points relating to, for example, the range of external sources of technical advice firms turn to for help.

In this chapter, the focus is on pulling together these findings in order to establish what characteristics are prevalent in the more adept firms at technology partnering. Section 7.2 represents an important part of the thesis where the qualitative and semi-quantitative evidence are brought into focus. At this stage, it is worth reiterating that the interpretation of the qualitative data and the subsequent analysis does not aim to provide an absolute measure of technology partnering arrangements but simply aims to make sense of the data. The point is to try to understand what is happening within the various types of partnering arrangements and impose framework around which to make sense of the interview transcripts. The previous chapter also highlighted a group of firms that appeared to excel at technology partnering in relation to the rest of the sample. During telephone conversations with major purchasers (Vauxhall (1995), Peugeot (1995), Toyota (1995) and Nissan (1995)) this group also ranked favourably. This evidence is also considered in this section.

In order to display the specific properties of particular partnering arrangements uncovered in the research project and to act as a stepping stone on the guide to best practice, section 7.3 presents three case studies. These case studies depict three firms (of various size) in partnership with either larger firms or orchestrating a partnership with a group of firms. They aim to be sufficiently varied to help illuminate some of the key issues in a technology partnership. These case studies extend and characterise the four main managerial behaviour/attitude fields and levels presented in chapter six. Each case study is accompanied by a conceptual map which summarises the technology partnership evolvement. Later in the thesis, further questions are posed and explored with regard to these fields. For example, are there a group of firms located in a field which largely supply one particular assembler? A comparison between two motor component suppliers is also presented. The point here is to help highlight the managerial attitude and behavioural approaches to partnering displayed by two firms with many demographic similarities yet have a very different approach to partnering.

Section 7.4 presents a matched pairs comparison of the data as an alternative to the more general correlations and interpretations of scatter diagram data.

Section 7.5 explores further the network effects discussed above and considers how important it is for a component supplier to establish technical contacts within and outside the industry in order to improve its knowledge base. It takes a brief look at three current industry-specific initiatives directly or indirectly aimed at encouraging the flow of information and knowledge between firms. These initiatives are of diverse membership size, aims, and direction yet common to all is the opportunity for proactive or receptive firms to meet and understand each others' capabilities. Other facilitating organisations and mechanisms are also cited.

7.2 Merging the findings: Some preliminary conclusions:

7.2.1 Introduction:

The aim now is to bring together all of the findings in order to determine the more adept firms at technology partnering. As far as the qualitative data is concerned, the broader contributory factors to technology partnering, case study material that follows, comparison studies, supplier service award evidence as well as direct statements made by various purchase managers, and information collated on industry initiative membership may all be used to position a firm within one of the four partnering fields. The TPPI measure also serves as a valuable tool in placing each firm. The point is to identify with greater confidence the characteristics that represent best practice technology partnering. Given the quantitative evidence in relation to the other types of evidence showed a very weak association, this analysis set is not reintroduced here.

Four levels of technology partnering activity emerged from the initial runs through the fieldwork data. These levels were characterised mainly according to the perceived extent of alliance organisation and knowledge exchange between the partners. As figure 5.1 first indicated, each level is then bounded in fields by differing managerial attitudes and behaviour toward the partnership. Managerial behaviour and attitude are separated here. This section will conclude depicting figure 5.1 with each firm interviewed positioned within the various fields. This will be achieved using a scoring procedure described below, (table 7.1).

Before continuing, it is worth reiterating the points made in chapter five with regard to managerial behaviour. In a partnering arrangement, behaviour may be assessed given a historical description of an alliance organisation, structure and progress, managers attitude and beliefs may be gauged during interview. The distinction was made here because managers often appeared to behave in a partnering relationship within normative boundaries yet hold other beliefs about the actual value of technology partnership.

For example, ASPO are a French company that set up a car bumper manufacturing division in 1986 at Telford in a £2m investment. They employ over 300 people and earn an annual sales turnover in excess of £30 m.They manufacture in all types of plastic specialising in fluorinated resins, PTFE products. The Managing Director was interviewed to establish the level and depth of their technology partnerships with other firms.

ASPO became involved in one cost-down exercise with a major assembler concerning a front bumper. Since the launch of this particular model, the firm has supplied front bumpers on a synchronised basis to the assembler. The bumper was made with two small fog lamp covers which were painted separately from the bumper. These covers could left in or taken out and replaced by fog lamps depending on the customer's order. In the event of the lights being fitted, the covers would be thrown away.

The supplier suggested that instead of painting the fog lamp covers separately that they spray the entire bumper assembly thus eliminating the separate paintwork cost. The assembler's initial reaction was negative because when the cover was taken off, it left a black 'ring' mark. However, it was found that the fog lamp itself covered this mark. Despite convincing the assembler that the process elimination would save 'substantial' costs, they were still relatively slow or resistant to change largely due to their dislike of changing a process once it is in full production. Eventually, the process change was accepted.

This example provides some indication of how a concentrated 'partnership' exercise was undertaken and what was achieved. In particular, it highlights the behaviour of the supplier management, ie their proactive stance towards solving the problem and achieving a good result.

The MD then considered the barriers to otherwise progressive partnerships and highlighted middle management factors and reward structures to blame, adding,

"... this partnership business is not working properly yet inasmuch as the top brass are committed yet the rewards system for people lower down the tree still encourage middle managers to 'beat the supplier around the head' in order to get a salary bonus. The whole management structure is not geared towards partnership. ... It gets very frustrating. For example, in the past 12 months, plastic raw material has gone up dramatically and we have spent a lot of time trying to get the motor industry to accept those price increase. I can do

nothing if BP increase their prices - I can't absorb it so we spend a huge amount of time, energy and stress to get them to accept the new material price increases. It is very difficult ... it is simply not partnership."

This insight into managerial belief is in sharp contrast to the seemingly 'rosy' fog lamp partnership arrangement described above. They behave in a way that is acceptable and 'modern' yet believe that the development of true partnering relationships in the motor industry have a long way to go. Another interesting point arising from ASPO is that the proportion of business accounted for by Nissan, and particularly Toyota, is comparatively small, yet the resources required to support it are disproportionately large. This perhaps reflects the wider view amongst suppliers' that have encountered a continuous pressure from their customers to improve, which often means reducing costs. The transplants focus on their suppliers' manufacturing cost, and work with them to reduce these costs and hence price. These assemblers are also active in helping the supplier to become more efficient to pass on most, if not all, of the savings.

7.2.2 Merging the findings:

Here, the three findings summarised in section 7.1 are merged into a format which may help the process of identifying the better partnering firms. This will involve the use of a scoring system to enable each firm to be positioned within a particular partnering field as table 7.1 illustrates.

The two core sets of evidence used for this summary ultimately rotate around,

a) the qualitative contributory factors to technology partnering - considered in section 6.2, and

b) the TPPI results - presented in 6.3.

The case studies - discussed below - act as a 'check' on the final positions of each firm while the other qualitative evidence such as the direct quotes from assembler purchaser management serve to position each firm with greater confidence.

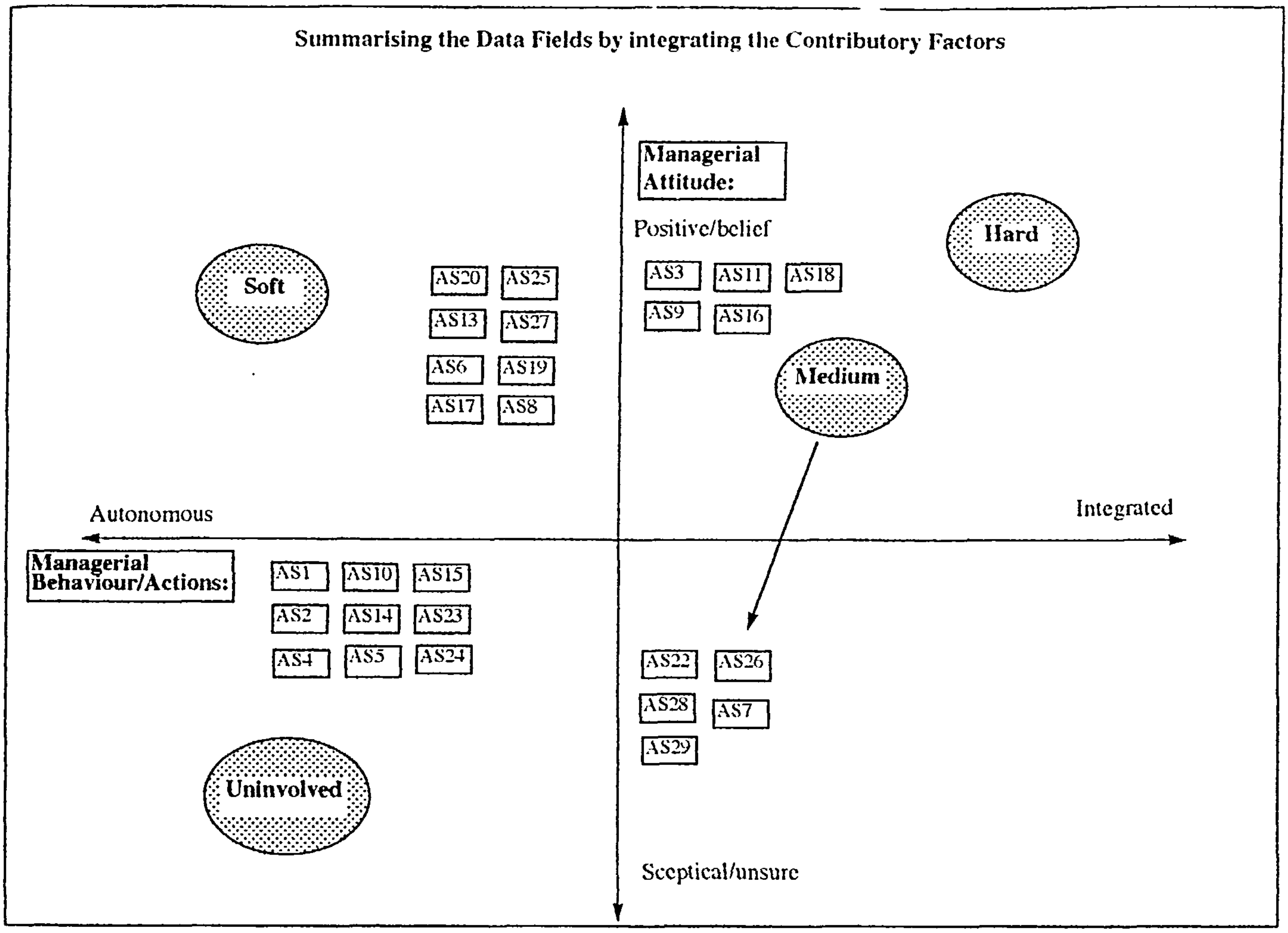
Table 7.1: Aggregate data analysis position system

Data Analysis set	Chapter/section reference	Method of scoring and/or field positioning
I Qualitative:		
(**i**) Broader contributory factors to technology partnering	Chapter 6, Table 6.2	Assess each firm in relation to the factors and position accordingly.
(**ii**) Case studies	Chapter 7, section 7.3	Position in fields as given.
Also, supporting information - Supplier Service Awards and direct quotes from assembler purchasing management and industry initiative data (both chapter seven). The latter may be scored with reference to each firm's number of associations, ie 1 association - soft level, 2 associations - medium level, and 3 associations - hard level.		
II Semi-Quantitative:		
(**iii**) Technology Partnering Performance Indices	Chapter 6, section 6.2	Using the TPPI rank (Figure 6.2) Quartile 1 - Hard Quartile 2 - Medium Quartile 3 - Soft Quartile 4 - Uninvolved

The first step in this exercise was to re-consider the contributory factors to technology partnering. The aim was to review each firm in relation to the contributory factors and sub-levels and then take a view on where each firm may be positioned within the fields. Section 6.3 provided a considerable amount of evidence for this exercise.

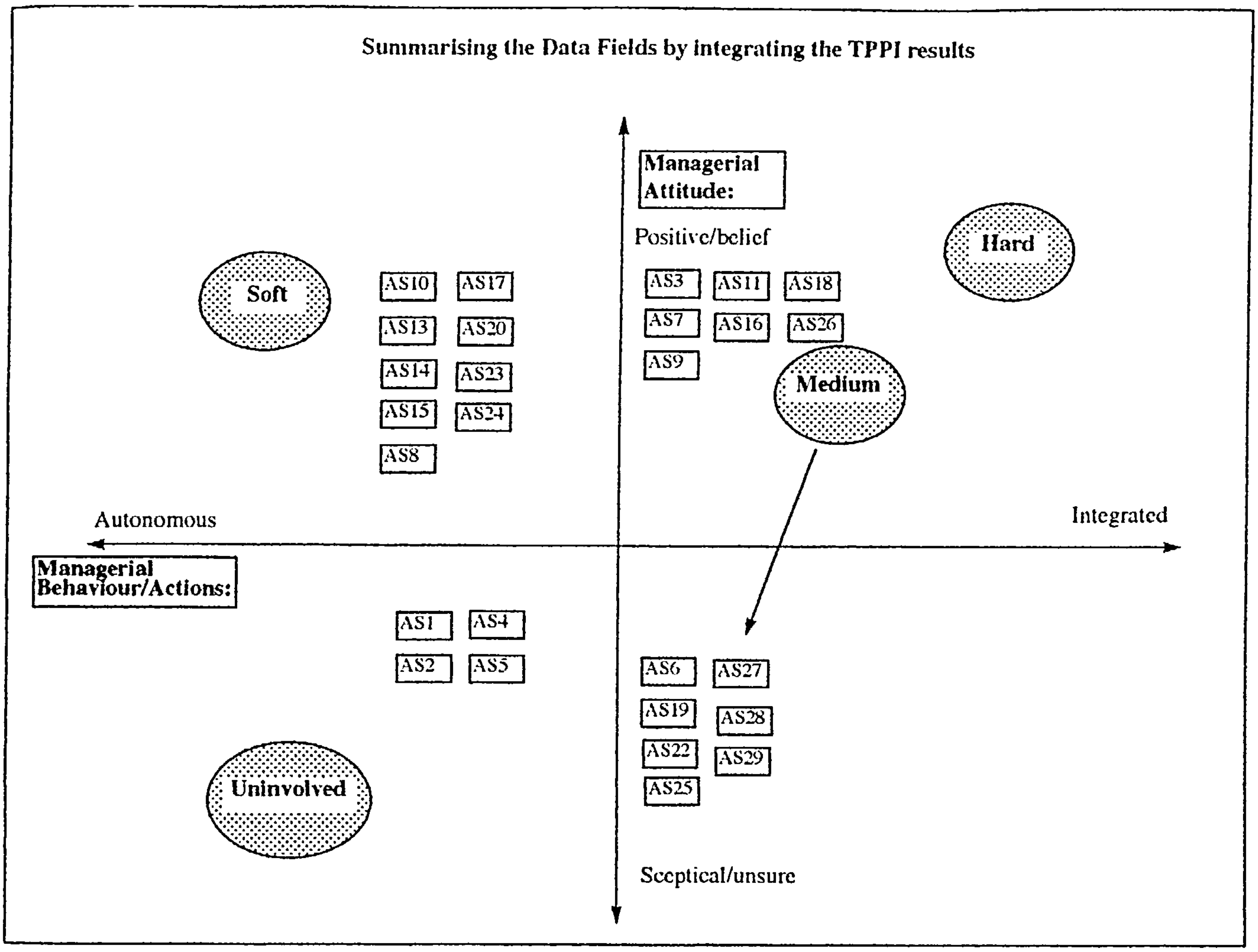
After transposing the component suppliers onto this field grid using the method described above, figure 7.1 conveys the initial positions.

Figure 7.1



Next, the TPPI scores were re-examined in order to transpose the overview of various firms partnering performance onto the fields applying the method described in table 7.1. Figure 7.2 presents these positions.

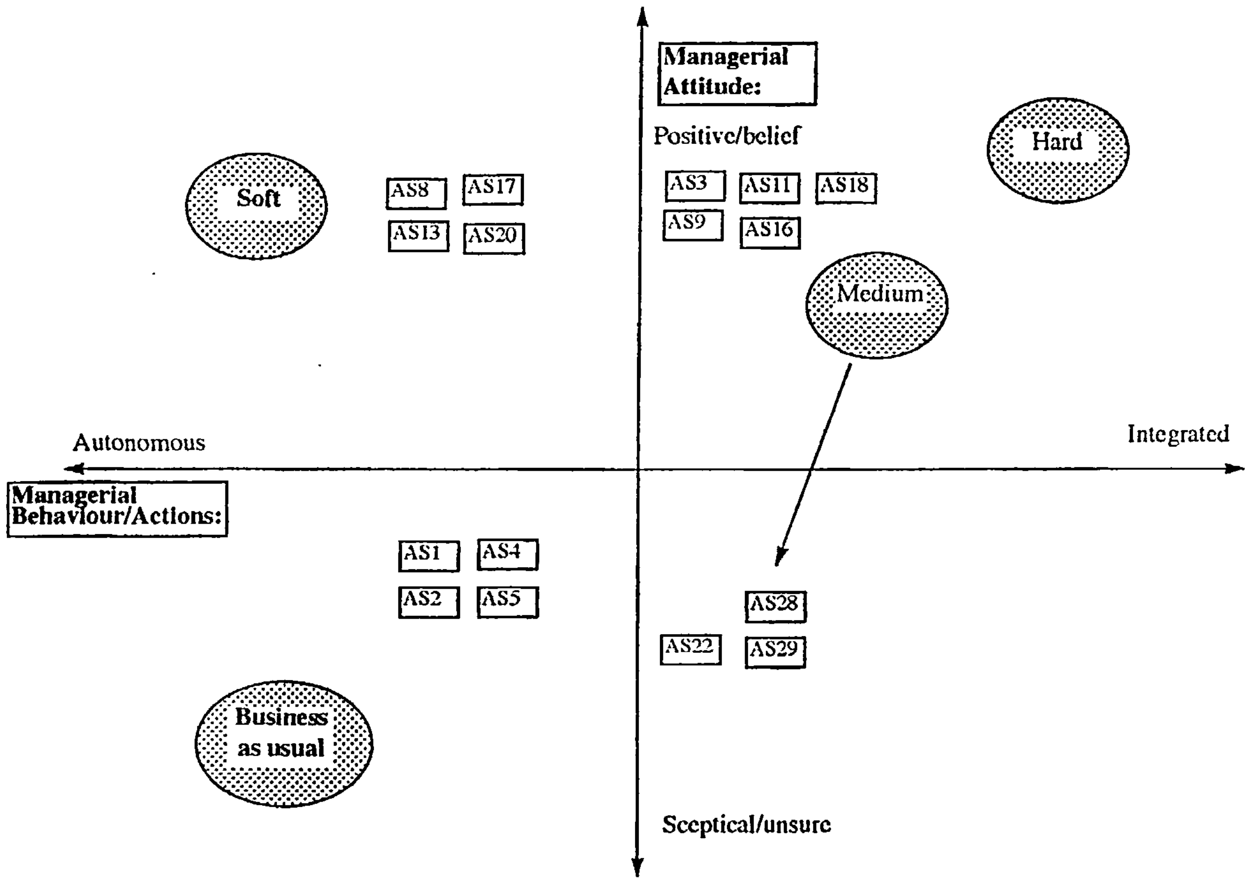
Figure 7.2



Given the subjective nature of this analysis, some slippage or shifting from one field to the next is bound to occur. Those firms that have moved from their position in figure 7.2 are indicated with arrows showing their original position. Despite the 'maverick' nature of some firms, none jumped two position, ie from soft to hard or from uninvolved to medium. Some firms remained in their positions from figure 7.1 to 7.2. These groups are highlighted with figure 7.3 and generally represent the consistent groups at either level of partnering.

Figure 7.3

Overall view of the Data Fields



This figure conveys four distinct groups of firms identified through merging the qualitative and TPPI measures of data analysis. The point being made here is that these firms show evidence of consistently approaching partnering arrangements at particular levels; some develop all or most of their technology in-house making full use of internal expertise, while others engage in a multi disciplined and highly structured alliance arrangement that recognises the formal division of risks and rewards.

It is important to reiterate the point that it is not the intention here to group firms into one box for the sake of further analysing those firms. The aim is to attempt to make better sense of largely qualitative data and broadly streamline firms in relation to their partnering behaviour and outlook. Technology partnering is a process where the technological development is brought into sharper focus as the working relationship evolves and each side gains a better understanding of, and respect for, each others capabilities. The position described above simply represents a snap shot depicting a collection of firms' behaviours and attitudes to partnering.

In terms of this grouping of firms and their respective motives to partnering, the literature provides some interesting guidelines. Hagedoorn (1993) noted how technological complementarity of partners, concrete development of innovations and the need for technology monitoring are important motives for forming alliances. Therefore technologically capable firms are to achieve a higher degree of 'courtship' than less innovative firms. This assumption is supported by Hladik (1985) who found that positive effects on *successful cooperation in joint ventures and the occurrence of cooperation are, amongst other things, related to the similarity of partners with respect to technical assets.* Thus, this supports the belief that there are many similarities between the firms at each level. Section 6.3 first 'speculated' on the facets that appeared to bind the better firms together. The case studies which follow characterise the three active levels of partnering together with some best practice guidelines.

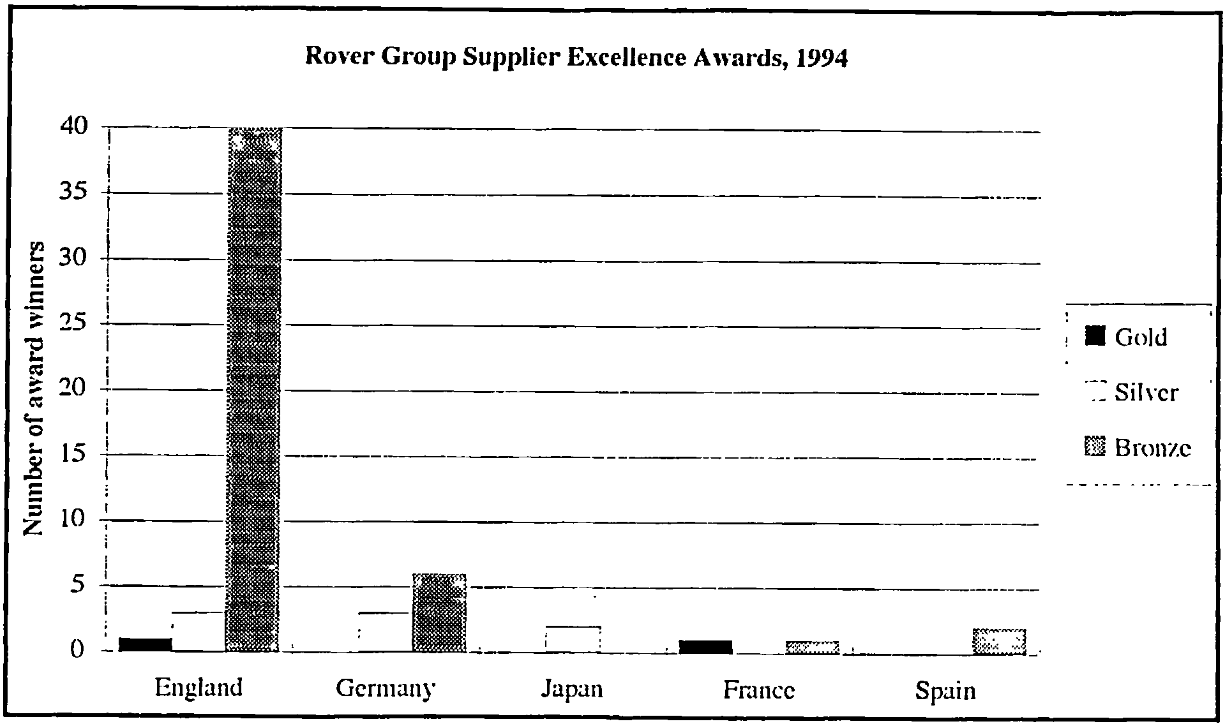
Finally, despite the TPPI partly representing an attempt to reduce the subjectivity of the analysis, one of the areas for concern is the actual validity of the TPPI and the ranked firms. In other words, is it reasonable to form a conclusion on a measure which is certainly less rigorous than say, an assembler's supplier assessment rating. The fieldwork data, after all, came largely from one or two hours face-to-face interviewing. In view of this, some effort was directed at gaining independent authoritative evidence from the assembler with regard to the capabilities of their supply base. A series of direct telephone calls with purchasing management within Nissan, Peugeot, Vauxhall and Rover resulted in some interesting insights. The next section considers the results coupled with a discussion of the variety of supplier service awards in operation today.

7.2.3 Supplier Service Awards:

The Rover Group Supplier Excellence Awards scheme is driven by the assembler's supplier initiative RG 2000 which itself was launched in 1991. The basis of the award levels is improvement. RG 2000 was designed to consider all the elements of a supplier's performance, including its management culture, in order to construct a joint development plan based on best practice and Just In Time production. It uses BS 5750 as a base quality benchmark.

Rover review each supplier's progress on an annual basis against RG 2000 made by the whole supplier base. They then draw a cut-off in terms of the level, or progress, that a particular group of suppliers has achieved. There is no absolute number because each year the relative performance or growth that a company makes will need to be modified next year. Through a process of discussion and review, Rover identify companies above a certain level who receive a silver or bronze, or for particularly outstanding level of improvement, a gold award. There is no fixed number of each; it fluctuates every year. Rover broadcast the Supplier Excellence Award results in paid space placed in the *Financial Times*. Rover hope that sight of such an advertisement would spur suppliers, both award winners and others, on to even higher standards. Figures 7.4 depict the dispersion of awards by country of origin and level of award. It conveys the spread of Supplier Excellence Awards in 1994 between four European countries and Japan. Despite the talk of foreign firms - especially German - being more efficient at component supply than English firms, it was encouraging to note that from the 58 firms that received an award nearly 70 per cent were based in the UK. In particular, of those that were interviewed during this study, seven received awards, namely, AS3, AS9, AS15, AS16, AS19, AS20, ASPO.

Figure 7.4



The retiring Purchasing Director at Rover Group remarked in an earlier interview (CIPS, 1994) about the assembler's Supplier Excellence Awards. He observed that the companies most likely to achieve the higher scores in the awards come from the electrical, electronic and trim fields. Those achieving awards, but with lower scores, are more likely to supply items such as forgings and castings.

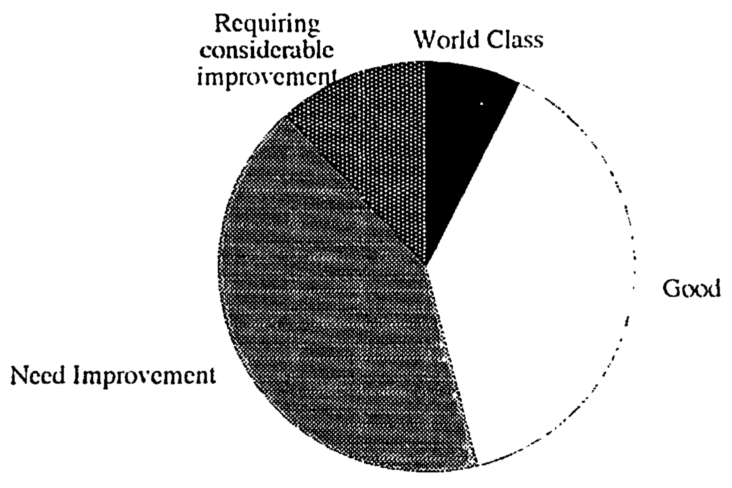
He placed Rover suppliers into four distinct groups. He describes those suppliers who have achieved World Class as 'mature'. The second category consists of those learning what has to be done to move up a division. The third group are those who have come to realise that something has to be done and, probably, what that is, but have yet to progress further. The fourth category he dismisses as 'the total what?', those who have no idea that they need to improve, let alone what has to be done.

It is his contention that most of his company's suppliers are currently in the second and third categories, a state of affairs that he hopes the new awards will alter. In some respects, this grouping reflects the four levels of partnering identified in the last chapter. The 'uninvolved' group that displays little or no interest in partnering bear a close resemblance to Rover's 'the total what?' group.

It is interesting to check the Purchasing Director's perception of the supply base with one gained directly, (Rover, 1995). A Rover Purchasing Manager responded to a research enquiry which listed all of the firms' visited and asked him to categorise the suppliers into four groups according to their RG 2000 score. The groupings were based upon the latest assessment details of the suppliers. Figure 7.5 conveys the grouping.

Figure 7.5

Rover Group categories of the component suppliers in this research project sample



Twenty-nine suppliers were listed and Rover ranked 26. Rover added,

"Three suppliers have not been assessed to the requirements of RG 2000. This may be for a number of reasons such as; an audit has not yet been scheduled, the supplier has been categorised according to the type of component that they supply as not requiring an audit, or the supplier is viewed as non strategic in the medium to long term. I am unable to say in these particular instances what the reason for non-assessment is as I am not involved in the strategy development for these companies."

Although Rover declined to indicate where each of the firms' interviewed ranked, this evidence does provide a distribution of this sample in terms of technical and managerial capability - which may be correlated with the ranked distribution of the TPPI. Furthermore, seven firms from the study sample have earned Bronze awards this suggests that they all fit into Rover's 'World Class' or 'Good' category.

This brief insight is particularly useful in the sense that it represents independent authoritative evidence of how good a supplier is. As we shall see later, AS3 and AS9 in particular appeared to be very receptive towards technology partnering arrangements. The same Rover Manager also remarked in response to the thought set out in proposition three (chapter three) that small firm management are often limited to interacting on a daily basis with middle purchaser management that show a tendency to rotate job functions frequently. Indeed this idea was also introduced within the fourth research proposition in chapter three. It noted that the senior purchasing management who were at the board level will often provide a viewpoint and 'vision' of partnering which was more on the lines of strategic/holistic or even abstract. However, a middle ranking manager will provide a focused interpretation of events. The question was put that the job rotation practice appears to create problems for small firms in building a rapport. The Rover Manager agreed, adding,

"It is generally true that MD's within small firms interact with buyers or team leaders within Rover, whereas management within BTR, say, will come into more contact with our Purchasing Director. On our side, we need a consistency of purpose so that when the next buyer comes in, he/she can get up to speed on the capabilities of the suppler."

An interview by *Automotive Sourcing* journal of the new Rover Purchasing Director (who, incidentally, was interviewed in this study in 1993 as head of purchasing at Toyota) asked: Does achieving a Quality Excellence Award from Rover mean preferential treatment or security for future contracts?

"No, but it probably helps! The likelihood is that longevity of a business relationship will be enhanced and maintained by the winning of an excellence award. Longer term security is better, but there is no preferential treatment."

Again, this is another interesting insight about what creates good relationships which necessarily determines good technology partnerships.

While Rover have pioneered their own supplier service awards, other assemblers have developed their own. For example, Nissan UK have developed a future strategy called NX96 (Nissan Excellence 1996) which is designed to allow the company, working with its suppliers on a shared series of objectives, to meet the chosen benchmark which is to be better than Japan.

Another insight of the strength of various suppliers as well as their managerial capabilities and attitude was revealed during a telephone conversation with a Nissan purchasing manager where he remarked about two firms which ranked high in the TPPI index, namely, AS3 and AS16.

"(AS3) are generally OK but they struggle. They are a second tier supplier to us through a Nissan subsidiary. They are still some way behind their European rivals and miles behind in the world league."

and of AS16, the manager noted,

"(AS16) are very good. Their management has been strengthened since the takeover by Thyssen. They are not a direct supplier to us but we know of them elsewhere."

With this independent evidence provides some support that the appraisal of the firms' interviewed is meaningful, the next step in the analysis is to examine selected case studies in depth. The three case studies which follow aim to characterise further what is meant by each of the three levels of technology partnering. A summary of learning points with particular regard to better practice follows each case study. These points will be returned to within chapter nine.

7.3 Case studies

To reiterate the guidelines within chapter five, a supplier within .. soft partnership would typically develop all or most of its product, materials or process technology requirements in-house and invest *with the confidence* that the main customer will provide a ready market for the final product. In the context of the research propositions, technology partnering at this level may be summed up as *informal knowledge exchange*.

7.3.1 Example of 'soft' level: AS8 & Toyota (UK)

Introduction:

AS8 Limited are a leading supplier of hinges, locks, pulleys, etc. to most of the major vehicle assemblers. The Rover Group are its biggest customer. AS8 Limited are based in the Black Country and employ some 450 people. The Group's automotive division employs 150 people. Established in 1915, the family owned firm funds all its development work from retained earnings. They are involved in the Engineers to Japan Scheme, and the SMMT Industry Forum.

They are also active participants in the 'Inside UK Enterprise' scheme. UK Enterprise provides an opportunity to visit over 100 leading companies employing best practice in a wide range of product areas. All visits are designed to give a better understanding of the various processes involved and a forum in which to discuss with senior management the implications of the advanced technology, and the strategic issues which help to create business success.

Visitors to AS8 are given the opportunity to see a modern manufacturing cell using all the latest technology normally associated with multi-nationals. The issues discussed with visitors include: Engineering Design and Development; Advanced Presswork Manufacturing Unit; The Forge.

'The new professional management team at BEL set out to rebuild the company some eight years ago. At that time, it was out of investment, out of profit and nearly out of customers. The new facility is the result of hard work and dedication to win new business by understanding the customer's needs, placing emphasis on engineering support from concept to manufacture. ... we have also achieved Investors in People status.' [Inside UK Enterprise Guide, (1994)].

The visit in November, 1994 was entirely prompted by a brief article in the CBI News,

"AS8 Limited has shown the ultimate benefits of improving the supplier relationship in the UK. Through understanding their customer needs, and employing technological innovation in both design and manufacturing, they have satisfied Toyota so well in the UK that their engine fan pulley is now being supplied to Toyota in Japan from June, 1994."

Following a one hour interview with the Managing Director and, on a later occasion, the Commercial Director, the development of the fan pulley, its benefits, and the role of technology partnering were considered.

The development of the engine fan pulley:

AS8 had developed relations with Toyota Motor Manufacturing UK Limited (TMMUK) since the assembler set up in Burmaston, Derbyshire in 1990. AS8 developed their door hinge and door check mechanisms with the help of TMMUK. When TMMUK asked them to supply the fan pulley, AS8 raised the possibility of designing and manufacturing the pulley as one piece instead of two pieces spot-welded together.

After some initial price negotiations, AS8 took a proactive stance and set about the new design and, within months, presented TMMUK with drawings for the one piece pulley. The MD first thought of the design and led the project from start to finish. After 18 years working in engine and transmission design at Rover, the MD transferred to AS8 in 1985. No formal collaboration activities were undertaken during the development of the new pulley - all work was performed utilising in-house skills and resources. However, the MD made frequent trips to a spinning machine firm in Germany where he met with a director of the firm to exchange ideas on how to manufacture the pulley.

The technology (machinery and techniques) that were used to help develop the one piece pulley was widely known throughout the press work industry.

Cost reduction benefits:

Before the development of the one piece deep drawn engine fan pulley, AS8 quoted TMMUK £2.34 for a two piece pulley. After the initial discussions, one piece design drawings, prototype, and full scale manufacture, AS8 managed to reduce the cost of a one piece down to £1.37. The volumes sold in the UK were 76,000 pa before the one piece design and then rose by 197,000 pa as units to Japan. (An interim price of £1.50 was achieved when the pulley was being sold in the UK alone and before the Japanese volume related reductions came into play).

Other benefits or attractions to the assembler of the one piece was that the corrosive element of the pulley was reduced because there was no longer a surface gap between the two pulleys where they have been welded together. Further, the problem of concentricity that often accompanies components that are welded together was removed. The manufacturing route of the one piece is different from the two piece. The pulley begins life as a pressed cup and then goes through a cycle of machining, spinning, and painting. Consequently, a whole set of press and welding operations are removed. AS8 applied the hydraulic drawn method during their press operations to achieve this rather than a standard press. Despite the press operation of drawing a one piece pulley being slower, it takes out the need for other operations. Cost reduction was achieved here.

Building R & D capabilities:

The company's strategy is to build its research and development capabilities through 'home grown' individuals, ie people who have earned hands-on toolmaking engineering experience at the company. The Commercial Director remarked how the company had been designing and manufacturing pulleys in excess of ten years. During that period they have gathered an immense amount of knowledge about the process from principally machine manufacturers.

AS8 have developed good links with Birmingham University, recruiting up to eight post-graduate students each year to sponsor their projects. The MD acknowledged the additional source of ideas from the visiting professors through this link yet the flow of ideas is predominantly one way - from AS8 to Birmingham.

When asked about a policy of identifying 'product champions' to see a product's development through from start to finish, the Commercial Director suggested that multi-disciplined product teams are preferred to single product champions. The company's strategy is to have breadth as well as depth of engineering knowledge. They do not encourage their staff to become specialists in one area or product but to have development knowledge of a variety of products.

Future technology partnering arrangements:

At the time of the visit, the MD was in the midst of discussions with the DTI and three Midland universities regarding the possibility of setting up a research programme on material flow. It involves the development of a software programme that can predict material flows. The possibility of applying for a EUREKA grant was being explored. The MD's concern, however, was that the conditions that accompany such grants talk of collaboration and how the different parties can work together yet he believes that since AS8 are the experts, they do not need input from anyone else.

The Commercial Director referred to a set of organisations that AS8 occasionally contact for technical assistance, eg local and national trade institutes, machine manufacturers, PIRA, etc. Applying a simple scale to rank the extent of collaboration, ie 1 = Informal network, and 10 = close to forming a joint venture, the Director ranked most of their activities with such organisations as being '2 or 3 ... it's informal networking'. He referred to a company in North America who have a very similar operation to AS8 yet only supply the US market.

"We have technological transfer meetings from time to time. We have often worked with each others' patents under licence. That is not at an official level ... but you are probably talking about a 5 or 6 ranking because they are in the States, and we operate in the UK then we can afford to do that."

Openness with the vehicle assemblers:

AS8 contend that while they are very open and forthcoming with information when the customer demands it. However, the European assemblers are less forthcoming. To illustrate, the assemblers continually benchmark their supplier base yet rarely inform the supplier how well they are performing in relation to their competitors. In other words, they still have some way to go before developing their supply base in order to meet world class manufacturing standards, as the Commercial Director remarked,

"Customers don't tell us everything. Sometimes we get the information we want, sometimes we don't. If you don't have that interchange, then you can't benchmark."

Internal and external interfaces:

At AS8, engineers frequently talk to their opposite numbers at the assembler. Indeed, during the months when the one piece pulley was being developed, AS8's and TMMUK's engineering departments were closely involved with each other. In November, 1994 the MD initiated the organisational shift away from being tagged as a 'sales organisation' to a 'programme management organisation'. In effect, the sales department has been replaced by a key group of individuals responsible for interfacing with the customer at different functions and controlling the current programmes.

Conclusion:

AS8 have identified TMMUK as a valuable source of ideas, particularly the engineering department. A good rapport appears to have developed between the counterparts in each company. Although most of the actual development work for the innovative one piece pulley was undertaken in-house, the continuous and uninterrupted stream of dialogue between the two firms served to speed up that design process. Clearly, the supplier trusted the assembler to provide a ready market upon completion of the one piece design. Interestingly, when referring the evolving relationships that AS8 had developed with TMMUK, the Commercial Director remarked,

"There was no doubt in our minds that the Japanese could have picked up on our technology because they have got the same type of machinery and development processes, etc. It may be that they could have produced it cheaper in Japan, India, Korea, or China BUT there is an allegiance to the effort that you have made to Toyota in the UK."

The actual role of technology partnering in this supplier may be light yet the rich information that has flowed from the purchaser to the supplier supports the view that improved products at significantly reduced cost can, and are, launched on the basis of working relations that have integrity.

There are several important learning points to note before looking at the next case - particularly in relation to better practice.

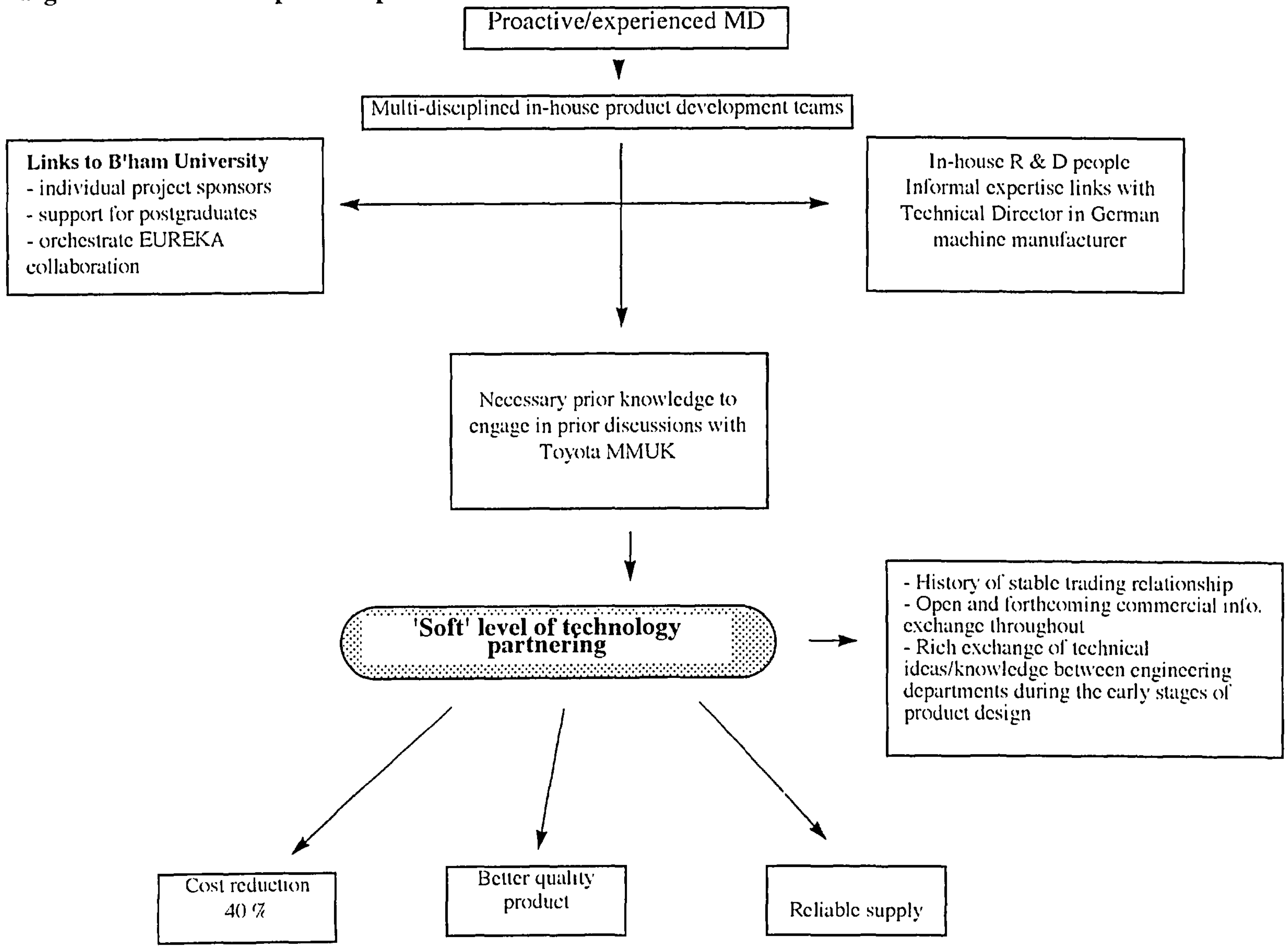
This case has illustrated:

- the benefits of time-tabling several years into establishing a supply relationship enabling the two parties to develop a high level of trust and mutual respect for each others' capabilities. Consequently a focussed technological collaborative arrangement followed and proved lucrative for the partners. In one sense, the relationship grew 'organically' according to need rather than forcing a rigid structure on it.

- the supplier's willingness to share knowledge and respond quickly to the customer's needs. AS8 displayed a managerial attitude that epitomised openness and flexibility. The accent was on 'trying to improve and innovate when the opportunity arises' rather than relaxing when a quality standard is achieved. This is coupled with the supplier's enthusiasm for the partnership with Toyota, itself just recently become fully operational in the UK with committed technical managers allowing the supplier unlimited access to their personnel resource base.

- how the development of the development of personal contacts and networks plays an important part in improving knowledge and identifying opportunities. Practical steps to develop such contacts and networks include active participation in 'industry initiatives' and various seminars run for businesses as well as participation in business training courses and contributions to conferences and trade journals.

Figure 7.6: AS8 Conceptual Map



Next, a case of 'medium' level partnering. Chapter five first defined this activity level as formal/organised knowledge and technical exchange.

7.3.2 Example of 'medium' level: AS26 Supplier Association:

Kyoryoku kai (Supplier Associations) have been seen as fundamental in developing suppliers in Japan. The Welsh Development Agency (WDA) developed this idea in the UK with AS26, which is part of the Nissan group. AS26 is a leading manufacturer of a innovative copper radiators for a variety of vehicles, in an addition to aluminium radiators, heater cores, oil coolers and intercoolers. Its customers include General Motors, Nissan and Rover. In anticipation of further contracts with European vehicle manufacturers, AS26 has opened a new R & D centre South Wales. Although AS26's European operations are able to call upon the technical resources of its parent in Japan, this latest development indicates the growing requirement to have local R & D personnel who are able to join the design and development teams of customers. The number of staff at the new R & D centre is expected to rise by around 50 per cent almost to the 100 level.

AS26's definition of supplier association is 'a mutually benefiting group of the Company's strategic sub-contractors brought together on a regular basis for the purpose of coordination, cooperation and development.'

The company decided to pilot this approach and the first Association was formed in 1991.

From the outset the partnership recognised that in order to gain from the benefits of improved supplier performance, it will be imperative for the final assemblers to take a proactive role in the development of their network of suppliers. The principal reason for this is that if they do not, and no third party does so, the smaller suppliers are unlikely to benefit from the rapid development required today. It was considered necessary to help firm's supplier networks through a process of **diffused integration**, or treating the supply network as if it were part of the larger company by spreading the benefits of active kaizen style development, ('the extended enterprise'). The problem which AS26 and the WDA faced was how best to achieve the process of diffused integration, when in general the process requires the active involvement of all members of the OEM, not just the purchasing department. The answer was considered to be in establishing a forum whereby suppliers meet each other and their customer on a regular basis to discuss action plans for this accelerated development.

Note: Throughout this research, it was found that several firms have successfully arranged supplier conferences, yet these events were infrequent (annual at best) and discussed general topics without concise action plans. In addition, the supplier base varied considerably between meetings. The net effect is that there is little effective cross-supplier dialogue and the relations between customer and supplier are no better. These points will be referred to again within chapter nine.

The route taken by the WDA and AS26 to establish the association:

Stage 1:

The WDA set out to apply this theory to the European environment through seeking a firm that had reached a critical stage in its development where it realised that its future development is contingent on the development of its supplier base. In 1989, AS26 was at this point. The next stage was to learn more about supplier associations through working examples. None were found in the UK. However, the WDA located the Canon Suppliers Partner's Club (CPF) in Brittany, France and it was arranged that two key members of staff from AS26 to visit Canon so that they could explain how such associations worked in Japan and how the CPF operated in France.

Stage 2:

Following this visit, the possibilities were explored as to how best to synthesise these preliminary observations of the model used in Japan and produce a hybrid better than the original. From this standpoint, the following developments took place:

1. The membership of the supplier association would not be limited to direct suppliers, as in Japan and at Canon but would include indirect (second tier suppliers). There were two reasons for this: a) there was little doubt that a modified kyoryoku kai association could be formed yet if the Japanese model was followed this would take several decades to start the rapid development of all but the direct suppliers. It was considered that AS26 could not wait that long, and b) some of the indirect suppliers have a more significant input into the success or otherwise of AS26 than some direct suppliers, ie the design and tooling of major components and sub-assemblies purchased by the firm often occurred at the second tier level.

2. The inclusion of service sector companies as well as manufactured product companies. This development was considered to be necessary as the transport company that distributes products for Llanelli Radiator as well as transporting supplies to Llanelli was thought to be their most important supplier. The principal reason was that the transport firm were the outward extension of Llanelli and it is this firm that has daily contact with Llanelli's customers. Interestingly, it was perceived that the service sector had been traditionally ignored in firm's supplier development programmes and hence this particular transporter was unlikely to have received much, if any, development from its customers.

3. The size of the association was initially fixed at a total of ten firms so that development schemes could be focused. After an initial period and providing members agreed, this number could be increased to diffuse the integration process more widely.

4. A modification of the traditional Japanese paternalistic attitude between supplier and their parent customers. This was considered necessary since the direct replication of the Japanese relations was unlikely to work given that UK suppliers are more at home with adversarial relationships with their customers.

5. In order to avoid the problem caused by the initial time requirements that these associations place on firms, the WDA took responsibility to act as facilitator.

Stage 3:

The next stage involved contacting the potential direct member firms to discuss whether they would be willing to participate within an association. Membership was restricted to strategic sub-contractors and their first tier suppliers. The selection criteria was as follows:

- Degree of dependency
- Degree of unique/joint product design
- Degree of investment in people, process, products
- Positive relationships

It is interesting to highlight here a remark made by the Commercial Manager at AS26 about their strategic partners,

"... it's about co-existence - we can't exist and they can't exist without us. When you get down to it, that is the bonding mechanism. We need each other."

-AS26 Supplier Association:

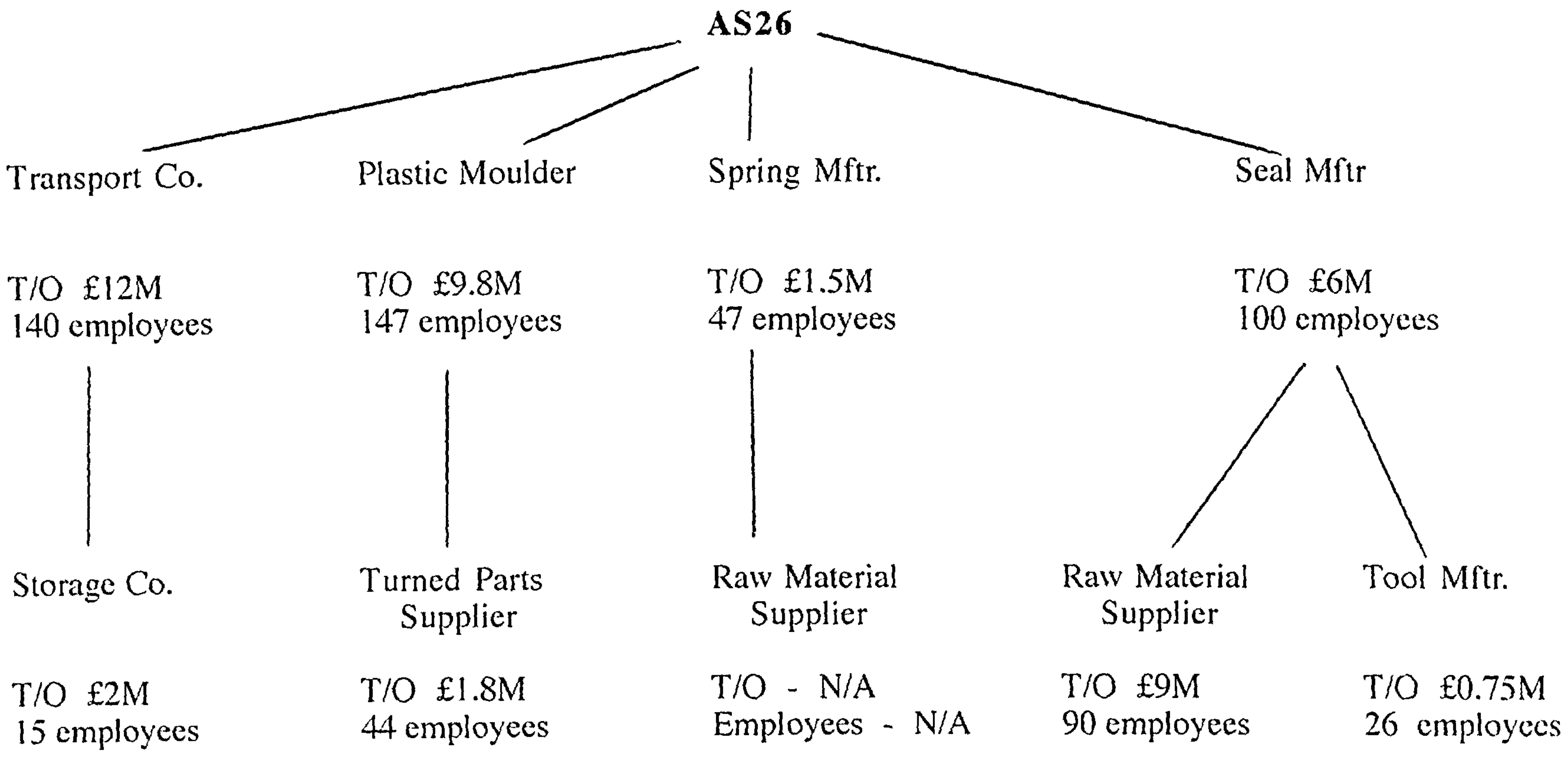


Figure 7.7: The Association membership.

Stage 4:

This activity involved the WDA performing a one day audit review of each member firm in order to assess their internal activities. The review covered areas under the headings: Leadership and management, Management control, Quality and design and External relations. The objective of this review was threefold:

- Through examining each division or activity centre of all the companies - areas of strength and weakness could be identified. As a result of the review each firm was sent a summary report proposing suggestions regarding any or all parts of their business.

- This information could then be used to set a bench mark position for the firm in relation to best practice. The bench marks created for each firm were then disseminated to the individual firms as well as the positioning of the other member firms in the network. From this information, it was possible to specifically target the weakest in the network for special help.

- It was considered that the creation of the bench marks would permit an annual re-auditing process to gauge the member firms progress.

Stage 5:

The final part of the setting up process meant staging a one day inaugural seminar at AS26 in 1991. The morning session agenda included a brief resume of the reasons why the association had been established, the benefits to members, and a group discussion of the audit reviews. Members were given a site tour of AS26 plant in the afternoon before reconvening to a frank and open discussion as to how the association should go forward.

The main areas discussed of joint benefit to members included:
(i) Employee Involvement Schemes.
(ii) Machine Downtime Analysis and Improvement Schemes.
(iii) Value Analysis.
(iv) Integrated Design, involving firms in at least co-designing the parts they produce.
(v) External Relations with Customers and Suppliers.

It was decided that seminar meetings would be held quarterly at the different member's sites which would provide a natural forum to demonstrate the benefits achieved to other network members. The quarterly meetings would discuss how the five points above can be put into practice. It was anticipated that spin-off workshops designed for operational staff from the different firms that specifically address issues of direct relevance to all member firms would develop. The results of such workshops would be disseminated back to the network at the next meeting.

<u>Further development: Period 1992 - 1994</u>

A second association was set up in 1992 with ten companies joining. The group was initially kept separate form the first group for several reasons. For example, the second group would require a fast-track development programme to bring them up to speed with the first members. In addition, some members of the first group were in close competition with members of the second. Although this was not perceived as a long term problem, it was considered that the two groups should remain separate entities until a 'sufficiently close and trusting relationship could be built.'

Hines (1994) noted the beneficial areas of the association in interviews with member suppliers. One supplier remarked,

" (The supplier association) *provides a communication system for timely information on AS26's plans and contacts, which enables us to plan future capacity and quality requirements ahead of schedule. The associated development programme, with its emphasis on joint continuous improvement ... and the development of best practices, has enabled us to develop business links with other AS26 Group companies abroad.*"

Another supplier said,

"... Perhaps even more useful have been the informal contacts built up with other AS26 suppliers."

In an interview with a supplier member during this study, the MD wasted no time in getting to the point,

"The main reason why we get involved in these types of associations is to get cost down and reduce waste. Other reasons are that we want to understand the customer's problems and we want to network and become part of a larger supply chain. To succeed in that, you must be the quickest, cheapest and technologically superior supplier around."

It is interesting to note that this supplier has sent a guest engineer to AS26 for two days per week 'for months'. The Commercial Manager at AS26 added, *"He got involved with our design people on the concept. He also became involved in the resolution of various issues. For example, commercial, logistics, new engineering, or research and development. ... The benefits to us of having a guest engineer here are about simultaneous development and time benefits. We get the knowledge of the development of plastic water tanks - the supplier engineer can optimise the design for us with the radiator. He can tell us of any complication in the process. He sits with us in front of the customer. It's much quicker communication and we can get the product developed quicker."*

The benefits to AS26 have been felt in the design, costing and delivery areas as well as the inter-company relationship aspect. This allowed AS26 and the supplier members to jointly develop VE/VA plans to meet the exacting targets for cost and quality set by the assemblers. An example of these early benefits may be illustrated by the fall in defect levels from member suppliers; defect levels fell 50 per cent in the first year of the association and a further 30 per cent in the second year. For AS26, since the start of the association, stocks have fallen by around 34 per cent whilst sales and turnover have continued to increase.

The Commercial Manager thought that the benefits to Rover were,

"... by talking to us, they are talking to a chain or a tier - all the way through to the raw material supplier - the AS26 Supply Chain will be in front of them ... that is what Rover want."

Finally, the Commercial Manager at AS26 remarked about his freedom to make the Association work and how it helped to create a general attitude in which flexibility and individualism, adding

"We do not have a budget for the Association. We have got the freedom to do what is necessary. At the start , we didn't know what the benefits would be but we were confident in the belief that the benefits would flow from it. We were free to research and pursue it."

While there are clear benefits to all participants arising from the Association, there are also some hidden obstacles. To illustrate, where supplier members are owned by larger groups, eg BTR, the Association management find that the member is often constrained in its approach to develop a strategy that is in line with other Association members. Despite the division management sharing the views of the Association management, the division's Head Office held different views - especially about their divisional units sharing know how with others, etc. To ensure that the Head Office have a better understanding of the purpose and work of the Association, AS26 have already invited senior management (eg the MD of RTZ Plc) o visit the South Wales facility and discuss the Association.

Figure 7.8: Calsonic Supplier Association - Conceptual Map

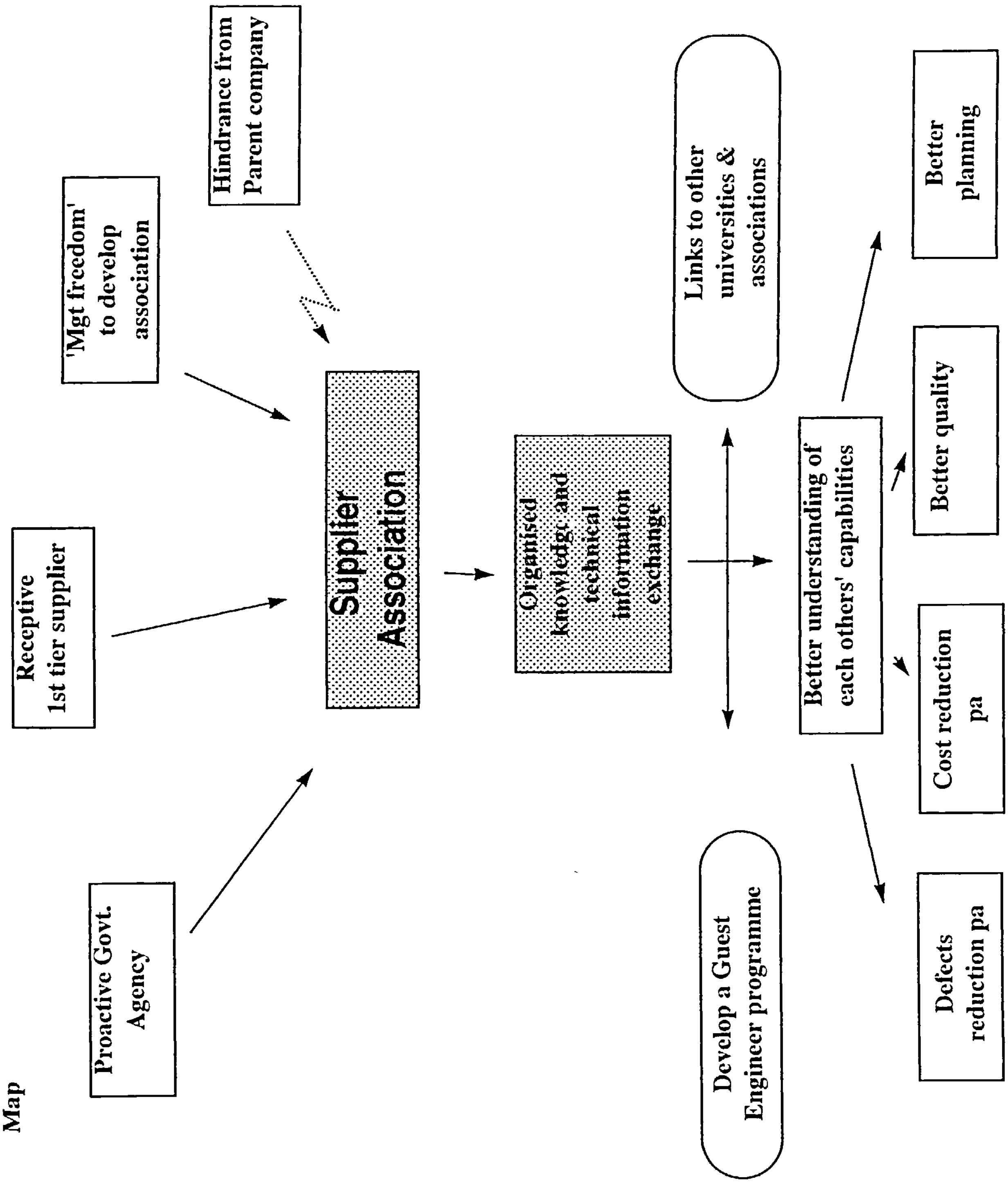


Figure 7.8: AS26 Association - Conceptual Map

Overall, this case illustrates how supplier associations can work in the UK motor industry - given the time to develop. Again, several learning points with regard to better practice may be highlighted:

- Best practice suppliers all want to be in the partnership/association - they view it as offering value for time spent. Best practice suppliers deftly demonstrate a level of commitment that separates them from those that pay lip service to the practice.

- An important feature, perhaps idiosyncratic to the arrangement in South Wales, is the apparent lack of budgetary control - both in terms of set up costs and, more importantly, managerial time to lead and orchestrate the association.

- Considerable effort goes in to identifying and selecting the right association members: a realistic assessment of (ad respect for) the supplier's capabilities as well as managerial attitude towards partnering.

- A vast amount of effort goes into communications and coordination - where AS26 keep the association members informed and aware of developments.

- The development of trust and and confidence was displayed in the AS26 case. With a two supplier associations running in parallel where some members of each were in direct competition calls for the utmost confidentiality by AS26. Much of this trust and confidence, particularly in the early stages of the two associations running together, hinged on good personal relationships.

Finally, the following case depicts a 'hard' level of partnering where the focus and aims of this type of collaboration appear to alter during the (longer) life of the technology development cycle time and post launch period. Partnering at this level appears to be more about meeting the company's strategic long term concerns than tactical short term considerations. A key feature of this type is multi-disciplined teams coordinating the product's development, occasionally characterised by alliance offices - helping to organise the alliance communication as well as protect the individual firm's proprietary know-how, ie helping to retain the attractiveness of each partner to the others.

7.3.3 Example of 'hard' level: AS18 & ICI

Introduction:

AS18 design and manufacture steering wheels and air bags. They currently supply 90 per cent of all steering wheels to the UK-based assemblers. They employ 350 people in Spring Hill, Birmingham. AS18 is part of a multinational group representing the 16th largest industrial company in the world. The group's main research centre is located in Hartford, Connecticut, USA. Working in close co-operation with the manufacturer, AS18 offers programmes for all phases of product development:design, creation of prototype, testing of the design development, production engineering and quality tests. Most often, AS18 starts with the manufacturer's functional specifications sheet, finds innovative solutions, designs and develops prototypes, and then handles the actual production.

The following case provides a brief glimpse into the events that led-up to forming a technology partnership with a major supplier, the factors that helped to maintain it and the commercial benefits arising to AS18. In addition, 'softer' arrangements between AS18 and its suppliers are considered. Finally, the company's perception of how much has really changed in the UK motor industry in terms of partnering is discussed. This information was derived from a one hour interview with AS18's Technical Director in January, 1995.

The route to the partnership with ICI:

Clark Shoes:

Following the increasing public demand for air bags, AS18 wanted to learn about alternative methods to manufacturing air bag covers without infringing on competitors. They found Clark Shoes were using Reaction Injection Moulding techniques which were similar to those used at AS18 - an elastomeric system. The family of materials used at Clark's for their shoe soles is the same as that used at AS18. AS18 sent a senior technical manager to Clarks, near Shepton Mallet for one day to learn about their manufacturing processes, how they tool and machine, etc. Although some ideas were exchanged, no further technology exchanged occurred. However, this activity did lead to an entry into ICI Polymers in Shepton Mallet. AS18 were already sourcing from ICI yet the supplier was not considered 'strategic', ie they were not readily identified as an ideal candidate for a collaborative project.

The technology partnership:

ICI as Technology Partner:

Following government legislation, the company were required to reduce the amount of CFCs in steering wheel material. They were also pressured by the requirement from motor vehicle assemblers to become more 'green'. Consequently, in 1990 AS18 spoke to three major material suppliers: ICI, Bayer, and Dow Chemicals with a clear view to forming a technology partnership with one of them in order to meet the legal and industrial need. Although ICI were not, at the time of presenting their work, considered to be the most proactive AS18 felt that they were the best candidate to 'open a dialogue with'.

Since 1990, AS18 have developed a very good relationship and partnership with ICI in the development of materials. AS18 introduced ICI to techniques that were being used in the motor industry for the design of experiments (DOE) to look at the function of the interaction of materials on the moulding capabilities. ICI had no experience of this technique prior to the partnership. AS18 firmly believe that over the last four years, their relationship with ICI 'has developed into one very much based on mutual trust and understanding.' The partnership consists of a core multi-disciplined team that meets, on average, six time per annum.

Benefits to AS18:

AS18 believe that the direct benefits arising from this technology partnership include:

1] Better response time;
2] Better cycle time;
3] Better utilisation of AS18's technical staff;
4] Wider technology scanning.

and indirect benefits of raw material cost reduction.

1] Better response time:

AS18 did have some trading supply agreements with ICI prior to 1990. The response time from ICI at that time was considered to be very poor. The Technical Director now considers the response time as being 'world-class'.

"They (ICI) are now very proactive towards our requirements. They have gone from a poor source to one that I would find it difficult to justify displacement of them."

2] Better cycle/lead time:

Given that the materials that AS18 buy are all sourced from the UK, the lead time from the order date to the point of delivery is much quicker and cheaper. AS18 conceded the arrangements prior to the partnership equated a 'logistics nightmare'. For example, deliveries by road tanker from Germany or Belgium could be delayed due to ferry schedule delays, weather, port problems such as drugs, papers, or wagon weight checks. In a Just-in-Time manufacturing environment, a delivery delay of several hours or more has, on occasion, jeopardised their position with the assembler.

3] Better utilisation of AS18's technical staff:

AS18 have found that, through the technology partnership, they have realised a better utilisation of their own internal processing staff. Because of the arrangement, AS18 are currently spending less time on actual product development on a specific entity. They now use the time better to enhance their product yield.

"To some extent, we have trained ICI to look for what it is we need to solve our problems. We provide ICI with the tooling and they develop the system and carry out all the laboratory scale trials. Through that process, we understand what their constraints are and what they need from us to perform better. They understand what our market is, our performance criteria, our specifications. Consequently, they come to us with results, and all the supporting documentation."

The partnership has also helped to reduce the cycle time of the introduction of materials,

"In order to react to new legislation, eg reduce CFCs, we need to have a partner who can pick up our requirement and run with it while we are still making parts for our customer."

4] Wider technology scanning:

ICI publish a monthly in-house technical magazine entitled, 'The ICI Engineer'. The Technical Director asked to be added to the circulation list. AS18 are now able to widen their technology scanning to assess what is emerging in ICI and other fields that may be of interest to them. Following legislation to ban cleaning agents such as methane to wash metals, AS18 identified a group of individuals working in ICI that could help to find alternative solutions to clean metal products, tooling, etc.

The two main avenues to scan for technology to date have been reading trade magazines and journals, and using the abstract services of PERA. According to the Technical Director, the trade magazines contain a lot of repetition,

"...for every 100 articles that you read, you may find one that has a direct impact on what you want to do."

The PERA route makes the task of scanning much easier and is considered a time effective method.

- Finally, although some raw material cost reduction has occurred, the principal driver is not easily identifiable. The manufacturing processes have changed from the F11 system through the R22 system through to the Water Blown system. This process has enabled AS18 to offset substantially higher raw material costs. AS18 believe that this change of process coupled with the better relationship established with ICI has earned the company a 10 per cent cost benefit over going to other companies.

Softer partnerships:

Another current near-collaborative effort concerns AS18's development of wooden steering wheels. The Technical Director referred to this arrangement as a 'customer-supplier relationship' between AS18 and the wood manufacturers' rather than a technology partnership. The arrangement grew out of a requirement for AS18 to design and supply wooden steering wheels to Jaguar. The wood manufacturer had, up to that point, only supplied the after-market. The Jaguar specification was, however, extremely difficult to meet and the original parts supplied by the wood supplier did not come close to meeting the standards demanded by Jaguar. In order to improve that situation, AS18 organised 7 - 8 meetings with the supplier in order to understand their processes and improve on the quality of work. AS18 brought in the specialist advice of the Furniture Industry Research Association who made some valuable suggestions on changing the process. For example, the wooden steering wheel must be designed in such a way that, in the event of a road accident, the wheel collapses in a formation that causes minimal harm to the driver, (the dislocation points must be carefully designed).

Outlook for further collaboration:

Overall, AS18 continue to work in partnership with other firms. The firm generally accepts that there are some suppliers, such as air bag module manufacturers, who they need to be in partnership with. In 1994, the company began to look at other steering wheel manufacturers who are not direct competitors with a view to sharing technology and facilities.

While AS18 appear particularly proactive at creating and maintaining technology partnerships with their suppliers and applaud the supplier management approach that the Japanese transplants have taken, yet they genuinely wonder if anything has changed amongst the American based assemblers. The Technical Director added,

"I would say that things are not getting any better with the American assemblers. I believe that the partnership principal has peaked and a lot of people are beginning to look at it cynically ...... it's not a partnership as such - because of the pressures that have been put on everyone to reduce costs. ... The Japanese transplants will spend an enormous amount of time to try to understand why it is that you can not reduce costs or to suggest ways, no matter what they are, of putting in effect a reduction."

Conclusion:

It became clear during this visit to AS18 that the purpose of collaboration with ICI was more concerned with strategic issues such as long-term positioning in the steering wheel market place and its position as a first tier supplier to the major UK assemblers, (versus short-term issues such as cost reduction). As we have seen, AS18 have benefited from the partnership by performing less early development work and thereby utilising their internal skill resources better. In other words, they have , to some extent, avoided the expense and risk of investing in speculative research. Even a brief review of the literature confirms such findings; Heaton (1988) quotes a leading Japanese industrialist whose experience of co-operative research led him to argue that its greatest benefit lay in negative research results. That is, it saved the company the costly and time-consuming business of internally pursuing dead-end technology and business avenues.

Technological innovation is critical for firms' continuing competitiveness. As Dodgson (1994) remarks, it is a complex and uncertain process which has strategic implication for a firm's long term performance. So the effective management of innovation is of the utmost priority in attempting to increase the chances of successful R & D. This is particularly so when managers have to address the problems of integrating external inputs and skillfully managing continuing linkages with other organisations and firms. Working in partnership with other firms with different strategies, structures, systems and cultures is a very difficult process and inevitably tension ridden.

Figure 7.9: AS18 Conceptual Map

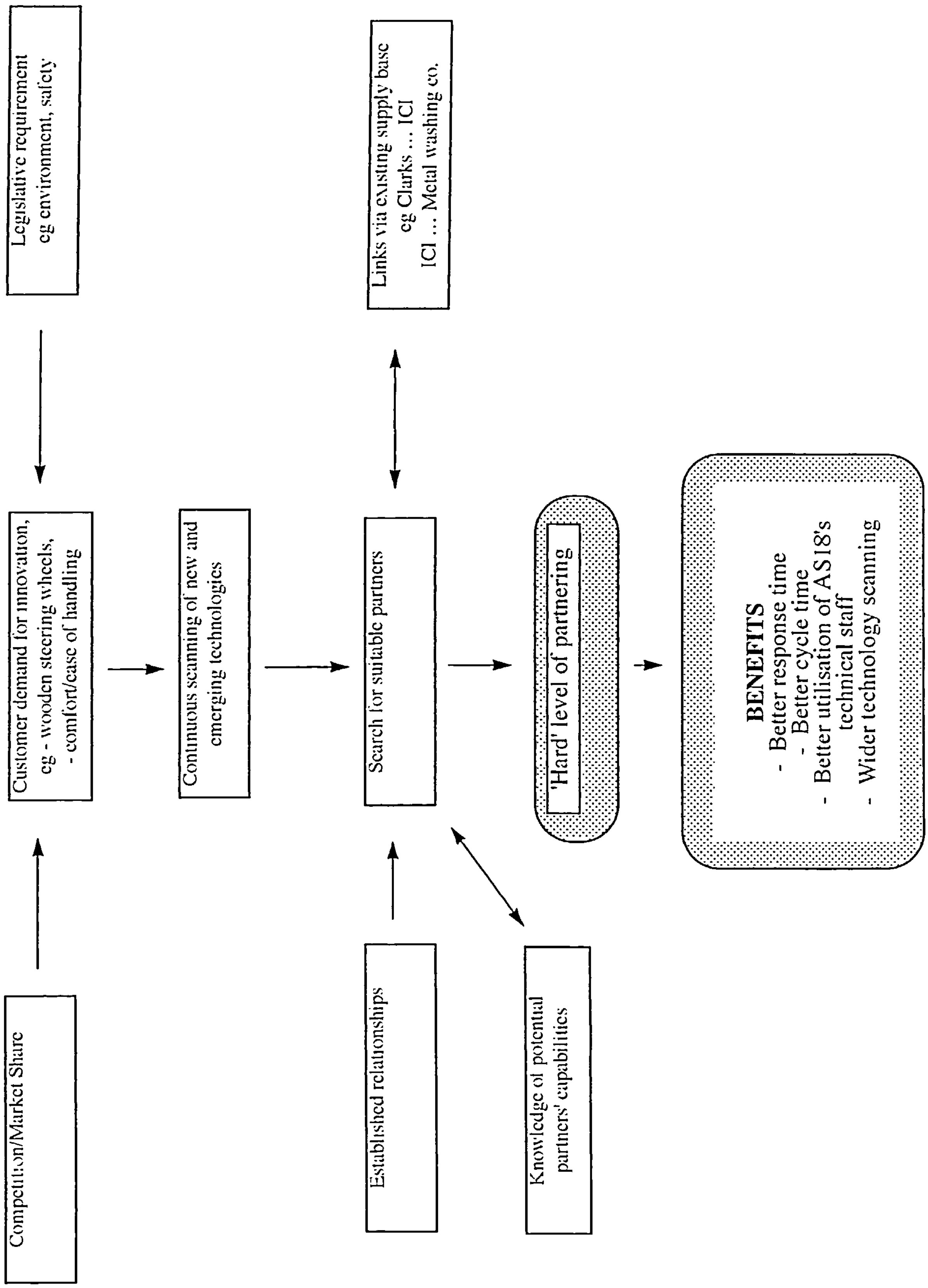


Figure 7.9: AS18 conceptual map

Finally, the benefits arising from the partnership present a clear case for technology partnership given the right conditions. Those conditions will inevitably be idiosyncratic to each potential partnership. In other words, there is no 'one-size-fits-all' technology partnership arrangement. The key learning points from this case are that a careful review of a firm's own technical resources to assess the need for technology collaboration, followed by some skillful strategic partner selection of an established supplier are just two of the prerequisites. In addition, some better practice features observed in this case include:

- The importance of the partnership team having an equal balance of technical competence thus avoiding delays and diversions of effort where the 'weaker' partner has to catch-up.

- Ensured that committed individuals became involved in the partnership and championed its cause. In this case, the technical director played a key role coupled with the close involvement of two senior ICI managers based in Everberg, Belgium. From a day-to-day point of view, these individuals were able to appreciate the nature of the research as well as its value to the parties. Inevitably, regular contact minimises the possibility for misunderstanding about the direction and results of the research.

- Overall, several clues were provided during the interview with regard to the partnerships success. First, the two groups of managers concerned shared the same thought processes, and built up a working relationship before the collaborative material supply agreement began. Second, AS18 thought very carefully about partner selection: they invited three firms and considered whether they could provide what is needed and be trusted to deliver what is needed. A significant amount of trust in ICI had accumulated in the years prior to the partnership. The regular core team meetings that ensued during the partnership helped to ensure a good team effort. Third, it was thought by AS18 that their project management skills and organisation were not dissimilar to those of ICI. Consequently, this eased the path to good external communication channels.

This concludes the case studies. To enrich the analysis, the following sections compare and contrast two metal pressing firms that show many economic and demographic similarities yet, in terms of their approach to collaboration with customers, are simply poles apart. Both firms are in close competition with each other, sell more than half their annual production volume to Rover, are similar in size and based in the West Midlands. However, the similarities end when we begin to look at a) each firms' rank on the TPPI (5th and 17th respectively), and b) each firms' financial performance. The two companies are simply poles apart.

7.4 Matched Pairs Study

The main purpose of this part of the data analysis is to establish if there is any relationship between a firm's technology partnering performance and its financial performance. The last chapter correlated the semi-quantitative indicator (TPPI analysis) with the financial data using a statistical software programme (SPSS) to investigate for any relationships. A selection of scatter diagrams depicting the results from this early exercise are presented within Appendix F. No statistical conclusions could be drawn from the analysis, presumably because of the many other factors affecting company performance which may obscure a relationship between partnering indices and financial performance, (section 6.6).

However, a relationship *may* be revealed if two firms are compared using a selection of characteristics to match them, for example, company size, geographical location, product group, customer base, age of firm, corporate status, etc. Through this approach, we might more reasonably expect to find a similar performance pattern for each pair of firms and yet be able to detect possible differences due to the influence of technology partnering. Three matched pair cases are presented below to illustrate the point. The following table shows the characteristics of the firms selected and the similarities.

Table 7.2: Matched Pairs

Matched Pairs Case:		**Case A**		**Case B**		**Case C**	
Component supplier:		**AS3**	**AS5**	**AS2**	**AS7**	**AS4**	**AS6**
Company size (nos. of employees)		105	118	192	150	121	164
Location		South Midlands	West Midlands	West Midlands	East Midlands	West Midlands	West Midlands
Kompass Product Group		Chassis	Chassis	Fuel systems	Fuel systems	Chassis	Chassis
Three largest customers	1st	Rover(85)	Rover(62)	Rover(60)	Rover(40)	Rover(50)	Rover(60)
(%age of annual business)	2nd	GM (10)	Other (38)	Ford (25)	Ford (25)	Jaguar(25)	Nissan (11)
	3rd	Honda(5)	-	Toyota (8)	Nissan(15)	Honda(20)	Ford (8)
Age of firm at at 1995		42 years	93 years	27 years	21 years	26 years	21 years
Corporate status		100% subsid.	100% subsid.	Indep.	100% subsid.	Indep.	100% subsid.

7.4.1 Case A: AS3 & AS5

Two visits to AS3 were made; the first in February, 1993 to assess the general approach the supplier takes to partnering with the assemblers, and the second in June, 1993 to test their reaction to a research proposal. The proposal considered the provision of an engineer by the assembler to visit its suppliers and provide a wide variety of technical information which may help to improve the SME's 'awareness' levels. Two visits to AS5 were also made; the first in June, 1993 to discuss the same research proposal and the second in November, 1994 as part of the 'motor industry revisited' study to discover what had changed in their business with the assemblers, (section 4.2.3).

AS3 was founded in 1953 by four employees of the MG Car company at Abingdon. In 1974, the company moved from its original site in Wantage to the present, freehold property in the neighbouring village of East Challow. Comprising of eight acres, four of which are open grassland for recreational activity, the current site houses various companies; the largest being AS3.

Management attributed the success of the company to the ability of the workforce to change and adapt quickly to new technology and new ways of working. Through dialogue, advanced quality planning, robotic technology and a trained, competent and willing team of people to uphold a genuine zero defects policy, AS3 aim to provide a total package.

AS5 was founded nearly a century ago. Rubery Owen took over the company in the 1940s.

'In 1981, amidst reorganisation within the Owen Group, (AS5's) management recognised a growth potential they felt could be better served by once again becoming independent. Against this background they persuaded the parent company to sanction a management buyout that would allow (AS5) in their own right to capitalise on the skills and traditions developed over the years.

Since then, under the same management team, AS5 have grown dramatically. In 1985 they moved to a much larger factory, purchasing the freehold on a 7.7 acre site in Wolverhampton. This provided the company not only with 63,000 square feet of production area, but also with ample land for further expansion.' (AS5's sales literature)

The first striking difference between each firm lies in its managerial attitude towards technology partnering and the way they communicate with other firms. For example, the managing director of AS3 described the motor component sector as,

"Infectious ... we all cooperate and talk, no problem with that generally in the industry. I believe that we have to work together to provide the Japanese transplants with a service that will stop them bringing their own suppliers in."

However, a director within AS5 remarked,

"We just don't talk to each other ... it's not that kind of industry."

What lies behind these two attitude statements? What qualities does the management team within AS3 possess that are not present within AS5 and other firms lower down the TPPI? What makes technology partnering work better within one group of firms than it does within another?

The following discussion explores these issues in relation to the research evidence gathered.

AS3 appeared to present and demonstrate itself to existing and potential customers as possessing an open and honest style of management - one which is willing to change their method of working; has a good track record in terms of quality, delivery to time and cost reduction procedures; an intuitive understanding of the customer's requirements - earned through continuous dialogue and acting on their advice; use the customer's expertise; allocate sufficient resources to their own skills training. This firm are also continually exchanging ideas with two other pressed metal production firms interviewed: AS9 and AS16. Indeed, AS9 and AS16 have begun one-day exchange personnel visits between themselves and AS3.

The managerial attitude with regard to partnering within AS5 appeared insular or uninvolved. They appeared blinkered by the role and potential benefits of technology partnering especially in relation to working with other suppliers,

"We have no rapport with other suppliers. It's not that kind of industry. It's about getting close to them (the customers), *not other suppliers."*

Similarly, another firm illustrated within figure 7.3 above in the 'uninvolved group', AS4 remarked, *"We don't get involved with other companies. We simply don't have the time to pontificate with other firms, whether they be competition or not. We have to give full attention to the support we give to the assembler, not other suppliers."*

Furthermore, AS5 appeared far more concerned with the speed at which purchasing people within Rover change and either earn promotion or move to other functions, (referred to again in chapter nine). This firm supplies over 60 per cent of its production volume to one assembler and spends a similar proportion of time interacting with a dynamic purchasing interface. The result is wasted time and effort and can only reduce their motivation to maintain a 'close partnership'.

Interestingly, the MD of AS7 - another firm positioned in soft field and supply 15 per cent of its annual production to Nissan - remarked,

"In Nissan and Toyota, it doesn't matter who you speak to because you have got that long term commitment. It may take three or four weeks to build up a relationship with a new person BUT you know that you have got that commitment"

The division between the two firms is made even more clear given the TPPI results across the three core areas, as figure 7.10 below shows. Similarly, figure 7.11 contrasts the annual sales turnover of each firm reinforcing the striking difference in performance.

Figure 7.10: Semi-quantitative evidence: AS3 & AS5 Technology Partnering Performance Indices

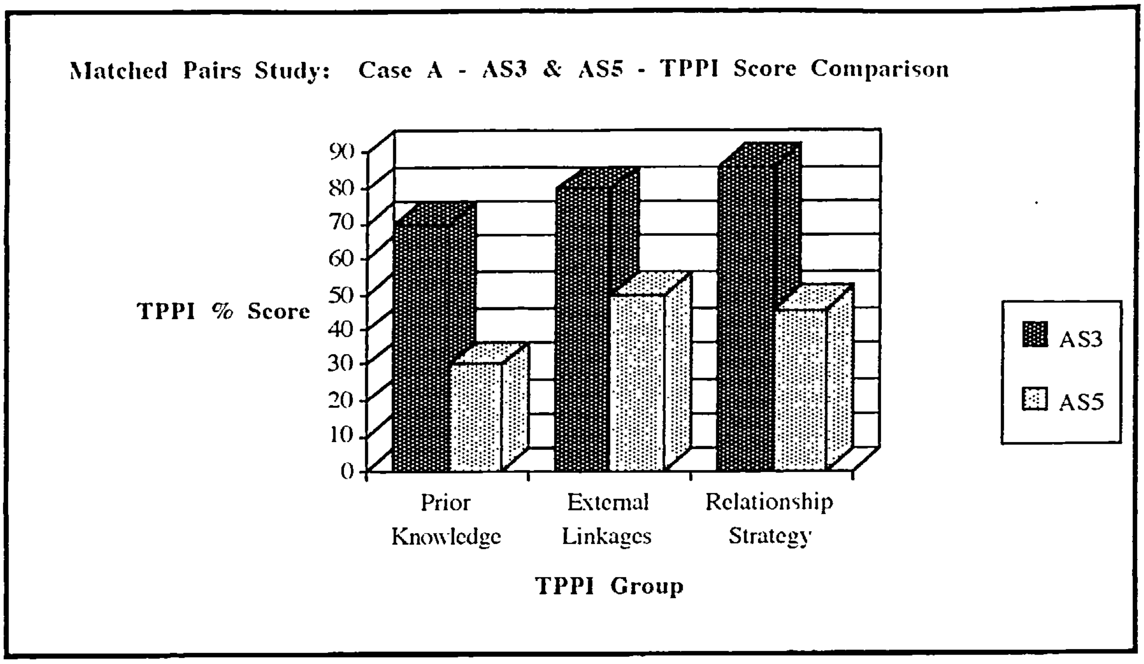


Figure 7.11: Quantitative evidence: Sales turnover AS3 and AS5

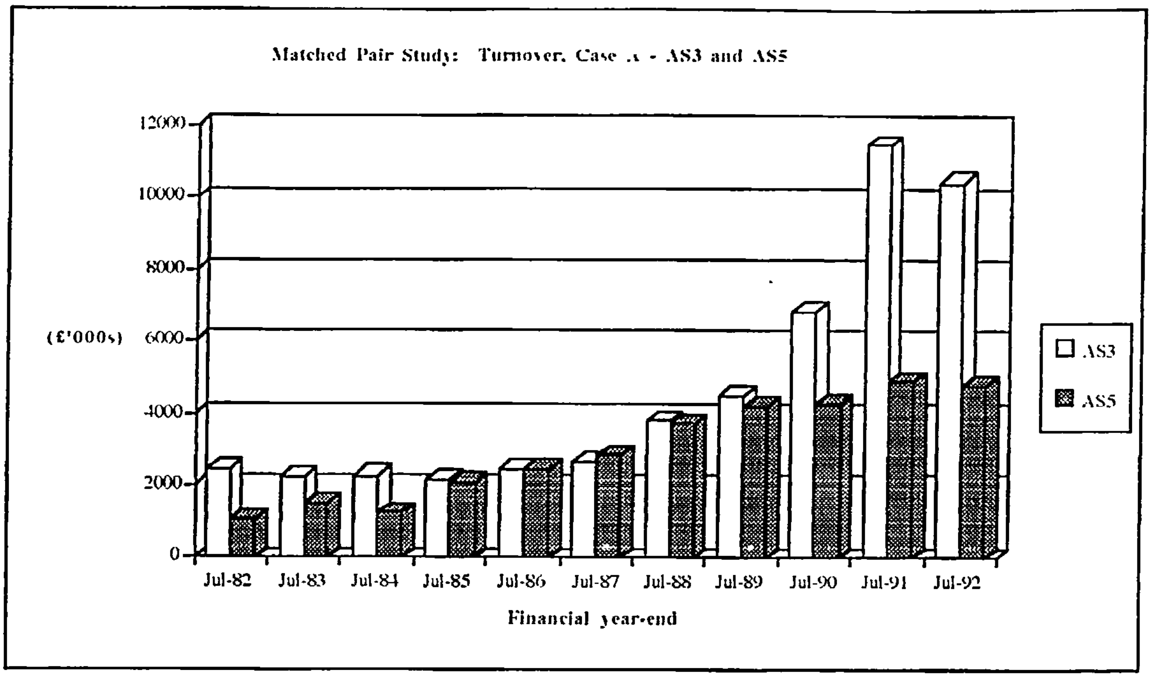


Figure 7.10 and 7.11 above reaffirm some striking differences between the two firms both in terms of management response to partnering and financial performance. This analysis suggests that AS3 are good at partnering but also demonstrate good financial performance. While some care in interpreting these results needs to be taken, they do suggest that firms which display good partnering capabilities and are generally 'receptive' to learning from outside sources, also increase sales each year and strengthen their balance sheet.

7.4.2 Case B: AS2 and AS7

Two visits to AS2 were made: the first in February, 1993 to assess the firm's general approach to partnering with their customers, and the second in May, 1993 to test their reaction to a research proposal, (see above). Two visits to AS7 were also made: the first in February, 1993 and the second in November, 1994 as part of a 'motor industry revisited' study.

As the table above indicates, these two firms share a very similar profile in terms of product group and customer base. The only difference appears to be with regard to each firm's status - AS2 is independent whereas AS7 is owned by Eagle Pilcher Plc. To some extent, the difference may be seen with regard to each firm's approach to scanning for technology. New environmental legislation in California will ultimately affect the firm's core business in fuel systems. To help AS7 find a solution to meet the new legislation, Eagle Pilcher the supplier to a US firm that were carrying out leading-edge work in the area of emissions.

In addition to a wide base of technical contacts, the MD remarked,

"We improve our knowledge through employing capable science doctorates with many years of experience."

Overall, there is little doubt that AS7 trawls far and wide for technology - proven solutions and technical expertise - that will help it speed-up their own in-house developments.

Conversely, component supplier, AS2, appear to insular in their approach to technological development claiming that lack of money prevents them from developing their technology base. In discussing one of two research proposals - the concept of a technology development consortia led by a vehicle assembler with input from an RTO, the MD was not attracted by any such arrangement. The MD remarked during interview,

"Everything we do here, we do ourselves. The problem is in the area of finance."

The company ran into financial difficulties during late 1994 and closed in the early part of 1995. This example may bring real meaning to the DTI's phrase, 'innovate or liquidate'.

Again, the division between the two firms is made clear given the TPPI results across the three core areas (figure 7.12) and the financial performance in terms of turnover (figure 7.13).

Figure 7.12: Semi-quantitative evidence: AS2 an AS7 Technology Partnering Performance Indices

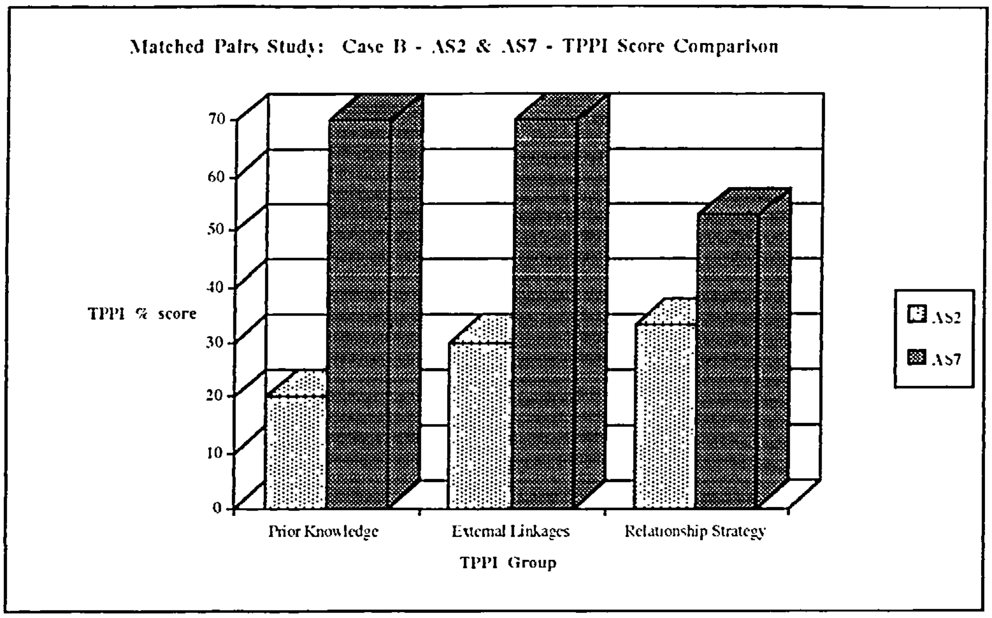
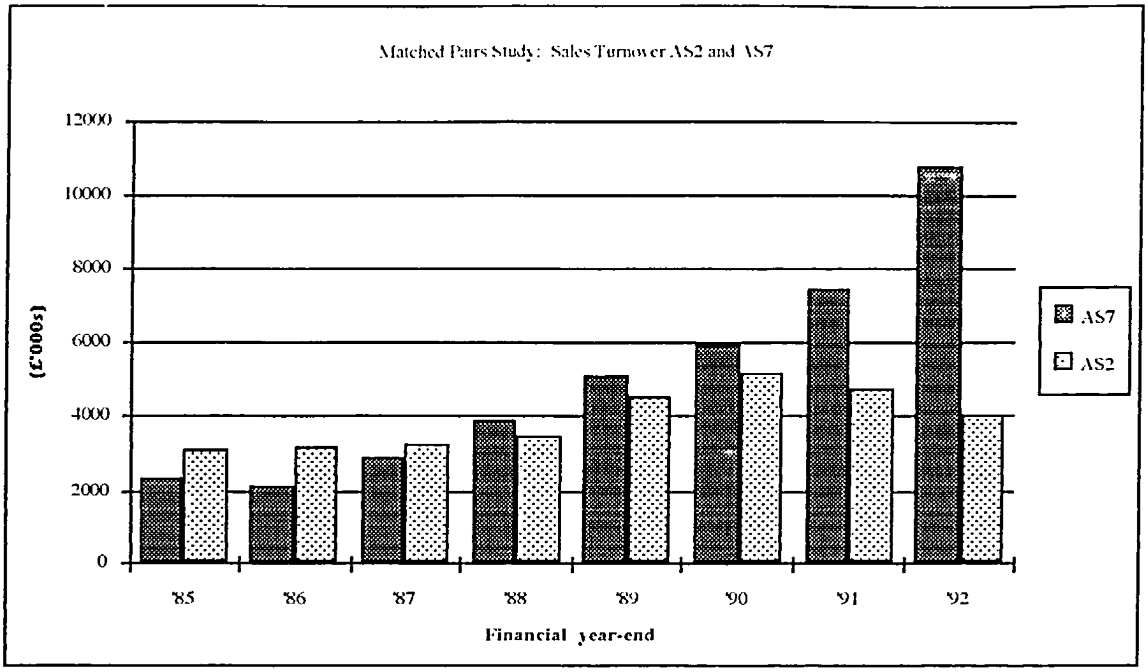


Figure 7.13: Quantitative evidence: Sales turnover AS2 and AS7



7.4.3 Case C: AS4 and AS6

One visit was made to AS4 in May 1993, again, to assess their general response to two research proposals. Two visits to AS6 were made; the first in February 1993 during the first round of interviews and the second in July 1993. The second visit came about through an earlier interview with AS21 when the Purchasing Director provided the opportunity to accompany an Industrial Engineer from AS21 to visit AS6 as part of a supplier quality assurance assessment. This was the second quality assurance audit performed by AS21 in two years. The aim of the visit was to gauge, using the same criteria, the level of improvement since the last visit. The criteria included: quality planning and education; management commitment; technical support; gauge control; incoming material; statistical process improvement; manufacturing system control; material identification handling. Where a supplier achieves a score of below 49 per cent this is unacceptable to the customer while a score in the region 90 to 100 per cent is considered as outstanding performance. AS6 scored 80 per cent following the first audit and 85 per cent after the second. Consequently, it remained a preferred supplier to AS21. Given that AS21 were in the process of reducing their supply base (1988: 248 suppliers, 1993: 96 suppliers), it was not surprising that the management of AS6 were particularly co-operative during the Engineer's visit.

During the first interview with AS6 the Technical Director revealed how they are continually exchanging ideas with customers (eg AS21) and other firms (eg AS16). The Director referred to the firm's general openness in co-operating with others providing a clear objective has been set and the outcome will benefit all concerned. Conversely, in discussions with the Managing Director of AS4 about the sources of external technical help and assistance, the MD added,

"We wouldn't like to become involved in any formal or even informal collaborative arrangement with anyone unless we had to. If we don't earn the Rover Group 2000 standard next November (1993) then we would have to reassess our own in-house capabilities and, if it came to it, seek external help from outside.... ultimately, the driving force to any type of co-operation would have to come from the assembler."

AS6 was less than happy when recalling the perceived benefits to their company following a recent visit by one of Rover Group's Core Team which spent four days at their site.

Figure 7.14: Semi-quantitative evidence: AS4 and AS6 Technology Partnering Performance Indices

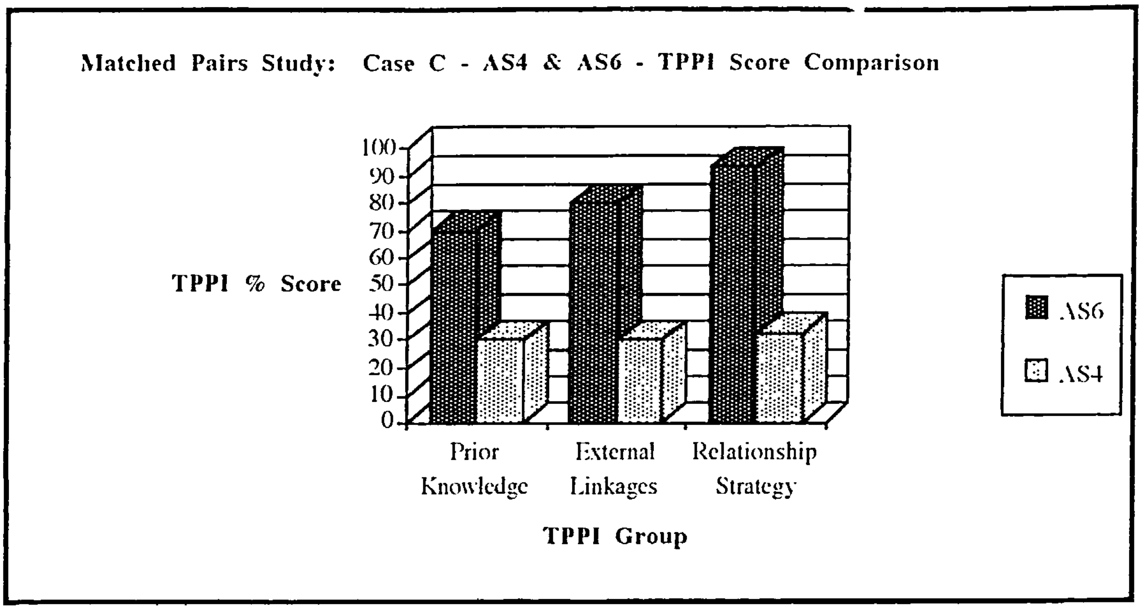
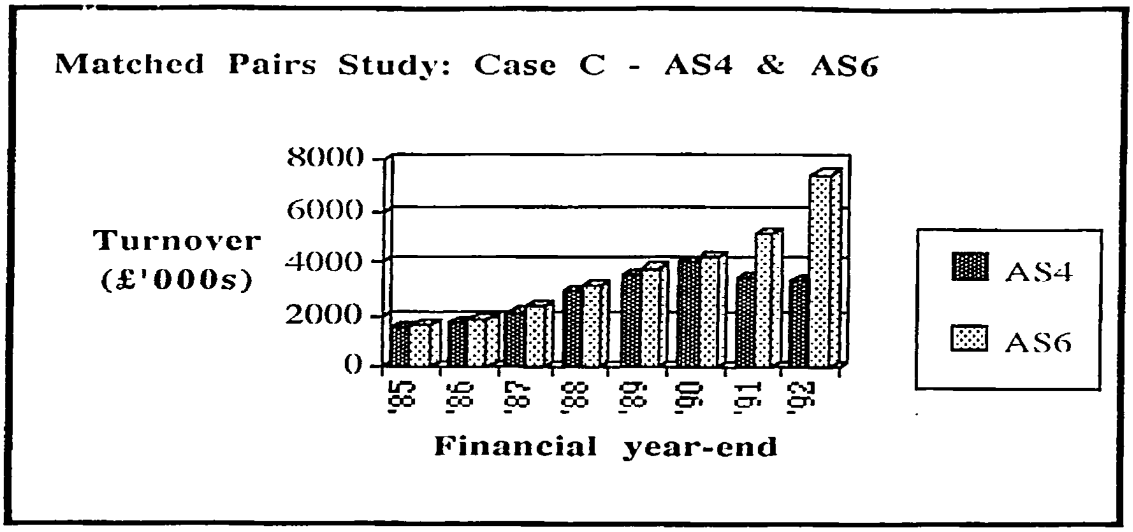


Figure 7.15: Quantitative evidence: Sales turnover AS4 and AS6



7.4.4 Conclusion:

The matched pairs approach has provided some insights into the differential capability of some firms, with very similar characteristics, to partnering as an approach to enhancing their knowledge base. The main facet which sets each pair of firms apart is their *managerial attitude and response to sharing technical know how.*

These results, some perhaps expected with others more surprising, add valuable information to our search to understand the factors underpinning good technology partnering activity. They are also helpful in considering what might be considered good management practice. A pattern of overall turnover growth amongst the 'better' firms, ie AS3, AS7, and AS6 was contrasted with turnover stability in the matched firms. Furthermore, two out of three of the 'better' firms are owned by international groups enabling them to widen their search for technology. However, on the basis of these three studies, the results indicate that the customer base has little influence on the firm's response to partnering. In other words, the response to technology partnering is internal to the firm and not influenced by who it supplies. Similarly, the age of the firm appeared to have little or no bearing on the supplier's response to collaboration.

The importance of the matched pairs approach in relation to analysing the data through a scatter diagram approach is clear. These studies have shown that by identifying firms with very similar characteristics and then comparing their approach to technological collaboration, striking differences are revealed, both in qualitative and quantitative terms. While care must be taken in interpreting the results, ie good partnering performance may not be the sole cause of an increase in turnover, the studies give strength to the view that partnering can contribute to a company's overall performance and competitiveness.

7.5 Networking and the role of intermediaries in the motor components sector

7.5.1 Introduction:

Chapter two introduced a brief review of the innovation network literature. Chapter five then developed a group of measures to judge the extent a company networks with other organisations, (Technology Partnering Performance Indices, Group One and Two). In the same way that the direct telephone conversations with assemblers placed some suppliers' capabilities and managerial attitude into sharper focus, this section examines three industry-specific initiatives that underpin the practice of sharing knowledge and ideas. On the premiss that membership of such initiatives is good evidence to support the view that such firms are 'receptive' to sharing ideas and learning from others, it examines their membership. The initiatives are 'Learning from Japan', 'Engineers to Japan', and the Society of Motor Manufacturers and Traders Industry Forum.

The discussion is set firmly within the context of intermediaries (or technology transfer agencies) and their role in supporting and facilitating the transfer knowledge. The three initiatives and those highlighted in the second phase (offshore industry) each represent facilitating schemes or forums to support the exchange of know how. The following three sections briefly describe the work of the initiatives and then an evaluation is made in relation to this study.

7.5.2 Learning from Japan Initiative:

The Learning from Japan Initiative is a two year programme sponsored by the DTI's Vehicles Division to enable a group of twelve UK second tier suppliers to achieve world class levels of performance. The initiative's objective is to demonstrate that UK component suppliers can become world class with practical experience of how to implement best practice.

A telephone call to the DTI Vehicles Division revealed that the twelve firms were selected mainly on the basis of their managerial attitude rather than a pre-defined set of wide-ranging criteria. The Japanese transplants were first asked for contact and company names of second tier suppliers which would be,

"... receptive to a learning opportunity ... enthusiastic. We appraised each company by a general feel ... there was no scientific procedure. We wanted to ensure that we had a good spread of companies geographically as well as in different product groups. In addition, the companies must not be big in the UK even though they may be elsewhere, for example, INA."

To confirm these points independently, the financial records of each company participating in the Learning from Japan scheme were collated to assess their relative strengths. Appendix G presents this information and clearly indicates that the average financial performance indicators spanning a four year period from 1989 - 1992 for each company differ considerably, eg the average four year sales growth ranges from - 6 per cent for one participant to 25 per cent for another.

This insight is particularly interesting given that three of the twelve suppliers in the programme were under study in this project. It is perhaps not surprising that the three companies all rank high in the TPPI. Further comment regarding this group will be given within chapter nine.

A supplier visited during the project and taking part in this initiative remarked about the benefits,

"It makes employees aware of new systematic Japanese competition. It stimulates the thinking in many different areas enabling us to address particular weaknesses. It frames the potential benefit of Japanese working practices."

While continuing the 'Japan' theme, it is widely recognised that this country has something unique to offer in terms of its technology and the ways in which companies successfully commercialise new products or develop existing products. However, it is only the most senior executives in industry who have the opportunity to see first hand how Japanese companies operate. The next section highlights another UK industry initiative yet open to a wider membership: The Engineers to Japan Scheme.

7.5.3 Engineers to Japan Scheme:

The central aim of the Engineers to Japan Scheme is to assist British companies develop their strategic links with Japanese companies ***or learn from best practice.***

Two component suppliers' visited during the research study which again emerged as 'better' firms at technology partnering (using the technology partnering performance indices in the last chapter) are active participants in the Engineers to Japan Scheme: AS8 and AS16. The following provides a brief insight into the style of the scheme from the point of view of two engineers.

"Graham Collin and Mike Clements are engineers with AS8 Limited and AS16 who supply Toyota with parts for car body shells. The Engineers to Japan scheme enabled AS8 and AS16 to send an engineer to Toyota Motor Corporation to learn more about Toyota, their culture and manufacturing systems. The aim of the secondment was that AS8 and AS16 could learn from best practice, enabling Michael and Graham to then return to the UK equipped with the knowledge to steer AS8 and AS16 towards becoming world class. The work programme agreed on by the companies focused on the design, development and manufacture of car body shells."

Engineers to Japan Scheme Lecture (Royal Academy of Engineering (1995))

The following section briefly reviews the third industry-specific initiative found during the research and broadly supporting the importance of inter-firm networking. The Society of Motor Manufacturers and Traders (SMMT) Industry Forum which has as its primary aim to support the achievement of sustainable world-leading competitiveness in the UK-based vehicle and components industry.

7.5.4 The SMMT Industry Forum:

The main thrust of this initiative is to develop 'partnership' sourcing rather than the traditional 'adversarial' relationships in UK vehicle components sourcing. As part of the initiative, the DTI Vehicles Division and the SMMT commissioned a review of the relationships between vehicle manufacturers and suppliers, Lamming (1994). The author concluded that 'the necessary levels of inter-firm trust were not present in the industry for lean supply - and therefore comprehensive lean production - to become a reality.'

One route to strengthening the levels of trust between supplier and assemblers is more interaction enabling each to gain a better understanding of each others' capabilities as well as business problems. In other words, a good commitment from the assemblers to the Forum is a prerequisite to success. Commenting on the launch of the Forum, all the major vehicle assemblers were generally supportive and pledged their support, SMMT (1994).

A telephone call to the SMMT revealed that barely 15 per cent of those firms' visited were members of the Forum. This may partly reflect the infancy of the Forum. Interestingly, the companies under study in this research and members of the Forum were AS9, AS16, AS19, AS25 and AS26. All these firms again ranked in the top quartile of the TPPI measure.

In addition to these three industry initiatives, a number of purchaser and supplier networks have emerged. For example, the Regional Supply Network became operational in 1995. Ten Regional Supply Offices (RSOs) funded by the DTI and covering the whole of England, are now in place. They aim to strengthen the links between purchasers and suppliers in the region and, as part of a national network, help increase the competitiveness of UK industry.

For the major purchasers, the RSO can offer advice on alternative competitive suppliers. They promote themselves as being 'a valuable extra resource for your procurement team.... For the supplier, the RSO can offer an assessment of the supplier's tendering processes allowing them 'to become more competitive.' They also claim to assist by presenting a supplier' capabilities to purchasers who may be unaware of the supplier.

Although the links developed from involvement in the RSO are perhaps not as broad as those which could be developed within the above initiatives, this mechanism does support the idea of networks and 'membership' further suggests that the supplier is receptive, albeit in a limited sense.

7.5.5 Evaluation of initiatives:

So far, three mainstream initiatives have been highlighted that, arguably, support the view that SMEs ought to network with each other in order to enhance their own technical capabilities. It has been argued that active participation in such initiatives in itself is yet further evidence to support a view of a component supplier's receptivity towards partnering. Another notable organisation that exists to support the efforts of British industry is the CBI; membership of which may further support the view about the individual firm's preparedness to listen to and share ideas with others.

Table 7.2 summarises the motor industry initiative membership including the CBI members in relation to the sample of firms visited. At a glance, the firms that are members of two or more initiatives include: AS3, AS9, AS16, AS19, and AS26.

The extent to which facilitating organisations enhance a firm's technical capabilities through providing a intermediary role is questionable. Lefever (1992) noted from the results of an industrial survey that whilst conventional sources of technology such as research associations, companies in the same market, component suppliers, and universities were widely used by firms, most made very little use of intermediaries.

"The lack of use made of other intermediaries can only be explained in two ways. Firstly, it is possible that industry is totally unaware of intermediaries, or secondly that industry does not generally consider intermediaries are well placed to meet their needs."

Table 7.3

Motor Industry Initiative Membership

Industry Initiative Membership:	SMMT Forum	Engineers to Japan	Learning from Japan	CBI member
AS1	No	No	No	No
AS2	No	No	No	No
AS3	Yes	No	No	Yes
AS4	No	No	No	No
AS5	No	No	No	No
AS6	No	No	No	Yes
AS7	No	No	No	No
AS8	No	Yes	No	No
AS9	Yes	No	Yes	No
AS10	No	No	No	No
AS11	No	No	No	No
AS12	No	No	No	No
AS13	No	No	No	No
AS14	No	No	No	No
AS15	No	No	No	No
AS16	Yes	Yes	No	Yes
AS17	No	No	No	No
AS18	No	No	No	No
AS19	Yes	No	Yes	No
AS20	No	No	No	No
AS21	No	No	No	Yes
AS22	No	No	No	Yes
AS23	No	No	No	Yes
AS24	No	No	No	Yes
AS25	Yes	No	No	No
AS26	Yes	No	No	Yes
AS27	No	No	No	No
AS28	No	No	No	No
AS29	No	No	No	Yes
ASMP	No	No	Yes	No

The table above indicates the low membership level given the sample of firms visited. This may reflect either the relative infancy of the groups, ie the Industry Forum began in 1994, or the restricted membership, ie the Learning from Japan initiative is confined to twelve member firms, or the actual appeal of the facilitating groups to the supplier firms. Inevitably, some small firm management feel that their time would be better spent establishing local contacts through chambers of commerce, TECs, and trade associations. Indeed, with so many free or heavily subsidised services to small firms, it appeared that these firms were directing their efforts towards them rather than become establish a wider network of contacts.

The next chapter concludes the data analysis within phase two of the research - the offshore supplies industry.

Chapter Eight: Results and preliminary analysis of the study of the evolvement of partnering in the offshore supplies industry: Phase two

8.1 Introduction

The previous two chapters considered and applied two measures of data analysis: The Technology Partnering Performance Indices (TPPI) measure and the collection of Qualitative measures. The TPPI is a research tool to measure each firm's capability level and response to technology partnering. While this measure attempts to pull together a collection of qualitative variables considered important to creating and maintaining a successful partnership, clearly many other factors come into play. The second collection of data evidence represented a set of broad contributory factors thought capable of influencing the progress of a technology partnership. A third, but subsequently, minor collection of data evidence represented the financial performance details of each of the firms' interviewed. This was referred to as 'quantitative'. The aim was to establish any interrelationships between, say, technology partnering and the impact on a company's 'bottom line'.

Further work using the three main tools to analyse Phase One resulted in three general findings/outputs. First, the interrelationships between the semi-quantitative and the quantitative data was weak. Consequently, the emphasis switched back to exploring the qualitative and semi-quantitative in greater detail. The second finding was the identification of fairly distinct levels of partnering arrangements, characterised by different managerial attitudes and behaviour. The third finding related to the TPPI measure of analysis and confirmed the importance for firms to maintain their external linkages with various sources of expertise. Although the TPPI is not meant to act as a rigorous test of each company's partnering performance, it does aim to provide a *guide* towards identifying some best practice characteristics. Following an analysis of the TPPI scores using a statistical package (SPSS) it was found that the most significant category was group two which related to a firm's internal and external linkages, ie reaffirming the importance for firms to network to enhance their in-house knowledge base. It was also found that, in terms of external linkages, the top seven TPPI performers in the component supplier sample were much more closely linked to the formal local business network. In addition, this group appeared to employ over 20 per cent of qualified scientists and engineers to other staff whereas the weaker firms employ less than 10 per cent. These three findings generally supported the propositions either collectively or in part.

The picture that emerged in chapter seven (figure 7.3) depicted four distinct groups of firms that, based on the qualitative and semi-quantitative data analysis alone, have different approaches to partnering. Then, in order to display the specific properties of particular partnering arrangements and to act as a stepping stone on the guide to best practice, three case studies were presented depicting three levels partnering activity.

In this chapter, a similar exploratory route to that taken earlier is adopted in order to reveal how partnering works in the offshore industry. Chapter four explained why this particular study was undertaken and the sponsor-specific aims. There are several similarities in data analysis approach between the two phases. Section 8.2 re-introduces the TPPI measure and presents the resultant 'scores' for some 13 offshore SME suppliers that were interviewed in England and Scotland during summer, 1994. This information is again transposed onto the data or 'partnering' fields using all available information. Some discussion is given to the quantitative data collated yet, as the first finding noted (above), the interrelationships between the quantitative and other two sets were weak. Consequently, this is not treated in depth in this chapter.

Section 8.3 presents three firms' approach to partnering within two case studies. In the last chapter, an historical/descriptive scene of each firm's partnering arrangements was presented. While, the cases here provide an insight into various partnering arrangements; the emphasis is both historical and exploring each firm's outlook for partnering. A summary of learning points round off each case study.

Section 8.4 presents a discussion of what was found during phase two of the research. This discussion uses qualitative evidence such as management comments heard and recorded during interview to enrich various points. The importance of networking re-emerges here and three examples of industry groups playing an intermediary role in technology transfer are considered and their benefits to small firms.

Finally, section 8.5 considers what this phase of the research has uncovered and whether it supports or dispels the original propositions.

Before continuing, table 8.1 reiterates the more specific OSO project aims of the second phase and indicates the relationships to the propositions.

Table 8.1 Research Propositions: Relationships to OSO Project aims

OSO Project Aims: / Research Propositions:	1	2	3	4	5
(i) To judge the strength and variation of existing alliances between oil companies, contractors and suppliers.	√	√	√	√	-
(ii) To identify how alliances have contributed to the development of new or existing technologies.	√	√	-	-	-

It was anticipated that the first OSO project aim would help to test research propositions one, two and three, (section 3.2). The qualitative judgment of the variations in partnering arrangements form one firm or cluster of firms to another brings to the fore the importance for partnering participants to have good external linkages. In addition, understanding the similarities and differences in managerial attitude between firms (proposition three) and gauging those factors correlates closely to the first OSO aim.

The second OSO aim generally pursues the first and second research propositions, namely, that external linkages are an important part of successful technology transfer and good internal communication channels are important for knowledge transfer.

The following section presents the analysis of the semi-quantitative data, mainly representing the TPPI measure of data analysis.

8.2 Analysing the semi-quantitative data

Figure 8.1 depicts the ranked order of offshore suppliers in terms of the overall TPPI percentage scores and table 8.2 provides the actual TPPI scores. Although the sample population is too small to make generalisations, at first glance the group shows the divided differences in internal capabilities to partnering.

Figure 8.1

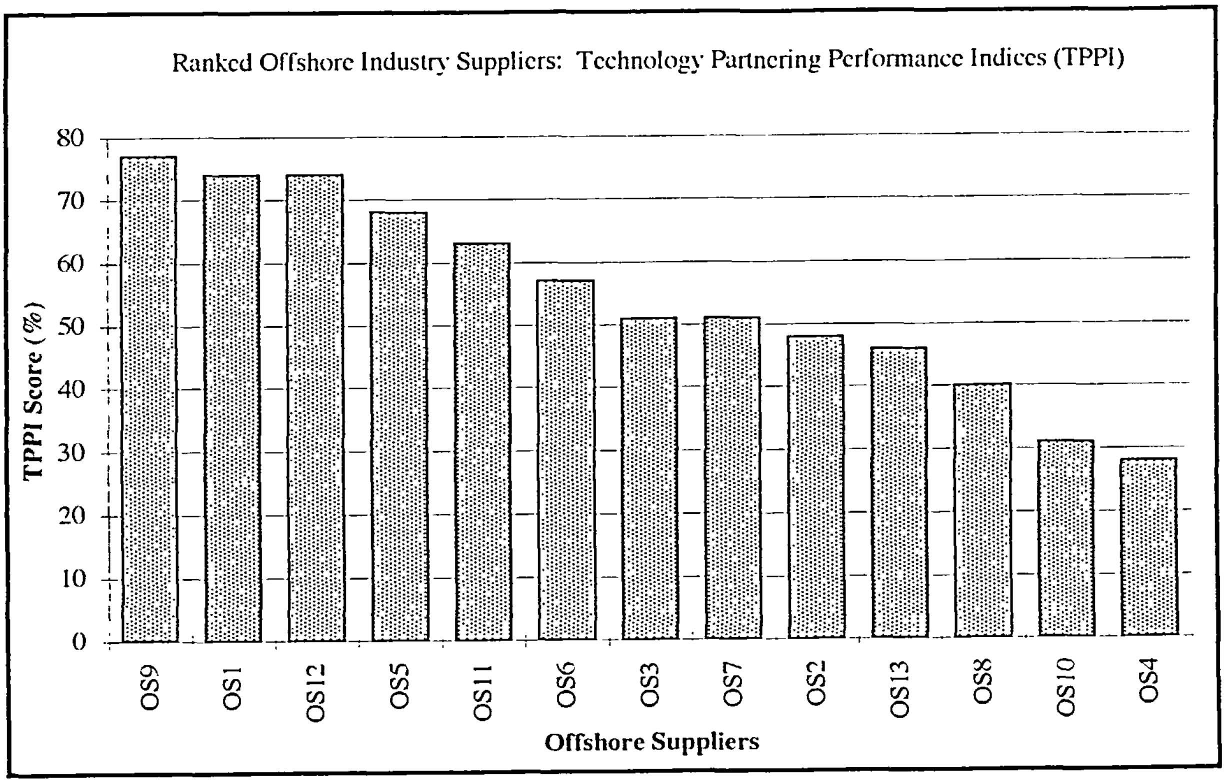


Table 8.2

Technology Partnering Performance Indices:
Offshore Industry Supplier Scores

SUPPLIERS	Group 1			Group 2			Group 3						4
Offshore	A	B	%	C	D	%	E	F	G	%	Score	%	H
OS1	4	5	90	5	2	70	0	5	5	66	26	74	80
OS2	4	5	90	1	2	30	0	3	2	33	17	48	35
OS3	3	5	80	3	2	50	0	3	2	33	18	51	35
OS4	1	5	60	1	1	20	0	1	1	13	10	28	20
OS5	4	5	90	3	2	50	0	5	5	66	24	68	85
OS6	4	5	90	3	1	40	0	3	4	46	20	57	65
OS7	3	5	80	1	3	40	0	3	3	40	18	51	55
OS8	2	5	70	1	2	30	0	1	3	27	14	40	50
OS9	4	5	90	5	3	80	0	5	5	66	27	77	85
OS10	2	4	60	1	1	20	0	1	2	20	11	31	30
OS11	4	4	80	3	3	60	0	3	5	53	22	63	80
OS12	4	4	80	5	3	80	0	5	5	66	26	74	80
OS13	4	4	80	1	3	40	0	3	1	27	16	46	25

Key:

A	Degree and depth of technology scanning
B	Number of professional engineers
C	Alliance organisation and structure
D	Range of external organisations consulted
E	Frequency of technical personnel exchange with customers
F	Frequency of inter-firm multi-disciplinary meetings
G	Receptivity toward partnering
H	Overall impression of supplier's strategy and managerial attitude toward partnering

As the last chapter argued (section 7.2), active participation in 'industry initiatives' may give a good indication about a supplier's receptivity towards partnering and its preparedness to share knowledge. Information on three such initiatives was gathered while actual membership data was confined to two groups based in Aberdeen: the Scottish Subsea Technology Group and the Scottish Oil and Gas Innovation Forum. Table 8.3 shows the membership with regard to the Aberdeen suppliers' interviewed:

Table 8.3

Offshore Industry Initiative Membership

Industry Initiative: Aberdeen Supplier Membership (Aberdeen-based companies)	SSTG	SOGIF
OS1	Yes	No
OS3	No (resigned)	Yes
OS5	Yes	Yes
OS6	Yes	No
OS8	No	No
OS9	Yes	No
OS10	No	No

This table indicates that OS8 and OS10 have no participation in either group. This partly confirms the TPPI positions on the partnering fields; these two firms may be found occupying the bottom quartile. Conversely OS5 is an active member of both groups and where the MD was recently elected a director of the SOGIF.

Consistent with the process of analysis presented in chapter six, the same set of quantitative data (financial performance information) was collated for each firm and the interrelationship with the TPPI results assessed; first using rudimentary spreadsheet and second with the aid of the SPSS package. Consistent with the earlier conclusion, no clear relationships exist. A list of tests conducted is presented in Table 8.4. No significant correlations are revealed.

Chapter six explored the sources of technical advice and assistance which the motor component firms' interviewed could have used to overcome their technology related problems may be explored. The same analysis is performed here indicating that the top performing TPPI companies (or those on the far left of figure 8.1), are likely to have contacted a much wider range of organisations than those at the lower end. This analysis showed that this group of companies contacted on average 6 organisations, compared with an average of 2 for the bottom

Table 8.4

Correlation Coefficients using SPSS

Class/Group OFFSHORE	A	B	C	D	E	F	G	H	GP 1	GP 2	GP 3	PAT	ROCE	SALES	Class/Grou OFFSHORE	Mean	Std Dev	Minimum	Maximum
A	1	-0.294	0.5	0.5433	0	0.8181	0.5938	0.6268	0.8975	0.6767	0.7571	0.0167	0.341	0.1163	A	3.31	1.03	1.00	4.00
B		1	0.016	-0.3	0	0.0703	0.025	-0.1038	0.0461	0.3212	0.0461	-0.1135	-0.1257	-0.4445	B	4.69	0.48	4.00	5.00
C			1	0.309	0	0.8216	0.8083	0.7989	0.5563	0.9289	0.8724	0.0438	0.1653	0.1844	C	2.54	1.66	1.00	5.00
D				1	0	0.527	0.35	0.4143	0.3854	0.6384	0.4768	-0.1482	0.875	0.4049	D	2.15	0.80	1.00	3.00
E					1	0	0	0	0	0	0	0	0	0	E	0.00	0.00	0.00	0.00
F						1	0.7326	0.7728	0.8126	0.8698	0.9265	0.1718	0.4672	0.1778	F	3.15	1.52	1.00	5.00
G							1	0.9929	0.5782	0.7902	0.9347	0.1286	0.3032	0.0412	G	3.31	1.60	1.00	5.00
H								1	0.6238	0.8076	0.9524	0.1428	0.3032	0.0412	H	55.77	24.74	20.00	85.00
GP 1									1	0.76001	0.7435	-0.0345	0.3173	-0.0646	GP 1	80.00	10.80	60.00	90.00
GP 2										1	0.8914	-0.0222	0.4686	0.3036	GP 2	46.57	20.57	20.00	80.00
GP 3											1	0.161	0.4173	0.1199	GP 3	42.77	19.09	13.00	66.00
PAT												1	0.249	-0.0643	PAT	0.25	0.38	0.00	1.08
ROCE													1	0.3771	ROCE	2.90	18.52	-22.00	35.80
SALES														1	SALES	17.58	23.32	0.00	74.50

Key:

Group 1	Technical Ability
Group 2	Internal and External Linkages
Group 3	Relationship Strategy
A	Degree and depth of technology scanning
B	Number of professional engineers
C	Alliance organisation and structure
D	Range of external organisations consulted
E	Frequency of technical personnel exchange with customers
F	Frequency of inter-firm multi-disciplinary meetings
G	Receptivity toward partnering
H	Overall impression of supplier with regard to its strategy and managerial attitude toward partnering
PAT	Patent Intensity
ROCE	Return on Capital Employed
SALES	Sales Growth

TPPI group of firms. This again confirms that the best practice companies are much more closely linked to the formal local business network. Overall, the most popular source of external advice was 'purchasers' (or oil companies and major contractors) (100 per cent) followed by 'own suppliers' and 'specialist organisations' (equal 69 per cent) whereas the least contacted organisations in the sample of firms' visited were Universities, local colleges, Business Link, TECs, Regional Technology Centres and Technology Transfer Agents. The picture in the offshore industry is one where a cluster of organisation are frequently used yet the 'wider' or less direct organisations are little used. This low usage may be explained by the fact that most of these organisations do not directly supply the technology, but rather carry out a technical evaluation and then make suggestions as to the appropriate technical solution. However, given the assertion that small firms 'often lack the in-house technical resources' to develop such resources, it would be reasonable to expect that small firms make more use of, say, universities. Given that the sample itself is small and it is difficult to make any generalisations about a particular industry sector. In addition to SME offshore suppliers and consultants utilising the expertise of their parent organisation, they have established close links with companies operating in other industries as well as Research and Technology Organisations (39 per cent of the sample). Clearly, this group of organisations have more direct access to the technology they understand and want for their firm. The way that Scottish firms in particular appear to get access to that technology from other firms and specialists is through local facilitating bodies, such as the Scottish Subsea Technology Group and the Scottish Oil and Gas Innovation Forum. These are considered later in section 8.5.

The two case studies that follow describe different partnering arrangements found during the field research. For each of them it describes the origins and progress of the partnership as well as the future outlook and some key features of the alliance.

8.3 Case studies

The first case considers a 'hard' level of partnering where the collaboration activity is meticulously planned and features a significant element of shared development risk between the partners. They are an independent small firm employing some 45 people in Epsom, Surrey. Their annual turnover is approximately £3 m - where 40 per cent is derived from international customers. The second case discusses two firms at different stages along the partnering learning curve: OS7 and OS12. OS7 are based in Ware, Hertfordshire and employ some 20 people who specialise in the design and supply of process equipment to the offshore/onshore gas, oil, and water treatment industries. OS12 are based in Aberdeen and represent a fast expanding company employing over 100 people with an annual turnover exceeding £10 m. The reason for the presentation here is that no clear division could be drawn between 'hard', medium' and 'soft' given the offshore sample of firms. Hence, two firms represent a mixture of the latter levels. These two case studies represent more informal examples of knowledge exchange in offshore technology partnering arrangements.

8.3.1 Example of 'hard' level of technology partnering: OS9

OS9 are active members of the Scottish Subsea Technology Group. The company is organised in three functional divisions:

i) Oil and gas consultancy (engineering) division which addresses the design and technology of oil and gas operations, and has centred its development on capabilities to support the front end engineering and project appraisal activities of oil and gas companies.

ii) Management consultancy division which offers a strategic planning capability to companies in the energy sector.

iii) The Information Technology group which provides an IT management service including the development of bespoke software for its clients .

The company client portfolio has given it experience in a wide range of markets including the Former Soviet Union, Europe, Middle East, South East Asia, and the Americas.

During the late 1980s, OS9 developed QUESTOR, which is a combination of engineering and software skills. QUESTOR offshore is an advanced decision making tool used within all major North Sea oil operators at the prospect evaluation stages to estimate development costs, eg drilling, platform, pipeline costs, etc. It uses a large cost data base collated from extensive research carried out worldwide including the UKCS, Norwegian sector, Gulf of Mexico, West Africa, and South America. This has recently been supplemented by research carried out in the Eastern Bloc - representing probably the most comprehensive single project undertaken by a consulting company on behalf of foreign oil companies to study oilfield practice in the Former Soviet Union, (ROGES - Russian Oil and Gas Equipment Survey). The onshore software is currently used to examine oil and gas development schemes, such as surface drilling, export terminals, onshore pipelines, etc.

The software suite provides the company with a powerful entry point into oil companies at the early stages of asset development. The programmes are being continually developed and maintained following regular user discussions. Although, the software was developed internally without alliance involvement, OS9 received some support from an oil company during the early stages of developing the offshore programme. Ten copies of the package have been sold to Japanese customers whilst a customised version has been developed for Mobil to use in their operations around the globe.

OS9 are currently developing their INPRO system, an engineering tool which allows clients to optimise the design all of the topside facilities in considerable detail. Developed in the Windows environment using Microsoft Excel, it helps the engineer in each step of the feasibility and conceptual design process of an offshore and onshore oil and gas production facility. Again, the INPRO system is being developed in-house without inter-firm collaboration.

OS9's alliance experience to date:

In terms of alliance-type contracts, the engineering division has the greatest potential to enhance their own capabilities. Indeed, they have already created formalised links with other firms. OS9's technological priorities are twofold and focus around subsea engineering developments:

[1] To develop their DEEPSEP (Deep Water Subsea Separation System).
[2] To extend their work on Minimum Cost Subsea Developments, (partly funded by the OSO).

The DEEPSEP alliance:

OS9 initiated and put forward a novel engineering idea for a deep water subsea separation system to a group of oil operators: DEEPSEP. The idea equates to a subsea production and testing facility designed to operate in water depths from 200 m down to 1000 m and at distances up to 50 km from existing infrastructure. It has conventional wellhead completions, subsea manifolds, sand traps, separators and pumps for liquids but one of its unique features is that gas flows freely (unpumped, although a liquids pump module is necessary) back to the host platform. Overall, the design philosophy is one of simplicity and high availability with a minimum number of components, standard wherever possible.

The idea crystallised into a formal proposal and later presented to a select number of oil companies. Four operators welcomed the idea and funded part of the feasibility study along with the OSO and Babcock Energy whilst OS9 provided the balance of costs during Phase One. During the early stages of Phase One, Technomare UK joined the alliance and provided an input into subsea engineering capability. Technomare UK were selected primarily on the basis of earlier contacts and knowledge of deep water developments. The first phase lasted six months and five meetings were held between the participants. An integrated team was formed between Technomare UK and OS9 for the day-to-day management whilst operator personnel provided a valuable input at the monthly meetings. If anything, the balance of power was in the suppliers' favour during these early stages given their indepth technical know how. Indeed, just three months after the project began, an increasing awareness and potential of deepwater developments took a grip which strengthened the partners' power relationship in the market place.

The quantifiable benefits were analysed during this first phase, and it was found that significant economic improvements could be made. OS9 carried out an economic comparison during the feasibility study between DEEPSEP and a conventional production system, both lying in 1000 m of water requiring three production wells and two water injection wells. Although the capital cost of DEEPSEP proved to be one third more than the equivalent cost of the conventional system and annual operating costs were predicted to be 20 per cent higher, production is expected to start at a rate 90 per cent higher than that of the conventional system. The net result is a financial return of 24 per cent pa against 15 per cent for the conventional system. This means that a marginal field which cannot support fixed systems can be developed economically.

The second stage is due to start soon (pre-engineering) and OS9 have secured funding from three operators and the DTI with the possibility of a fourth operator joining the alliance. Depending on the outcome of future meetings, Technomare UK may participate during the second phase. SOCAR, the state oil company of Azerbaijan, have also demonstrated their interest in DEEPSEP and will shortly be introduced into the alliance. SOCAR became interested through earlier work which OS9 had performed. OS9 were appointed technical advisor to the operator for performance of technical support and cost audit work on the Caspian Sea.

In addition, DEEPSEP has now won the support of a group of offshore equipment vendors. The arrangement with these vendors is tentative although it is anticipated that the alliance of suppliers will become formalised and the relationship building will get underway as the project goes through the pre-engineering stage. Although the communication channels between all partners are considered excellent, OS9 expect a few problems to arise as the alliance grows. The key representative suppliers include: Babcock Energy (Pressure Vessels), GEC Marconi (Control Systems), ICI Traceco (Level Control Systems), and Introl (Control Valves).

Future outlook of DEEPEP:

OS9 have estimated that the total market for systems such as DEEPSEP to be 57 units throughout the world over the next 15 years. This represents a value close to £2 billion in goods and services for separators alone. The consultants expect to be 'in the water' with a commercial product by the end of 1996.

The consultants are also involved in advanced discussions with a major fabricator who are interested in investing in the new company, Deepsep Limited. The company will act as the umbrella for the main product and any further subsea technology spinoffs arising from it. It is anticipated that new company would have commercial arrangements with the oil operators - licensing technology where appropriate - and will forge formal alliances with the supplies sector implying further scope for small firms with novel solutions to offer.

Where alliances can work:

Finally, OS9 firmly believe that small firms need to be clear on their own technical and financial capabilities and exactly how close those strengths intertwine with a potential partner. OS9 have worked with other suppliers/engineering consultants which are at the front end of engineering consultancy such as another firm interviewed, OS2, on cross-subsea technology, and AUPEC (Aberdeen University Petroleum Economics Consultancy) on examining tax regimes and other fiscal matters, including risk assessment. These firms have known and worked with each other for several years on an informal basis which has allowed working relationships to develop and accelerate the progress of presenting attractive packages to clients. For example, OS9 have formed a strategic alliance with AUPEC in the knowledge that OS9's consultancy strengths can combine with AUPEC's skills to give a total analytical capability from early appraisal study through to conclusive economic assessment of projects.

Before continuing, some key learning points of this case may be summed up as:

- The importance of good project management capabilities. In addition to the usual skills of overseeing project objectives, budgetary control and man management, technological collaboration often demands special diplomatic skills and powers of persuasion - especially given the relative size of OS9 in relation to the other partners.

- how the consultant was able to trade enough information about the DEEPSEP to make the early part of the collaboration work yet without compromising their independence and attractiveness to other partners.

8.3.2 Example of an informal knowledge exchange arrangement: OS7 & OS12

OS7 Limited are an international engineering firm competing in various market sectors including oil and gas processing, waste water treatment, silencing products, surge control software and hardware, pulsation control, and heat exchangers. They also have considerable expertise in offshore/onshore separation equipment.

At the time of interview, the firm were re-shaping their business to provide an increasing number of 'mini-modules' to medium sized contractors, instead of individual pieces of equipment. The company have observed the trend of contractors creating semi-formal groups during the bidding process calling for larger modules from the suppliers - typically up to 1500 tons. OS7 have, therefore, begun to consider aligning themselves and formalising links with other suppliers with a view to creating technology partnerships.

Current technology alliances:

Despite the relative early stages of alliance arrangements across the offshore supplies industry, OS7 are currently holding advanced discussions with a major Norwegian contractor with a view to forming a technology alliance to support the Norne project for Statoil. This contractor already exerts considerable influence in the Norwegian sector and is capable of providing large modules through to the complete platform. From the contractor's point of view, they selected OS7 on the basis of their mix of engineering design skills, their (self-funded) research and development activity exploring process internals, and their shared managerial outlook towards technology partnering.

Present and future prospects of alliances with major UK contractors:

Given the reduced manpower levels within the major contractors, the larger 'packages' previously undertaken using in-house resources are being issued for enquiry. It is almost inevitable that alliances will have to be formed between firms to deliver the requirements. However, the magnitude of most projects - even sub-divided - is beyond the capacity of the small firm hence the opportunities to partner directly with the major UK contractors is reduced.

However, the company predict better opportunities to partner with the smaller contractors which have recently broken into the sector from a consultancy base. The following case conveys OS12's approach to partnering and their direct involvement in steering a technology committee.

Another supplier interviewed, OS12, is slightly further into the development of technology alliance arrangements. OS12 are leaders in developing specialised niche markets predominantly in the design and development of offshore pumping equipment and cold tubing. Whilst there are many other firms offering similar equipment and services, they are not direct competitors to OS12 because they fail to match the firm's capability of design through to execution. In other words, the highly specialist nature of OS12's work means that they have few competitors. In addition, given their product base and track record on delivering performance improvements directly to the operator, OS12 compare favourably against some of the major contractors such as Halliburton.

OS12 had already become a key player on the Forties Field with BP prior to being offered the alliance-type well management contract. Simultaneously, BP asked their supply base to form strategic alliances amongst themselves in order to combine the skills and resources required to carry out the project. OS12 then considered the complete range of options available to them: from partnering with one or two firms to setting up several alliances with a variety of firms each bringing new skills to the team. In the interests of demonstrating commitment to BP, OS12 decided to consolidate their efforts into one alliance and reached an agreement with Schlumberger. Camco, and Dowell, (which later became known a- the CDP alliance). The benefits to OS12 as an independent firm are many. Not least, they are able to use the early research and development results of the Schlumberger Group to strengthen its input into the alliance as well as test ideas amongst a wider network of experts without any qualms about confidentiality.

BP sought to ensure at the pre-qualification stages that the internal structure and the day-to-day management of the alliance would be managed by the parties themselves. As part of this alliance, BP chairs the Technology Committee, which is made up of member representatives, meets as and when required to discuss ideas and report on any relevant new technologies emerging from the supplies sector. In other words, the internal structure of the alliance effectively prevents 'lock-out' situations for small firms. Indeed, Bower and Keogh (1995) noted recent operators' comments that they are collaborating with 'outstandingly innovative small firms'. If a supplier/consultant can demonstrate an innovative piece of technology that can improve performance, the Technology Committee ensures that representatives from these firms are invited to present their case to the Committee. After agreement, the technology can then be imported into the project and/or modified quickly using the partners' facilities.

Whilst the CDP alliance began with a loose structure, it has become more formalised with an agreement in place. A dedicated CDP office staffed by seconded operations supervisors from each firm looks after the Forties project.

In summary, OS12 believe that to succeed in alliances, small firms must be more creative in their approach to collaborating with other firms. Every alliance must have an internal structure which is agreed from the outset that enables the swift introduction of new technology from outside the alliance. The company considered that the Scottish Subsea Technology Group played an excellent intermediary role in helping small firms to learn about each others capabilities and present their case to operators.

8.3.3 Offshore Supplier Comparison: OS4 and OS5

The following presents a brief comparison study between two firms that, on first glance have many similarities, yet their approach and response to partnering is very different. Both firms design and manufacture products mainly for the oil-related sectors, they earn an annual sales turnover of less than £2m, employ less than 15 people, are less than ten years old, and are located in two commercial centres of North Sea activity: Aberdeen and Great Yarmouth.

OS4 have become a leading firm in the design and production of specialised inspection equipment. The company began with a product base limited to pipeline X and gamma ray crawlers and associated equipment, and subsea CCTV systems. The product range has been extended to include a 6 MEV Betatron providing a high energy portable X-ray generator, radiation monitoring and warning equipment, microfocus X-ray systems for laboratory and other medical applications. Recent offshore developments include a subsea pipeline inspection system to operate with Remote Operated Vehicles (ROV) in order to provide a positive radiographic system to check for siltings, scour and corrosion inside pipelines. The company won a SMART award (Small Firms Merit Award for Research and Technology) in 1992 to develop a miniature portable X-ray stress analyser. The product would satisfy the industrial need for high speed low cost and simple to use X-ray diffraction measurement equipment.

OS5 manufacture and supply leading edge subsea electronic and robotic products to the ROV and other markets. The company's main markets are in Europe, Japan and Scandinavia with business also gained in Australia, the Middle East, Poland, Singapore and the USA. In 15 countries the company has agents chosen for their market knowledge. In addition to the international oil and gas industry they sell to a number of other industries, including fishing, nuclear and defence. They won the International Award, presented by the American Marine Technology Society at a major technical conference in San Diego. This award was for the 'Entrepreneurial Introduction of Innovative Products to the International Community'. In addition to active participation with the Scottish Subsea Technology Group where the Managing Director was recently appointed a director of the Group, OS5 provide full support to the Scottish Oil and Gas Innovation Forum. The SOGIF aims to assist SMEs enhance their international performance through innovative product and process design. OS5's recent technological advancements include the development of the QHP Quadruple Head profiling Sonar package, which uses two profilers to map out the sea bed on either side of a pipe, with two additional profilers mapping the lower part of the pipe to determine if it is actually sitting on the sea bed. Trials have already proved successful.

Approach to technology partnering:

OS4 does not have any formal offshore technology alliances with other companies, either locally or nationally. Most of their equipment to date has been bought by contractors single sourcing North Sea clients; typically for pipe laying contracts. Nearly all development work is funded internally, (except for current OSO support for an Underwater X-ray Inspection System, and earlier DTI (SMART) funds).

The technology need is principally derived through individual customers approaching OS4 and defining their unique requirements. OS4 then develop the solution by adapting an existing piece of kit to meet their needs. For example, OS4 recently developed a compact Betatron accelerator for electron beam radiotherapy which has just begun retailing at one tenth the value of its nearest competitor. An existing piece of technology was modified to produce electrons with sufficient penetrating power fit for cancer treatment purposes. OS4 considers its strength to be in enhancing its own technology and using it to expand into different markets whilst continuously improving the quality of the product. Cost reduction considerations, whilst important, are not the main consideration given the size of the firm, the volume of machines sold annually, etc. The CRINE initiative has made minimal impact on the firm.

Meanwhile, OS5's Managing Director has created a strategy where, instead of creating formal alliances, their philosophy is to continually develop a strong international network of experts from a range of engineering disciplines from which to seek help and identify industrial needs. The breadth and depth of OS5's senior management in subsea engineering enables them to select the best sub-contractor either locally or abroad.

However, some international alliances have been undertaken. For example, through careful selection, OS5 initiated an alliance arrangement with an American firm to produce Netsweep 325; a high performance and cost effective trawling sonar system, based on the well proven industry standard ST325 sonar. OS5 selected the partner principally because of their considerable experience in the North Pacific and Alaskan trawling markets. The first units have already been sold in these markets with continuing trials in the Balkan Sea.

In addition, OS5 linked with another firm several years ago to find a better solution in underwater dredging operations both in the offshore oil industry and ordnance recovery work for the Ministry of Defence. The product alliance developed the Zip Pump: a subsea excavation system which is so compact that it may be mounted on most work class ROVs. After successful trials at the British Underwater Test and Evaluation Centre, the product was launched in three standard hydraulic horsepower sizes and offered to clients at extremely competitive prices, ie £20 - 30 K less than its nearest competitor.

In summary, whilst fewer direct relationships exist now than previously between the operators and suppliers, OS5 continue to strengthen their direct links with some of the major Operators, eg BP, Shell, and Amerada Hess. These points effectively dispel the myth that there is a widespread danger for small firms to become locked out of otherwise 'watertight' alliance-type three - five year contracts. The formal channels of communication between the major operators and their partnering contractors are of little importance to OS5 who regularly interface with senior operator personnel directly where necessary. The fundamental areas which concern OS5 are policy changes in government rather than strategic manoeuvres by a select number of oil operators and contractors.

To summarise, these two firms are very different in terms of their managerial behaviour and attitude to technology partnering. OS4 ranks within the 'uninvolved' partnering field while OS5 in the 'medium' field. The apparent widespread 'skeptical' attitudes (discussed below) in the offshore industry must generally reflect the infancy of the partnering concept. Thus, OS5 showed some signs of an insular approach - fearing loss of control in the innovation process. This division is made even more clear in comparing the TPPI results across the three core areas, as figure 8.2 shows. Figure 8.3 also highlights the distinction between the two firms in terms of financial performance - confirming that OS5 is a fast growth firm.

Figure 8.2: Semi-quantitative evidence: TPPI comparison scores

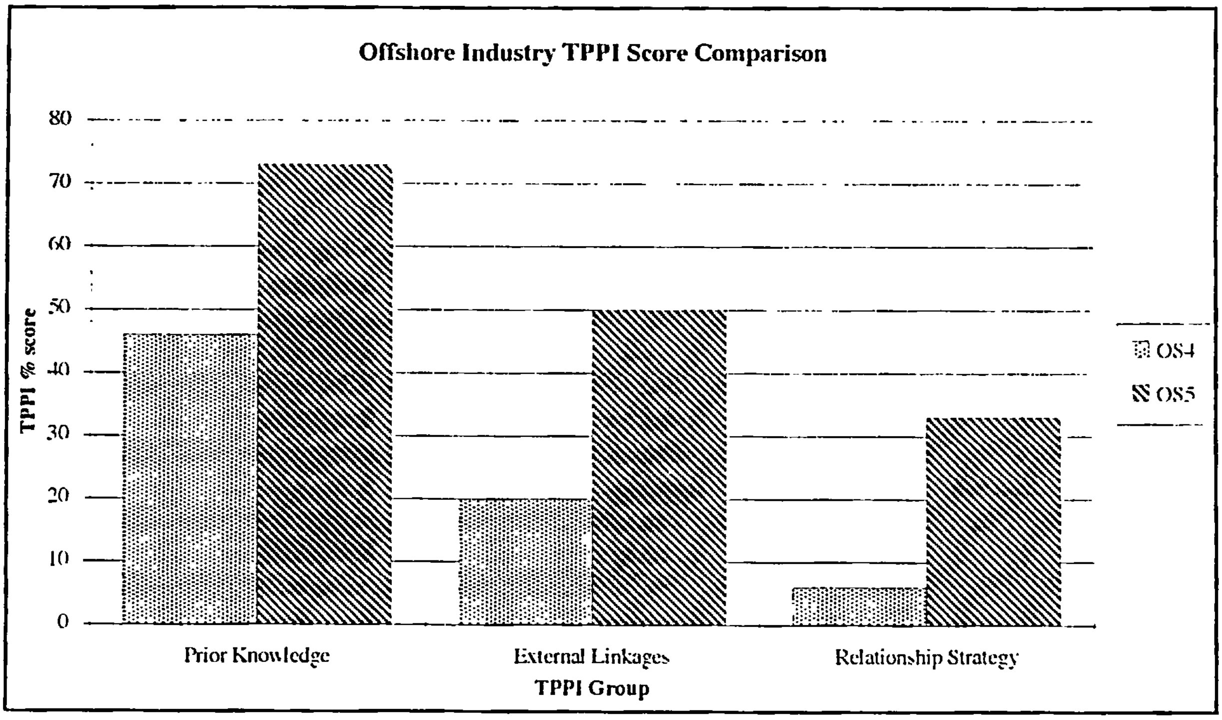
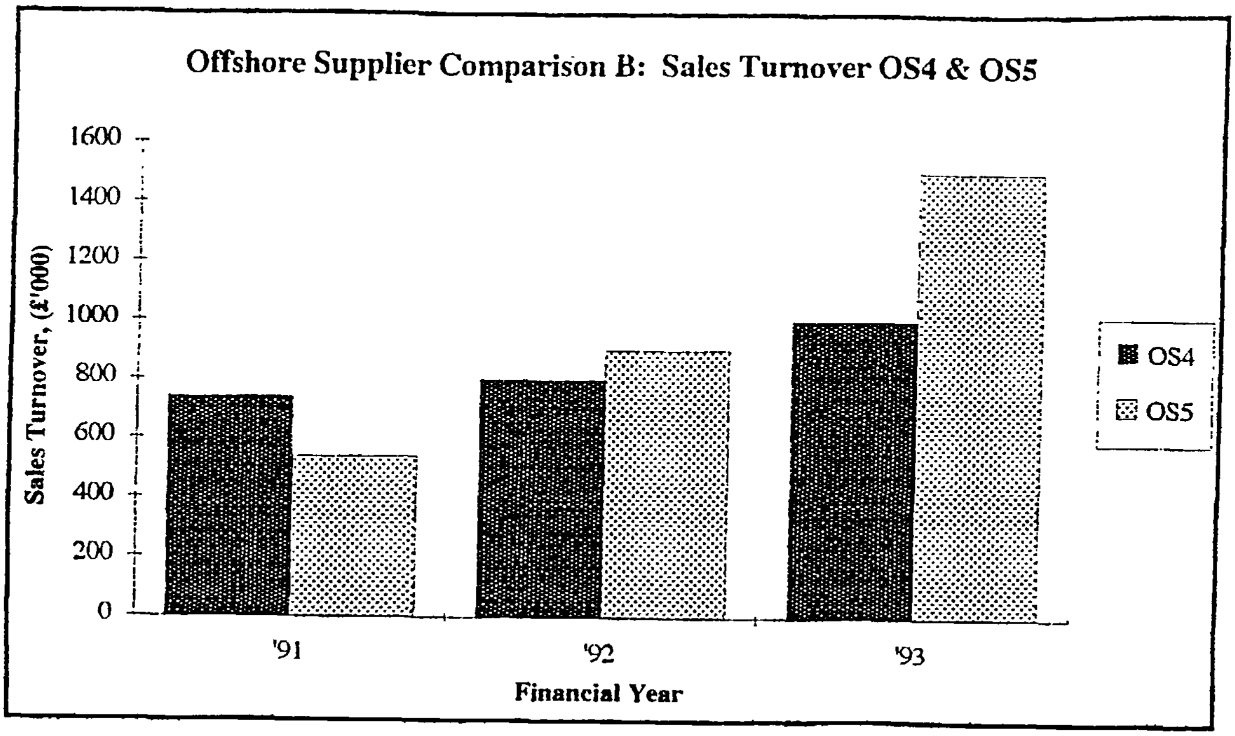


Figure 8.3: Offshore Comparison B: Sales turnover of OS4 and OS5



8.4 Interpretation of small firms' perception of partnering:

This section presents an interpretation of the advantages and disadvantages of partnering as perceived by small offshore supply firms. The discussion relates to the output of the third stage of phase two where six interviews were conducted with firms in the South East of England and seven in Aberdeen (see section 4.3.2). The aim of these interviews was to gain a better understanding about the suppliers' plans, strategies, and approach to partnering with the contractors, and their attitude towards such cooperative relationships given the gradual switch in direct relationships from supplier-operator to supplier-contractor. Small firms are treated here as those with less than 50 staff.

8.4.1 <u>The main points arising from the interviews:</u>

i] Founder members of small product design firms are reluctant to allow outside interference in their business. They prefer to insulate their firm from the 'side effects of partnering arrangements', especially with the contracting sector. They perceive the managing contractor as angling for either complete ownership or a controlling interest in their company. They fear losing control over quality and the innovation element.

To illustrate the views of some small firms,

"We feel that our independence is the only way that we can control our quality and the output of the people we employ and the product we make." (Reference OS10)

"Contractors issue written contracts stating that we can't advertise that we have provided a solution to them ... that's one of of biggest concerns - they take some of the innovation out of our solution." (Reference OS3).

"Our innovation business is almost disappearing because of the structural changes." (Reference OS3).

"Small companies like ourselves don't do business with the major contractors because they want a whizo company to develop something and get out ... they are not interested in developing something for the long term benefit." (Reference OS2).

ii] A clear division in attitudes to partnering prevails in the offshore supplies industry. On the whole, the basis for doing business determines which attitude camp each supplier aligns to. Those engineering consultancy firms arguably have a greater potential for technical information exchange in the trading relationship which will generally result in better prospects to establish a longer term technology partnering arrangement. Conversely, those firms predominantly concerned with designing new products who are instinctively careful about sharing proprietary information and know how will have weaker prospects.

"The areas in which we work is not that applicable to partnering" (Reference OS10)

iii] Small firms value their independence and appear to have few ambitions to become absorbed into technology alliances. To illustrate, five independent firms in particular were each founded and run by experienced engineers with a thorough knowledge of subsea product technologies earned through careers in international firms. Whilst all five firms had plans to grow, it was not about growth in staff numbers but enhancing their technical skills base which could free the MD and directors to concentrate more time and effort on innovation. A recent study carried out an investigation into 300 small manufacturing firms (< 100 employees) in the South East, and concluded that sixty per cent of people who start businesses do not want to grow. The study concluded that part of the reason for this is that most small business entrepreneurs are notoriously reluctant to permit outside interference in their business. [Economic and Social Research Council (1993)] Another reason for their reticence is that small firms will not collaborate in core areas of technology where product applications are near market. However, if the focus of the collaboration is 'pre-competitive', or is concerned with

"The major contractors are not interested in innovation but man hours." (Reference OS3).

vi] Finally, one of the key features of the better practice owner-managed small offshore suppliers appeared to be the breadth of senior technical experience and international exposure that the Managing Director possessed. Most had worked for international oil companies and major contractors and often boasted how they knew 'everybody that is anybody in the business'. Indeed, a great deal of research has been undertaken in recent years on the backgrounds of those individuals who eventually start their own business. Much of this is designed to examine whether individuals with, for example managerial experience, are more likely to found businesses than those coming directly from the shop-floor. The interest here is less related to the question of the effect of background on the likelihood of starting a business. Instead the interest is whether certain types of career background influence the establishment and progression of the technology alliance. Briefly, the following selection quotations reflect the typical background of a small offshore firm director,

"Prior to the company set-up, I was with Shell in the Hague." (Reference OS5)

"All of our backgrounds are in developing major underwater projects." (Reference OS1)

"I was the chief underwater adviser for BP." (Reference OS1)

"John and I used to work at OIS - that is where we got our background knowledge for offshore based equipment." (Reference OS3)

"Through my oil company experience, we secured a job in Norway." (Reference OS7)

Following these interviews with the smaller firms, three central issues were identified: [i] Whether small product technology firms actively pursue the goal of forming alliances with other vendors and contractors, [ii] Whether formal alliances (versus informal networking amongst friends) are necessary to develop technology capable of competing with foreign imports, and [iii] To what extent is technology actually developed/enhanced in 'informal networks'?

8.4.2 <u>Do small offshore firms want to create formal inter-firm alliances?</u>

On the basis of those small firms interviewed, management did not generally perceive developing technology as the main motive to forming alliances. Their reasons stretched beyond the desire sustain quality and avoid the sheer management effort needed to make it work. For example, how should a contractual arrangement be reached with the medium and major contractors where the rewards and risk of product performance are shared equitably? One of the underlying reasons appeared to centre on the position of power between the parties. Contrary to ready talk of 'openness', the reality is that these firms do not trust clients with product know how following earlier abuse of confidences. Whatever the cozy discourse, imbalances of power present a barrier to otherwise progressive alliances.

However, several firms openly expressed their motives to creating technology alliances - some of whom are considered in detail within the case studies. The optimistic views expressed included:

"We feel that we have partnered correctly with a company that has a lot of influence in the Norwegian sector." (Reference OS7)

"By alliancing with AUPEC, we can get ourselves in the frame before anyone else". (Reference OS9).

"Because we partnered, we were a key player as far as BP were concerned when the Forties contract came up." (Reference OS12).

... while the slightly cynical views were expressed by managers who feared the dangers of being 'locked out' of the new alliances. Some of their views are highlighted here and, in many ways, characterise some managers shallow belief of partnering

"We will have to partner to get onto the (preferred) vendors list.". (Reference OS6).

"If you are a non-aligned supplier, you have to fall in with someone elses package." (Reference OS10).

The underlying point which threads through these remarks made by the better partnering firms relate to 'soft' criteria for judging the success of their partnering involvement such as maintaining a profile yet none specifically relate to any performance criteria such as achieving high profits, increasing sales, increasing market share, achieving long term growth, and so on. In many ways, this reinforces the earlier conclusion in chapter six that no or minimal relationship could be found between technology partnering performance and the impact on the financial statements. Some further motives for their involvement are given below.

8.4.3 Are alliances really appropriate to develop offshore technology?

It was clear that small firms did not actively pursue the creation of technology alliance arrangements. Small product supply firms perceive the managing contractor as angling for either complete ownership or a controlling interest in their company without any real interest in the concept or innovative product. They fear losing control over quality and the innovation element. Consequently, much of their innovation work is self driven and financed.

8.4.4 To what extent is technology exchanged through networking?

Based on the evidence gathered during these interviews, it would appear that despite a good understanding of each others' businesses, small firms do have some difficulty in assimilating and adopting new technologies through their 'floating' partners. Indeed, the Scottish Oil and Gas Innovation Forum undertook a survey in early 1995 aimed at identifying critical issues facing small and medium-sized enterprises revealed that 'technology adoption' ranked top of their priorities. Interviewees were asked to rank entries in a given list of factors according to the extent to which *they* regarded them as constraints to technology adoption. In order of priority the following were classified as major barriers: Cost of entry; Access to external finance; Access to internal finance; Government funding; External support for technology adoption.

The above insight reveals that small offshore firms *do not* perceive that lack of an internal base of technical know how limits their ability to adopt technology. Their primary concerns relate to financial constraints rather than, say, lack of time to transfer and mould ideas into their own business. Their apparent 'wealth' of internal know how is perhaps reflected in the semi-quantitative analysis. The TPPI set about measuring the number of professional engineers in each firm visited. The analysis revealed that a typical engineering consultancy firm employing ten people would represent a 'knowledge intensive' firm, ie it would employ say, seven graduates, a secretary/receptionist, an office administrator and a part-time book-keeper.

Furthermore, some circumstantial evidence also points towards the conclusion that at least a proportion of oil related SMEs are active in new technology development. Liddle (1994) carried out an in-depth survey of demand for and support supplied for innovation in forty small (median of 20 employees) firms in the sector. He found that their average R & D spend was 5 per cent of turnover, and that they believed that their past and future competitive advantage lay with technology developed in-house. An earlier report (Netherlands Economic Institute (1992)) found that R & D amounted to approximately 3 per cent of gross value added in oil-related Dutch firms, which have about 27 per cent of the North Sea market. Bower and Young (1995) undertook a study which examined the influence of the current environmental pressures on the current performance and strategic planning of a sample of firms selected from five sub-sectors of the North Sea service and supply industry network. In particular, it focussed on the information channels within the network which had contributed to decision-making. In a postal questionnaire where 126 firms responded (70 per cent of whom were reliant on the UKCS for most of their business) it was found that by far the most important positive influence on firms which had improved their performance was technology developed in-house. These reports tend to reinforce the proposition that the smaller firms may have played a significant role in new technology supply to the industry. More specifically they reinforce the argument above that small offshore firms do not perceive a strong need to develop technology in collaboration with others - preferring to develop technology in-house.

8.4.5 Summary:

On balance, small offshore supply firms remain skeptical of the benefits to technological collaboration. This enquiry established that small firms perceive few advantages to collaborating with other firms and generally rank technology development *through partnering* as low in their business priorities. Small independent firms prefer to channel their efforts towards sustaining close networks of expertise. Management often referred to an 'incestuous industry where formal alliances are unnecessary'. In particular, they appeared to share very similar views with regard to collaboration, namely 1] fear of losing new market opportunities, eg one firm noted the progressive requirement from contractors not to advertise where and when they they worked for particular contractors, 2] they are wary of the traditional contractor's approach to conducting business, and have difficulties in deciding how to put into practice the alliance philosophy within a standard commercial supply contract that ties rewards to product performance, ie how to share the risk and rewards, and 3] alongside the problematic nature of alliances, aspects of power play a formative part in how companies in the vertical supply chain work together. One of the main perceived barriers for small firms in adopting technology relate to lack of finance rather than lack of in-house technical know how.

The study cited earlier by Bower and Young (1995) highlighting the fact that most small firms prefer to develop offshore technology using in-house resources confirms these findings. The variety of reasons - only some of which are discussed here - are vast and often peculiar to the firm. One of the more general relates to the belief expressed earlier in chapter two that despite the potential advantages, working in partnership with other firms with different strategies, structures, systems and cultures is a very difficult process and inevitably tension-ridden. Circumstances change in partners and within the firm. For example, in the case of OS3 where the small firm had a partnering arrangement with Lotus Engineering with the aim of finding a better solution to reduce noise and vibrations offshore. This particular alliance arose from the problem that offshore installations and associated facilities necessarily contain processes which are very noisy and which generally predate present EC Noise at Work regulations. This alliance brought together OS3's engineering and analysis with practical experience of offshore construction, marine operations and deep diving with Lotus Engineering's renowned capability in noise and vibration engineering within the motor industry. OS3 worked closely with Lotus for many years to engineer the best solution for the North Sea market. After an internal corporate reorganisation, Lotus decided to exit the oil industry and hence the alliance with OS3 collapsed. The potential for introducing unique technology arising from this alliance was considered great and it would have strengthened OS3's environmental capabilities given the favourable interest from oil operators heard through various seminars and conferences. However, OS3 increasingly found that the bureaucracy of Lotus prevented them responding to their customer's needs in the shortest possible timeframe.

One of the surprising aspects of these results lies in the area of business objectives and motives for partnering albeit informal involvement. The better offshore firms at technology partnering remarked during interview about 'soft' performance factors such as keeping their firm in the business eye instead of other 'hard' factors such as profitability, market share or sales. In one sense, this may reflect the 'distance' they wish to keep from their contracting clients - having already experienced abuses of confidences and fears of losing control over the innovation element, etc. In other words, their remarks suggest arrangements which are consciously kept informal without agreements on risk and reward divisions, etc. The results also reinforce the importance of networking especially given the changing contractual scene where the small firms are seeing their links with the operators slowly being severed. Indeed, several firms noted the challenge of bringing their technology to the attention of the operators, given that their clients occasionally appear to shield their source of innovative solutions from the operators. In a sector which relies heavily on informal contacts, this represents a major shift and threat to small firms' place in the market. Consequently, the motivation to create and sustain good partnerships with the contracting sector is reduced.

Finally, the interviews revealed some thinly disguised obstacles lying ahead for some small suppliers still determined to maintain close working relationships with the operators. The third research proposition (chapter 3) highlighted the potential problems for small firms of 'management churn'. It was found here that small firms often communicate with operator middle management, who (a) may not be 'sold' on the idea of partnering - instinctively protecting their personal interest and maintaining the historical balance of power in the relationship, and (b) move into other roles given the flat organisational structure that most operators share. The reality is that small firm entrepreneurs quickly lose the will to rebuild relationships with project orientated operator staff who may not share the same vision.

The foregoing confirms that technology partnering is still in its infancy and it is difficult to measure how enthusiastic the contractors have been in undertaking their new role. In order to gain a common vision, the industry needs to go through at least one period of field development under the new regime.

8.5 Networking and the role of intermediaries in the offshore industry:

8.5.1 Introduction:

The emerging pattern of contracting in the oil industry is that operators are favouring partnering-type relationships with the prime contractor while sharing risks and rewards. Their research and development expenditures have also declined as part of the overall cost-cutting drive. Indeed, following a migration of expertise to the contracting sector, operators are now left with a much slimmer technical resource base. While the operators no longer have the predominance of 'product champions', this knowledge transfer has provoked some real concerns for the supplies industry, principally, who will push for innovation. While the contractors' new role in the asset based partnership encompasses support for the development of new technology, they are not inclined to invest substantial sums in R & D. The contractor wants proven technology that will quickly influence field performance and cost. Despite the myriad of innovative engineering projects swelling in small firms - albeit at the early stages of development - they are unlikely to advance without outside help. One of the main aims of offshore intermediary organisations and groups is to act as the bridge between small and large firms interested in taking these promising developments further. The following briefly describes three such groups before summarising their use to small firms.

8.5.2 Scottish Subsea Technology Group

The marketing group is made up of more than 30 subsea related companies; most have an annual sales turnover between £800 K - £ 2m. The group is in its third year. The Group started in the face of considerable contracting changes in the oil industry. Indeed, it has been quite an upheaval for the small companies, which were used to dealing with oil companies direct and which in some cases had been very helpful to the operators in their product development. There is now a more complex buying behaviour in place, involving long term contracts with the integrated contractors. The underlying theme is that SMEs are having to adapt to selling to the integrated contactors, which in turn have experienced a considerable change in their relationships with the oil operators. Scottish Enterprise is also encouraging the participation of small companies and has already set up two SME days, one with integrated contractor Brown and Root Energy Services and one with BP for the Andrew project, giving the SMEs the opportunity to present their capabilities to the appropriate people, (Financial Times (1995b)).

Scottish Enterprise is also supporting the SSTG - a marketing Group which aims to encourage a mechanism for smaller firms to come together to work on larger packages. The Group acts as a facilitator whilst the members carry out all the work. By working together, they claim to simplify the process and minimise the contractual relationships and develop trust between themselves. They can then offer packages to the medium sized contractors. The trend in purchasing towards integrated packages has been a major catalyst to the formation of the group. The Group believes that despite the links between oil companies and some suppliers being slowly severed, there is still a need to have direct contact. The Group aim to determine the operators' future technology needs, and then set up focussed presentations by members that address those requirements.

On the basis of these interviews and comments heard from independent sources. the Group appear to be successful in allowing small firms to be heard by some influential people from operating companies. Most were happy with the administration and welcomed the opportunity to meet other small firms whilst presenting their capabilities to oil companies and contractors.

The underlying suggestion is that small firms, whether they are scattered across the South East or clustered in one city enhancing the potential to form a critical mass, experience difficulties to initiating contractual alliance arrangements without some formal mechanism/facilitating body to support them. Several small firms remarked about the ease of cooperating with one another but they had yet to create and/or lead a consortia to provide a more attractive engineering package to the client. Nonetheless, the SSTG is a good example of a group playing an intermediary role to help small firms to meet, understand each others' capabilities, and present their case under common and topical themes to the operators and contractors.

8.5.3 Northern Offshore Federation

The Northern Offshore Federation is a self-funding organisation which was established in October, 1988 and now represents 260 companies in the North of England involved in the offshore oil and gas industry. It acts as a catalyst to address the main issues facing the service sector of exporting, training, and the research and development.

The aim of the Federation is for the large companies to share their knowledge with the smaller companies. For example, AMEC are one of the major drivers of the Federation and along with other purchasers who organise regular sessions where the suppliers can have access to them for 20 minutes. Here is another example of the type of intermediary role that can support the exchange of technical know how in a relatively simple but highly organised framework. Clearly, a major contributory factor to its success is the continued support of the larger firms to provide to personnel and information.

8.5.4 The Scottish Oil and Gas Innovation Forum

The stated mission of the Scottish Oil and Gas Innovation Forum (SOGIF) is to increase the international competitiveness of Scottish-based companies in the supply and service sector of the offshore oil and gas industry. SOGIF intends to achieve this by encouraging and assisting in improving the companies' performance in product and process innovation. SOGIF define innovation as '... the combined activity which results in creating and marketing a new product, process, material, or a very significant change in a production method or a management system.' The Forum aims to promote more joint projects and develop stronger relationships with finance and other supporting sectors to encourage competitiveness through innovation. When SOGIF was established in 1994, the Forum identified two clearly different though connected issues to be addressed. One was the identification of technological trends, needs and opportunities which is dealt with by the Technology Working Group; the other is concerned with the process of innovation including access to finance and other support, which is managed by the Process Working Group.

8.6 Summary

This chapter considered the role and applicability of partnering in the offshore industry - Phase Two. A major part of the discussion centred on the small firms' perception and highlighted within the case studies some of their reservations for non-participation in *formal* alliances. It also considered the role of local and regional facilitating groups. The conclusion is that small offshore firms' use of local facilitating organisations appears to be intense - primarily driven by their motive to build and maintain a dense web of informal interpersonal connections that may then enhance learning and support technology development. They tend to avoid formal partnering arrangements with large firms which they perceive as unsavoury - often resulting in abuse of confidences, falling pray to the internal politics of the large firm and losing control over the innovation element. While many motor component suppliers noted in the last chapter also maintain close links with local business networks, their actual use of any one or two facilitators is less intense partly reflecting the inextricable links they already have with the assemblers. Three main factors appear to determine the intensity of the linkage and, therefore, the extent to which knowledge is usefully exchanged: (1) the depth and breadth of the SME's in-house technical know how - ie its ability to actively scan for new technologies; (2) the SME's receptivity towards partnering ie the extent to which the management genuinely wish to participate; (3) the complexity of the product or project ie an innovative engineering solution or a modification to an already known technology.

The three broad areas that were identified in chapter five represent some preconditions to successful technology partnerships ie Prior Knowledge, Relationship Strategy, and Internal and External Linkages. While there is no definitive formula for success, a set of best practice guidelines based on these three areas offers some operational and strategic guidelines for small and large firms. These are presented in the next chapter coupled with a summary of the main field research findings.

Chapter nine: Automotive sector and Offshore Supply Industry: Comparison

9.1 Introduction:

This chapter aims to apply the conclusions of Phase One to Phase Two and to use this comparison to assess if any 'general' conclusions may be drawn. Clearly, there are some very significant differences between the motor and offshore industries which could affect partnering practise and a critical comparison may reveal which aspects of partnering practise could be generalised and which are idiosyncratic. Before exploring some of these differences in detail, the following section considers the evolvement of partnering in automotive and offshore supply industry. The aim is to recap on the factors driving each industry and place the remaining discussion in context.

Section 9.3 then focuses on some of the main differences between the two industries highlighting the economic, political, environmental, technological drivers to change which partly explains why the differences occur. Briefly, the main differences relate to: technologies; customer demands; nature of supply; level of supply chain integration; sources of expertise; extent of supplier development by the customer; management practice/norms of behaviour; basis of partnership.

Section 9.4 draws together a summary of the lessons learnt in the offshore industry which may equally apply to the motor industry as well as highlighting some more general similarities in respect of partnering between the two industries and why they are present.

9.2 Evolution of technology partnering in the motor component and offshore supply industries

9.2.1 <u>The evolvement of technology partnering in the motor industry</u>

In the UK motor industry, the traditional buyer-supplier relationship was premised on stable, high volume, low variety production; the relationship was one of closed competition, with any new business secured by one supplier being won at the expense of another; price competitiveness was the primary criterion on which contracts were awarded. The design effort tended to be one-sided (either the assembler of the supplier would design the component, but rarely would they collaborate); and the scheduling procedure would usually be a blanket order system employing only material control schedules to regulate the quantities required (schedules could be quickly revised, and suppliers were given limited information about the motor manufacturers' forward build programme).

A major change in the nature of the traditional model came in the mid-1970s. Following the first oil shock of 1973-4, there was a marked intensification of competition in the motor industry as demand fell and car design converged on the smaller, more fuel efficient models.

Under a more competitive environment, the traditional buyer-supplier relationship came under increasing stress. Raw material prices and energy costs were increasing at a time when assemblers were seeking to reduce costs, and component prices became an obvious target for cost reduction. Attempting to realise their market power, assemblers began to demand lower real prices for their bought-out parts and assemblies, which often sparked a price war among the supplier community. Many suppliers found themselves squeezed from both sides, having to agree to 'target prices' set by their major customers but unable to pass on higher costs to their own suppliers.

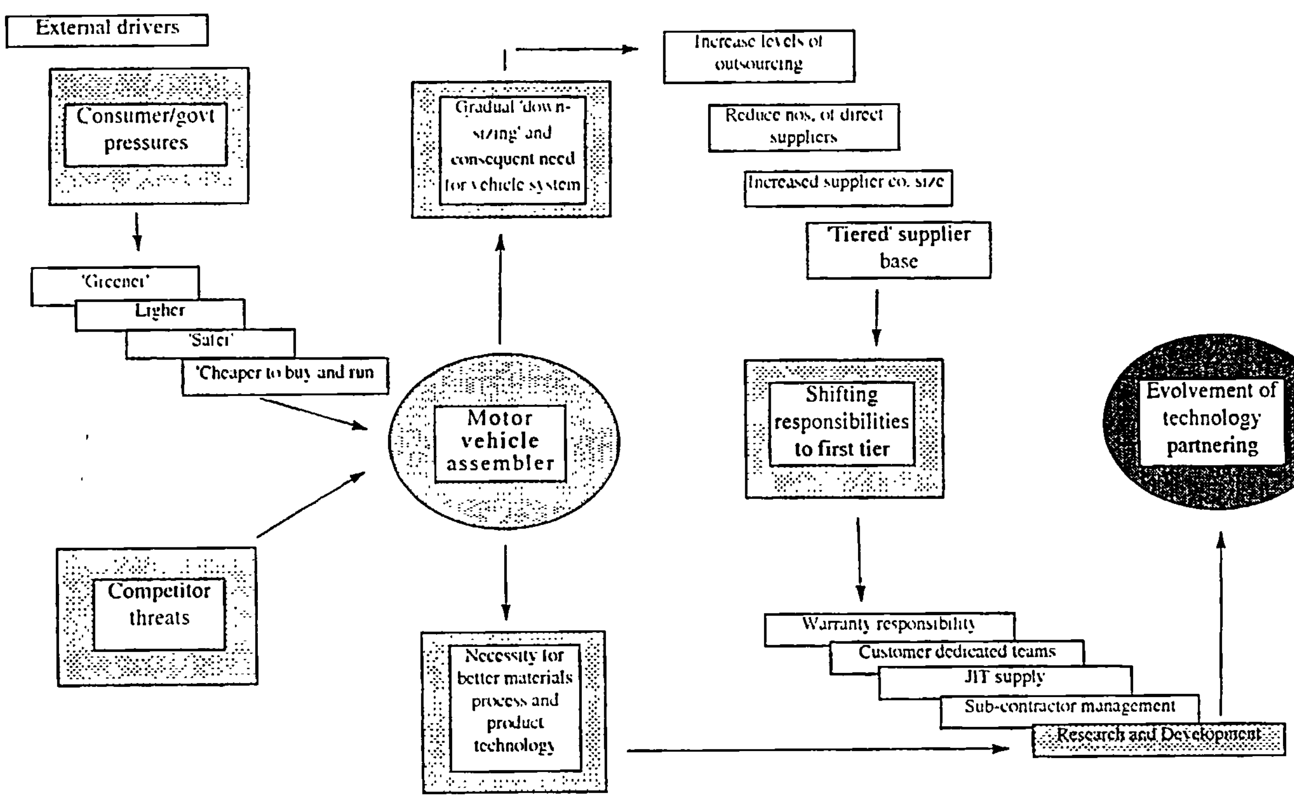
Assemblers also began to realise the buying advantages of dual or multiple sourcing, especially where little or no capital expenditure was required for tooling. Multiple sourcing was used to put further downward pressure on prices and to ensure continuity of supply in an increasingly troubled industrial relations environment. But multiple sourcing simply reduced production volumes at the supplier still further and added to the atmosphere of adversarial relations between buyer and supplier. The restriction on information between buyer and supplier continued, but with the further twist that assemblers were now less willing to inform suppliers of any variation to their vehicle build plans in case this reduced their negotiating power.

This relationship proved to be both counter-productive in the long run and did little to improve the competitiveness of the UK motor industry in the key areas of quality, design and delivery. The emphasis therefore shifted towards reducing unit costs via a 'partnership' relationship.

Overall, Britain's renascent car industry may partly attributed to the full operation of Nissan in 1986 and then Toyota in 1992. This greatly influenced a change in traditional thorny relationships between assemblers and their component suppliers. The Japanese purchasing policies pioneered the way in a number of respects, including the requirement that suppliers must have a full component design and development capability and operate to allow the assembler to hold minimum inventory levels. Above all, management attitude of suppliers has a greater prominence in a selection of suppliers than five or ten years ago. More than ever, assemblers look for suppliers who are not satisfied with where they are and are looking to move forward through performance improvement and innovation.

Figure 9.1 summarises the wider issues facing the automotive industry today: product technology, systems supply ability, innovation, financial strength and strategic alliances. The constant need to achieve higher levels of performance, quality and productivity means that a company should understand its capabilities and limitations and then focus on its core competencies. Supplying complete systems is increasingly becoming the responsibility of first tier suppliers as vehicle assemblers search for cost savings and efficiencies and are increasingly delegating design, development and production responsibility. Access to substantial funds for investment was another key requirement for major suppliers. Globalisation will increase as most European vehicle assemblers have a declared policy to source components from further afield if it is advantageous. Driven by the need to become world-class players on a global basis, and the need to cut costs, strategic alliances will develop between major component suppliers. All of these factors bring technology partnering into sharper focus.

Figure 9.1



Evolution of Technology Partnering

9.2.2 Evolvement of technology partnering in the offshore industry

Since the late 1980s there has been growing pressure to reduce the costs of the industry in order to prolong the economic life of existing fields, to increase the financial viability of new development and to improve the attractiveness of the UK industry for investment. Operators have been seeking step change reductions in costs. One response to these pressures has been the move to increased collaboration between operators and their contractors. Since 1990, terms like 'partnering', alliance' and 'win-win' relationships have started to be used. In 1993, operators, engineering contractors and government launched the Cost Reduction Initiative for the New Era (CRINE) which promotes collaborative working, as well as standardisation and use of functional specifications. CRINE is a major initiative of the offshore oil industry, the aim of which is to significantly reduce costs and to change the working culture. Briefly, CRINE's main objectives are to achieve a 30 per cent reduction in capital expenditure and a 50 per cent reduction in operating expenditure. These aims will be achieved by: persuading suppliers of the advantages of cost reduction; preparation and adoption of simple functional specification; and ongoing education and training. There is wide recognition in the offshore industry that 'cultural change' will be required if the significant cost improvements envisioned by CRINE are to be achieved. This change relates not only to the industry's approach to complex technical challenges, but, just as importantly, to industry attitudes and behaviours in managing its varied and complex interrelationships.

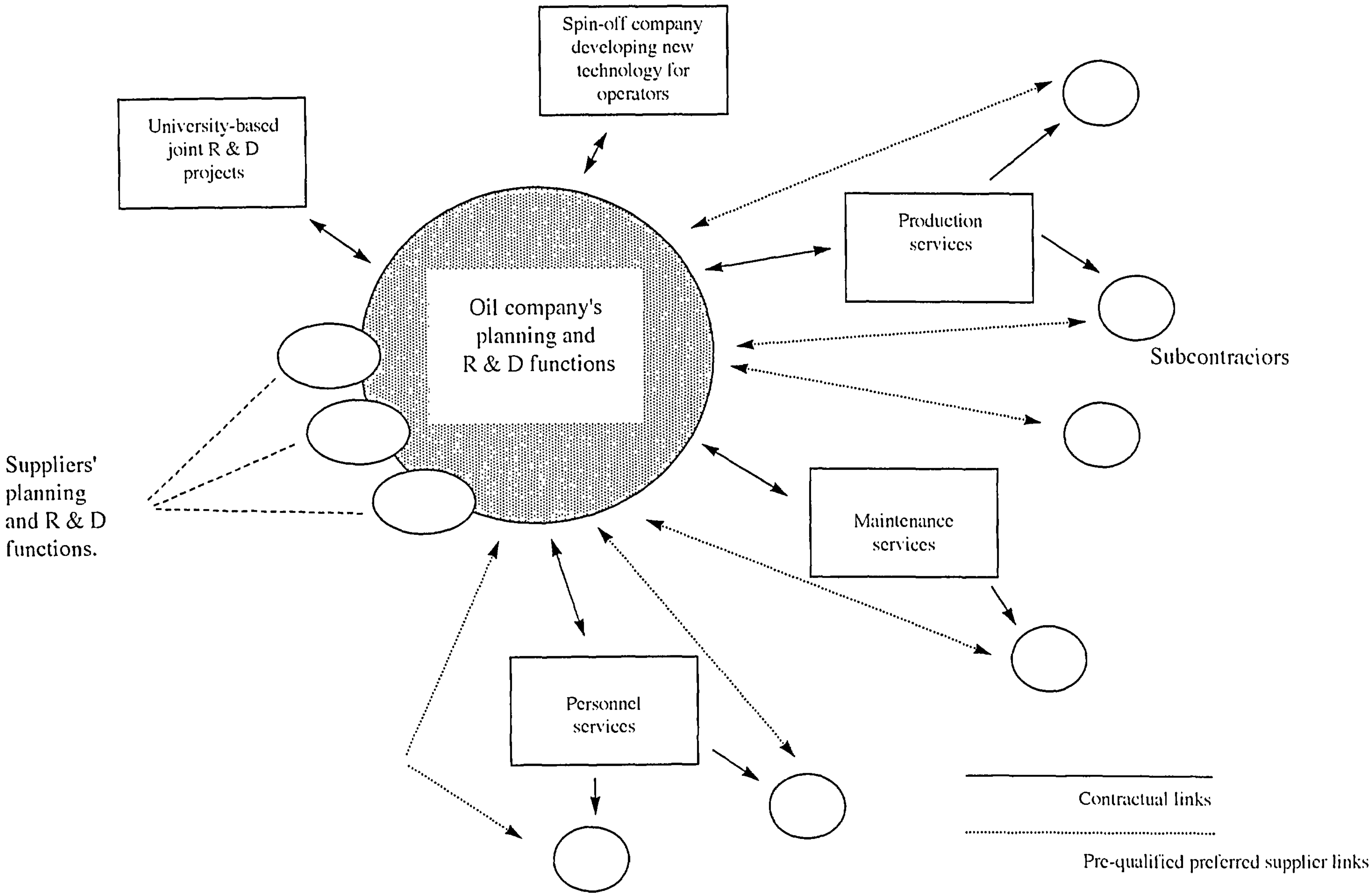
Relationships between Operator and Contractor: Overview

Before 1990, relationships between the operators and their contractors tended to be adversarial. Contract terms tended to be short (one year), and even when an operator had a very long relationship with a contractor the contract was often renegotiated each year. Such short contracts gave the contractors no security or continuity and they were not able to invest in staff development or research.

Contracts tended to be let on the basis of selecting the least cost tender from a group of competing companies. Relationships during the course of the contract tended to be adversarial as the operators audited and challenged the contractors' charges, and the contractors' attempted to claim for each modification requested by the operator. The reimbursable form of many of the contracts encouraged the contractors to extend the work beyond its target dates and to increase the costs beyond the original estimates. When lump-sum contracts were let, they often over-ran their original cost estimates leading to further conflict as contractors requested additional payment and the operators tried to resist. The least cost bidding process encouraged contractors to put in a low bid with the intention of increasing their income through claims for variations to the scope of work.

Figure 9.2 explains the early pattern of contracting practise in the oil industry. While operators differed in the extent to which they subcontracted design, operation and maintenance functions, all subcontracted a high proportion of activities, but maintained some duplication of these capabilities in-house. In-house staff specified, checked and monitored contractors' designs, products and services. All suppliers had to prequalify with the operators, even to supply contractors. In order to ensure that oil production was never interrupted, there was extensive duplication of facilities, and little concern for costs.

Figure 9.2: Early pattern of contracting practice in the oil industry



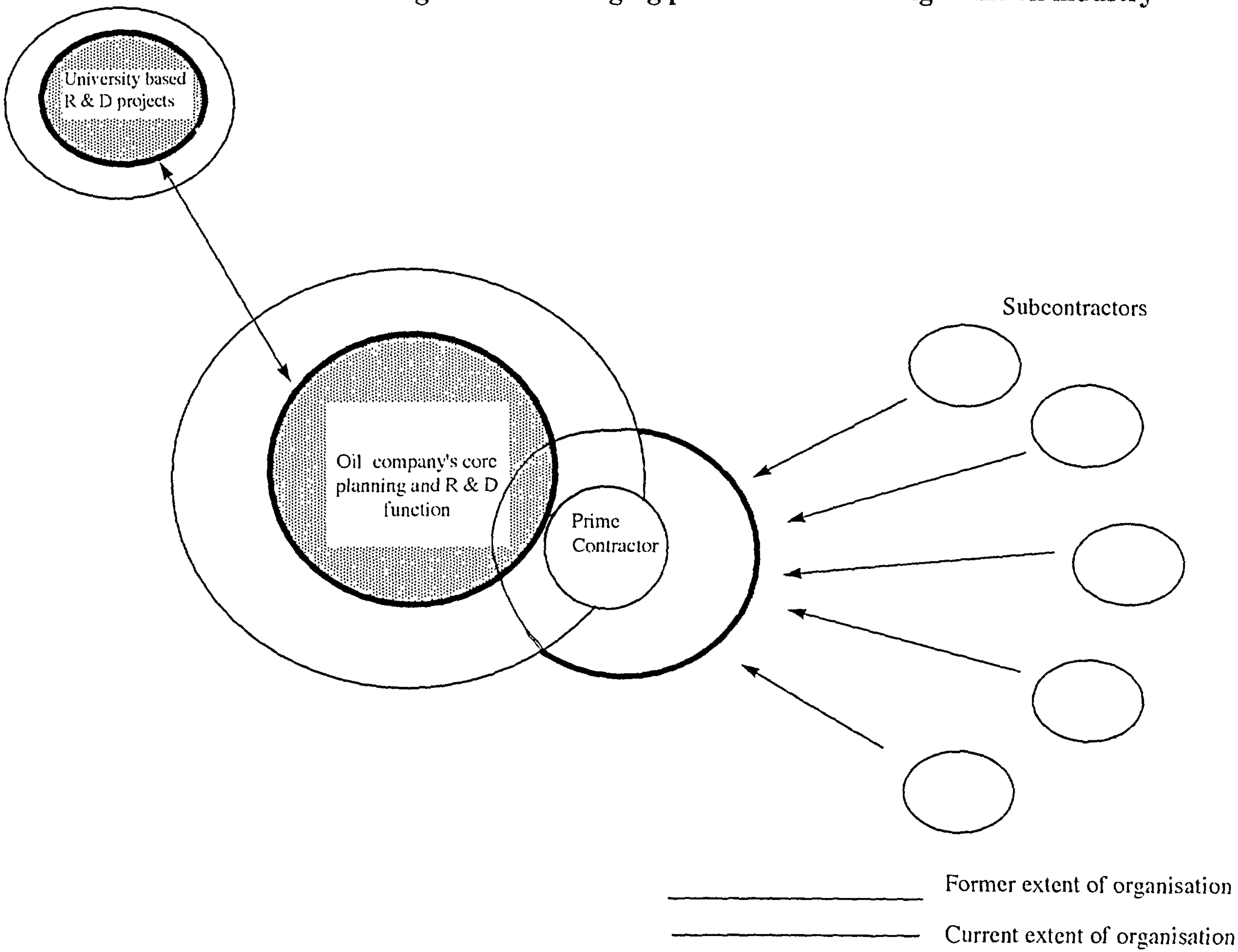
Since 1990, some operators and contractors have moved towards long term collaborative relationships with one another (partnering and alliances). The aim of the new style of working is to drive waste and cost out of the system by eliminating duplication of effort, by challenging established customs and practice which no longer add value and by making full use of the contractors' expertise. The contractors are brought into the design and planning processes much earlier and all the people involved work in a single integrated team.

The benefits of the new style relationships are that the customer is able to reduce his costs, and that the contractor has continuity of employment, is able to plan ahead and to invest in staff development and research. In addition, the agreements usually include some form of incentive structure so that both operator and contractors gain from cost savings and improved performance. The operator usually agrees to pay the contractors' direct costs and an element of overheads. However, the agreement is so structured that most or all of the contractor's profits depends on performance and generated savings in cost. The profit can depend on a variety of performance measures, including safety performance. Cost savings are typically shared 50/50 between operator and contractors. In some instances, cost over runs are also shared between the operator and contractor. In this case, the contractor's profit is not only at risk, he can lose part of his direct costs as well.

Figure 9.3 presents the emerging pattern of contracting in the oil industry. Operators are downsizing, outsourcing more, and reducing the number of direct contractors in favour of a prime contractor model. They are favouring 'partnering' relationships with the prime contractor, sharing risks and rewards to some degree, but the main risks still lie with the operators who have continuous responsibility for safety, environment etc. over the life of the field. The majority of operators are still expecting subcontractors to the prime contractors to prequalify with them, but are gradually passing more responsibility to prime contractors. Operators have ceased to employ most of the staff who previously monitored their contractors' activities. Their research and development expenditures have also declined as part of the overall cost-cutting drive.

Figure 9.3

Figure 9.3: Emerging pattern of contracting in the oil industry



With the new contracting strategies and the reduction in oil company staff there are either fewer informed buyers or new ones are being created in the major contractors. The main issues facing a cost effective product manufacturer are to identify the new buyers and to establish relationships with them. For a small company, this can be a very costly exercise. For the new buyers it is an enormous task to identify and contact this very large number of small companies proving new products. It is therefore essential to have access to group marketing exercises such as the Scottish Subsea Technology Group (SSTG).

The following section focuses on the specific differences between these sectors which could affect partnering practise.

9.3 Differences between the automotive and offshore supply sectors

9.3.1 Technologies:

In the offshore supply industry, operators, contractors and suppliers are having to become more innovative and flexible in the way they exploit the predominantly small and dispersed second generation oil fields. The new challenges and opportunities that such firms are facing mean that they require new skills and, above all a new management attitude and approach that can embrace partnering. Future fields are more likely to be complex with, for example, high temperature, high pressure product or difficult reservoirs. Coupled with industry analysts' belief that oil prices will not rise substantially in real terms over the remainder of this decade means that the viability of many future developments could be at risk unless costs can be reduced. Customers demand reliable, fit-for-purpose products that are able to operate under extreme circumstances. There is less emphasis on large volume related products delivered on a just-in-time basis.

In the automotive industry, motor vehicle assemblers demand products that will provide better fuel economy (lower weight); more fuel for money (lower cost/higher specification); reduced risk of corrosion and less maintenance; improved appearance and so on. The emphasis is on good products, delivered on time and to quality at less cost. Technology partnering is a good mechanism to help them achieve this.

While the main differences in respect of technologies relate to the nature of the product and the volume of supply required, the overall difference relates to the structure of the two industries (see 9.3.2). As discussed in the last chapter, the role of the local facilitating organisation in the offshore industry, such as the Scottish Subsea Technology Group, appears to play a far more important role than similar bodies in the motor industry. This is perhaps partly explained by the fact that the geographical centre of commercial oil and gas activity in the North Sea is Aberdeen whereas in the motor industry firms are scattered mainly across a region serving customers nationwide. It also partly reflects the nature and complexity of the technology - arguably, offshore technology requires much more innovation since it is applied to ever changing demands as one off situations, ie deep water applications, harsh environment, marginal fields, etc. Conversely, motor components are generally volume produced and the product or process technology is generally known or at least partially proven in an application. Nevertheless, there is little doubt here about the importance of such facilitating organisations which allow firms to meet and understand each others' capabilities.

A closely related point is that small offshore firms have some difficulty in adopting new technologies yet the causes are business related, ie lack of funds rather than any lack of an internal knowledge base, (8.4.4). They appear to be 'knowledge intensive' firms that prefer to channel their efforts toward maintaining a close network of experts. Hence, they make good use of local technology-specific facilitating organisations.

9.3.2 Level of supply chain integration:

The level of supply chain integration is clearly far greater in the automotive sector than in the offshore sector. Chapter four referred to the continued importance of the motor manufacturing industry to the British economy, it has continued to attract government support for various national level initiatives. For example, Learning from Japan scheme as well as the SMMT Industry Forum. While government support is given for similar initiatives in the offshore industry via Scottish Enterprise, for example, Scottish Oil and Gas Innovation Forum, these initiatives are still at early development stages.

The increasing emphasis on system assembly has been one of the main drivers in reshaping the structure of the components sector coupled with the Japanese influence of motor manufacturing. Reducing the supplier base is just one feature of the current transition towards a Japanese-style model based on just-in-time supply (JIT), long term collaborative contracts awarded to a limited number of 'single' or 'preferred' suppliers, quality assurance (or zero defects), and an increasing emphasis on system buying rather than individual components, for example, brake systems, complete facia units etc. Indeed, the Japanese model of supplier relations appears characterised by a very high degree of dependency between organisations (Womack et al (1992)). Turnbull et al notes that Nissan and Toyota, for example, share 45 suppliers out of 105 and 176 direct suppliers respectively. However, the dependency of Nissan's suppliers is typically over 90 per cent of the supplier's business with Nissan, while that of Toyota's suppliers is around 60 - 70 per cent. In both cases, 100 per cent of product and process innovation work would be with the parent firm. Thus, competition is based as much between supplier groups as between individual firms. In contrast, the structure of the UK motor industry indicates that there is a largely independent and shared first tier of suppliers, as well as a shared secondary tier. The authors argue that the Japanese structure allows greater technological diffusion between a given assembler and its suppliers, and facilitates the tighter coordination to operate JIT. In contrast, the structure of the UK motor industry, where suppliers are shared by a number of assemblers, creates obstacles to technology transfer and to the tight synchronisation and cooperation between buyer and supplier demanded by JIT production.

While small firms in the offshore supply industry are also re-shaping their business to provide an increasing number of 'mini-modules' to medium sized contractors, instead of individual pieces of equipment, the concept of 'supplier groupings' is still relatively new. This situation increases the demand for facilitators to orchestrate small groupings and encourage alliances.

Lamming et al (1995), in a report on supplier relations in the UK motor industry with some comparisons with Europe, Japan and USA makes some interesting conclusions. The authors observed that despite the apparent increase in commitment from vehicle manufacturers towards partnerships, this does not appear to be resulting in practical benefits, with non-partnership suppliers appearing to do just as well or even better than partnership suppliers in some aspects of JIT operation.

"One possible reason why partnership suppliers in the UK are not performing significantly better than non-partnership suppliers is that it takes time to develop such relationships: four years - the period which this survey addressed and for which there is evidence of rapid diffusion of partnerships - is simply not long enough to reap the benefits. If so, the UK suppliers have grounds for being optimistic about their future business prospects."

The 'length of time to develop relationships' is particularly interesting and may help to explain a good deal about the apparent reticence for offshore suppliers to take part in partnering activities on a more formal footing. Despite the observation noted in chapter eight that small product supply firms perceive the managing contractor as angling for either complete ownership or a controlling interest in their company without any real interest in the engineering concept or innovative product, this position may change/improve during the next few years.

The authors add that another possible reason for under-performing partnership suppliers may relate to having too many customers making different demands, only some of which are consistent with establishing partnerships.

"There is evidence that Europe-based vehicle manufacturers continue to pursue a diverse range of purchasing strategies. Given that these manufacturers share much of the same supplier base, it may be damaging for the industry as a whole for some of them to use partnership in an attempt to promote investment, while other customers are reducing supplier margins in a short-term effort to cut their own costs."

The authors also note from their survey that the partnership suppliers in the UK have a greater number of customers on average than non-partnership suppliers, for any given product, and expect to have an even greater number in four years' time - a difference not as marked elsewhere in Europe. This evidence may indicate a lack of understanding of, or an unwillingness to recognise, the need for suppliers themselves to make a long-term commitment with each of their customers.

9.3.3 Basis of partnership:

The basis of partnership in both industries is about cost reduction through innovation - resolving problems through a process of cooperation rather than competition. While partnering agreements within the offshore industry hinge on the sharing of risks and rewards, assemblers reward their partnership suppliers with long-term contracts and increasing volumes of business. Relationships in the automotive industry are characterised by far greater dependency, involving suppliers in design research and development work and quality control. This style facilitates more commitment from suppliers by allowing them to plan ahead in greater detail. However, relationships in the offshore industry are characterised by the ability of the supplier to quickly impact on the client's profits.

This aspect affects the nature of offshore partnering practise. To illustrate, in the case of research and development activities and subsequent use/purchase by operators. It is widely recognised in the industry that pressures to reduce costs will also mean that there is less research and development funding available. It is also recognised that an innovation must offer a significant improvement to financial performance before an operator will take a risk with innovative techniques, and innovations which offer only marginal improvement are unlikely to be adopted. First tier contractors who have already invested in equipment to support a collaborative relationship are unlikely to want to try new equipment unless it offers significant benefits. Companies wishing to promote their innovations must express the benefits in terms of contribution to financial performance rather than technical excellence. Indeed, some asset managers made it clear during interview that a new idea or method of working had to be able to make a minimum of 5 per cent to the 'bottom line' before it would be considered. Overall, the key change for small firms is one of marketing. The small firm now has to market to each project team and demonstrate the system benefits to them. This is often a much more difficult sell because some of the solutions do away with some of the project team. The need is for "informed buyers" to evaluate the idea for the benefit of the company and the project.

9.3.4 Supplier Development:

Despite the variations of partnering activity within the automotive industry and differential capabilities of some firms to adopt the concept discussed in earlier chapters, component suppliers receive far more support in terms of business and staff development than offshore suppliers. The reasons for the difference partly relate to the extent of openness, ie cost transparency where the assembler and supplier share cost information, including data which would traditionally be kept secret by each party, for use in negotiations. Given a cost transparency regime, this would make it possible for the assembler and supplier to work together to reduce costs and improve processes as well as exchange ideas. The supplier development process by the assembler accompanies cost transparency. The development activities include opportunities for the supplier to send staff on assembler-run training programmes, for example, Statistical Process Control. One further consequence of this style of continuous supplier development is that partnership firms appear to orientate themselves to particular customers depending on their long-term strategy outlook. These firms try to emulate their main customer's style of management and technical lead in order to maintain good working relationships, (section 6.2).

The level of development and integration in the automotive supply chain may be best summed up by observing the increasingly common practice of assemblers awarding suppliers for excellent quality (section 7.2.3). No such awards are presented in the offshore industry. Lamming (1995) reports that suppliers which have received supplier excellence awards also enjoy a higher growth in market share for the products.

Returning to some of the original research propositions, the next two sub-sections refer to two of the three key areas defined earlier as important considerations of a firm's partnering capabilities, namely, Prior Knowledge, Internal and External Linkages. Many of the points relating to Relationship Strategy have already been considered above. Some differences between the two industries are highlighted with specific reference to these two areas.

9.3.5 Prior Knowledge:

One line of enquiry illustrated in chapter three (section 3.2) questioned if small firms found difficulty in assimilating and adopting new technologies through their partners because they lack the internal knowledge base thus limiting their external knowledge accumulation. (ie they lack the in-house capability to transfer and mould ideas into their own business.) Section 6.2 highlighted the analysis of the TPPI using the second input variable 'Number of Professional Engineers' which helped to illuminate that the top seven TPPI performing component supplier firms appear to employ a greater proportion of qualified scientists and engineers to other staff than the 'uninvolved' group. In fact, these firms employ over 20 per cent (average score, 3.2) of QSE to other staff whereas the bottom eight TPPI performing firms employ less than 10 per cent (average score, 1.0). The same input variable is applied to the offshore suppliers (phase two) yet these firms were much smaller and generally engaged in one-off product design and engineering consultancy rather than volume related production businesses with a greater number of operator staff.

Section 3.2 also proposed that while the partnering concept appears to improve the awareness of technology development opportunities to prospective participants, it does relatively little to assist in the essential aspects of internal assimilation and adoption. One line of enquiry within section 3.2.2 aimed to establish if small firms with good external linkages have a better awareness of technology opportunities and whether they see clear associations between business needs and those technology opportunities. Based on the evidence gathered during these interviews, it would appear that despite a good understanding and therefore awareness of each others' businesses through informal linkages, small firms do have some difficulty in assimilating and adopting new technologies through their 'floating' partners, (chapter eight). Indeed, this view was confirmed by the Scottish Oil and Gas Innovation Forum which undertook a survey in early 1995 aimed at identifying critical issues facing small and medium-sized enterprises. They revealed that 'technology adoption' ranked top of their priorities. Interviewees were asked to rank entries in a given list of factors according to the extent to which *they* regarded them as constraints to technology adoption. In order of priority the following were classified as major barriers: Cost of entry; Access to external finance; Access to internal finance; Government funding; External support for technology adoption.

This insight reveals that small offshore firms *do not* perceive that lack of an internal base of technical know how limits their ability to adopt technology. Their primary concerns relate to financial constraints rather than, say, lack of time to transfer and mould ideas into their own business. Their apparent 'wealth' of internal know how is perhaps reflected in the TPPI analysis where it was revealed that a typical engineering consultancy firm employing ten people would represent a 'knowledge intensive' firm, ie it would employ say, seven graduates, a secretary/receptionist, an office administrator and a part-time book-keeper.

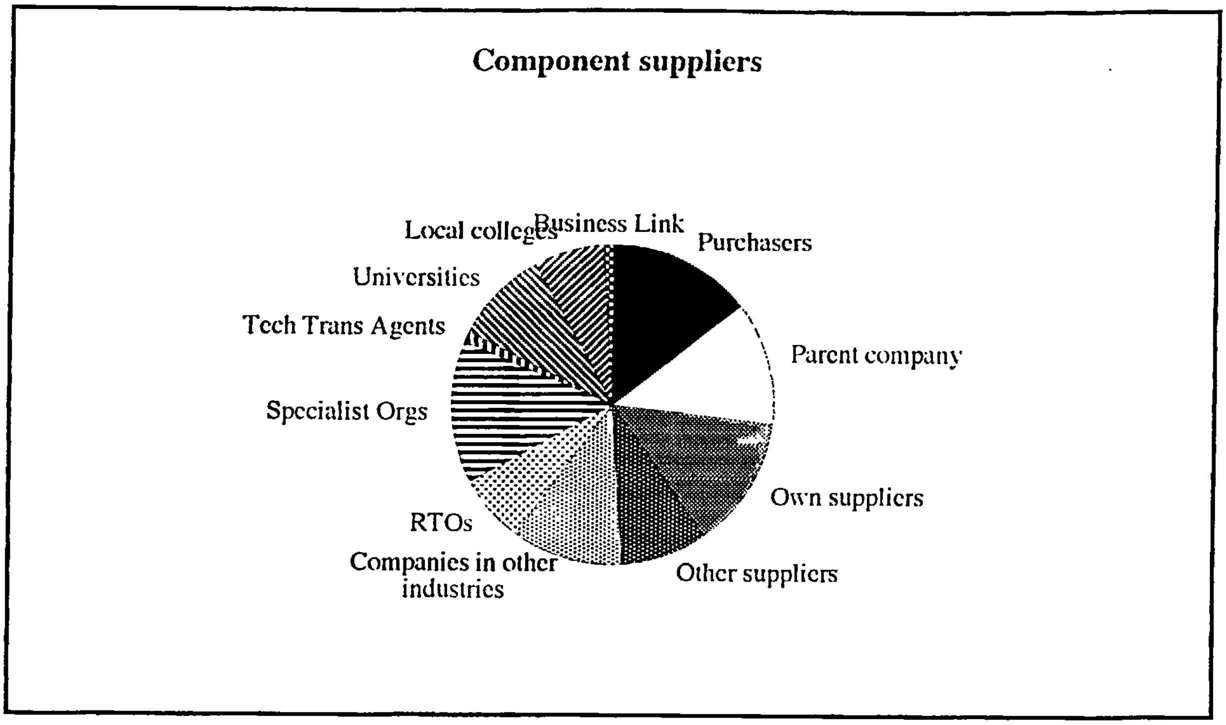
9.3.6 Internal and External Linkages:

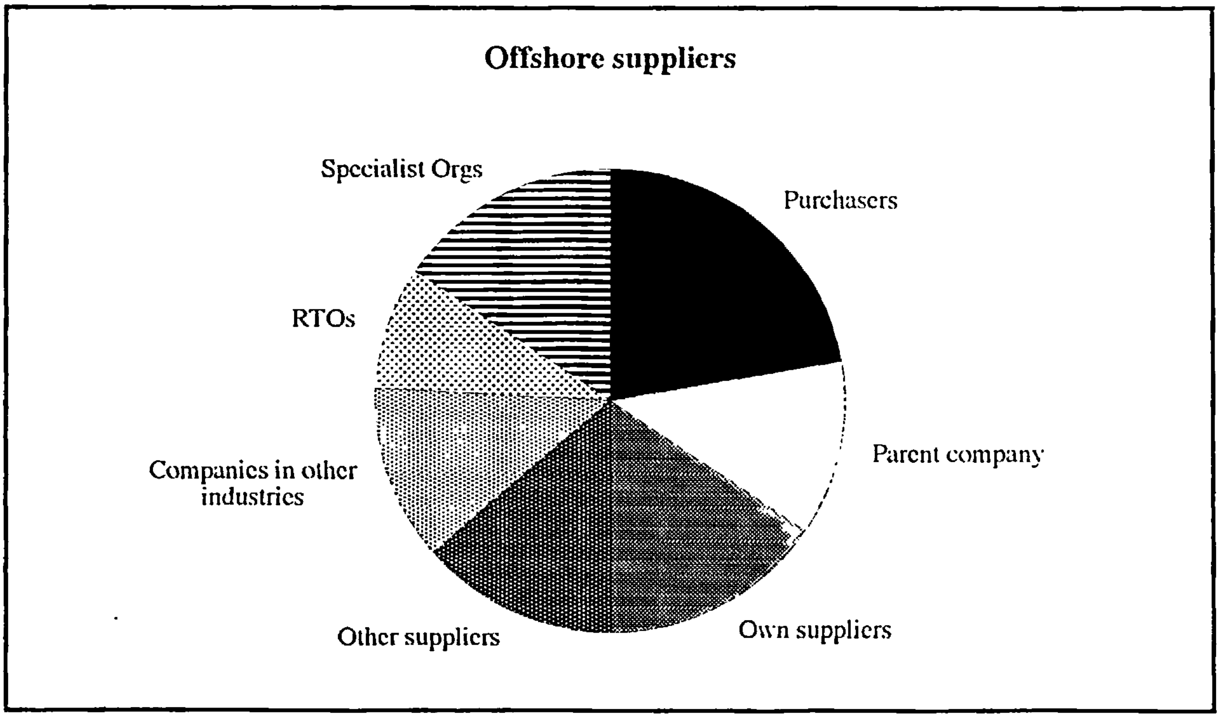
The first research aim presented in chapter two set out the need to evaluate under what general or idiosyncratic conditions is technology partnering a good practice. In order to meet this aim, some method of technology partnership performance measurement was necessary. Consequently, a performance index was developed (chapter five). Section 6.2 presented the results and depicted a ranked quartile order of motor component suppliers in terms of the overall TPPI percentage scores for seven input variables. From this analysis, two distinct groups of firms began to emerge which displayed differential ability with regard to partnering, figure 6.2. While only a limited reliance may be placed on this particular measure of analysis, some distinctions between the 'top seven TPPI performers' and the 'bottom eight TPPI performers' emerged. Despite the subjective nature of the TPPI, some firm conclusions may be established, viz. (section 6.3) The sources of technical advice and assistance which the firms' interviewed could have used to overcome their technology related problems was analysed.

The results showed that the top performing TPPI component supplier firms are likely to have contacted a much wider range or organisations than those at the lower end. It showed that these firms contacted on average 9.6 organisations, compared with an average of 4 for the bottom group of firms. This provides another guide that best practice firms are much more closely linked to the local business network although the range of external sources of technical advice and assistance is wider for motor component supply firms than for offshore firms. Section 8.2 presents the same analysis yet for the offshore industry. Overall, the most popular source of external advice for offshore suppliers was 'purchasers' (or oil companies and major contractors) (100 per cent) followed by 'own suppliers' and 'specialist organisations' (equal 69 per cent) whereas the least contacted organisations in the sample of firms' visited were Universities, local colleges, Business Link, TECs, Regional Technology Centres and Technology Transfer Agents.

The picture in the offshore industry is one where a cluster of organisations are frequently used yet, unlike the motor component suppliers, the 'wider' or less direct organisations are little used. This low usage may be explained by the fact that most of these organisations do not directly supply the technology, but rather carry out a technical evaluation and then make suggestions as to the appropriate technical solution. However, given the assertion that small firms 'often lack the in-house technical resources' to develop such resources, it would be reasonable to expect that small firms make more use of, say, universities. Figure 9.4 illustrates.

Figure 9.4: Sources of external advice and assistance





Finally, two further differences between the two industries are worthy of note.

(i) the extent of interaction between non-competing suppliers within one hour's travelling distance of each other appears to be far greater within the automotive than in the offshore industry. To illustrate, partnership firms establish their own exchange visit framework without the assistance of either purchaser or any type of facilitating organisation, (section 6.2).

(ii) the extent of electronic data interchange (table 6.2) - further supporting to maintenance of communication linkages - is less prevalent in the offshore industry than in the motor industry.

Although there are significant differences between the two industry sectors, there are also similarities. These may may be categorised as 'soft' and 'hard'. Soft similarities relate, for example, to lack of contractual trust; 'management churn' leading to difficulties in building good working relations, etc. Hard similarities relate, for example, to environmental drivers for technology partnering such as the case illustration in chapter eight (section 8.4.5) referring to OS3 where the small firm had a partnering arrangement with Lotus Engineering with the aim of finding a better solution to reduce noise and vibrations offshore. The automotive industry also faces many demands for environment friendly engineering solutions - ranging from a catalytic converter fitted to the exhaust system and designed to reduce the harmful carbon monoxide and dioxide in emission gases, to the requirement in October 1996 that all motor vehicle, newly registered in the EEC, will have to conform to EC directive 92/97/EEC on noise transmitted externally when a vehicle passes by, and improved safety.

The broader similarities between the two industries relate to a shared vision in relation to their supply base, for example: better relationships with suppliers; single sourcing; Total Quality Management in supply chains; open book costing and cost transparency; greater and earlier involvement for suppliers in product technology; fewer direct suppliers, etc.

The aim of the following section here is to present the more general aspects of partnering practise found in the offshore industry which apply equally to the motor industry.

9.4 Lessons learnt in the offshore industry

During the Phase Two interviews, comments were invited on proble 'ns which arose during the evolution of the partnership, general lessons learned and critical success factors, (see semi-structured discussion questions with offshore firms, Appendix B, section 2, question 2.2). The major themes from the comments are presented in this section. These themes thread together many of the points noted within chapter eight and address organisational issues (contractor and customer), and individual issues (managerial attitudes and role). In addition, they support the best practice guidelines which are presented in chapter ten.

• Contractor Issues: The contractor must be prepared to become more proactive and take over the responsibility offered, even if there seems to be resistance within the client company. Problems can occur when the contractor does not have the correct mix of skills to take over the planning and managing roles formerly performed by the customer. Benefits arise because the contractor can see the 'big picture' and because he can see the whole problem without being given a partial description which is second or third hand. Staff transferred from customer to contractor during the creation of a partnership can find that they have more opportunities to pursue their career than with the operator. Where additional temporary contract staff are recruited to work within a partnering-type contract, it is important to recognise that they may find it difficult to adjust their behaviour.

• Customer Issues: The customer's internal politics, distrust between departments and internal communications can be a severe barrier to the development and success of a relationship. These problems need to be resolved even if it means redeploying individuals whose behaviour and attitude are seen as a barrier. Customer's staff involved in setting up a relationship must have the right skills to deal with people and to understand the partner's point of view and needs. Choice of the wrong individuals can cause lasting problems.

• Managerial Attitudes: Clearly, attitudes of individuals can hinder or promote the development of a collaborative relationship. Negative attitudes develop because staff on both sides can feel threatened. This may be apparent particularly in the customer's middle management who are in a position to slow down the process. The tendency by customer's staff to try to control what happens, rather than allowing the contractors to proceed, threatens the collaboration.

It is also important that the customer's management give a clear message that collaborative working is expected and that they actively discourage non-collaborative attitudes. The role and attitudes of senior management involved are crucial to the success of the relationship. There is a real danger that managers use all the right words but that their behaviour demonstrates that they either do not understand or do not believe in what they are saying. A long hiatus before a partnering arrangement is established and before people are able to know their position, can be damaging.

• Savings: In the early stages it is possible to make large cost savings which can be shared between customer and contractor to encourage performance. However, the scope to make further substantial savings reduces as the partnering arrangement continues, and the incentive to maintain high performance is less clear. Incentives involving shares in value added may be needed.

9.5 Summary

The differences between the two industries broadly relate to technology development and its use/purchase, the extent of integration within each industry and how it encourages or hinders technology partnering, and the basis and motives for partnerships. In general terms, the present automotive scene favours the existence of long-term partnerships between suppliers and assemblers in a vertical innovation chain and, therefore, supports innovation partnerships. While partnering can work in the offshore industry, there is less scope for long-term vertical arrangements. The reason for the difference is partly due to the actual need for collaboration and the motives by the prospective players for doing so. Unless the small firm can make a substantial difference to reducing costs (>5%) the firm will become 'locked out' of partnering arrangements. While component suppliers are readily brought in at early stages of a new product design in order to help eliminate waste and reduce final product cost, their input is valued and they are rewarded with continuous or roll-over business from one car model to the next.

Finally, two broad important areas have emerged from this discussion.

• First, the need for policy to recognise the role of specialised intermediaries and/or marketing groups as facilitators particularly in the early stages of technology partnering development in relatively 'young' industries. In a young industry, the structure of the industry is still fragmented. The aim of the facilitator, therefore, is to help bring firms together in a forum to help strengthen their technical capabilities - providing the opportunity for participants to meet, exchange ideas and learn about each others' capabilities. This process will also enable them to make informed judgments about prospective technology partners to compliment their own skills.

• Second, the need to identify which industrial sectors might benefit from technology partnering given the changes in contracting philosophy.

Underlying these two areas, is the need to anticipate the likely managerial response to partnering-type arrangements given the historical perspective of the industry and the nature of technical change within. Some suppliers claimed, during interview, that lack of finance and pressure of time were the main factors preventing them from innovating at a level they would otherwise wish to undertake. However, firms don't have to be cash-rich to enhance their technology base. The process of innovation is more closely linked with the attitudes of managers than finding the money. Following an initial idea into a full-blown development project through collaboration with other suppliers and customers is the key to successful innovation.

Chapter ten: Collations and summary of the findings from the two phases of research

10.1 Introduction

This chapter draws together the main findings derived from the two phases of research. The issues covered within this thesis centre on some of the critical success factors to good technology partnering:

(i) SME ability to usefully incorporate new technical know how into its own knowledge base - Prior Knowledge;

(ii) The firm's ability to access sources of expertise and maintain those linkages to some useful outcome - External Linkages;

(iii) The managerial attitude to technology partnerships - Relationship Strategy.

The following section highlights some of the main findings of the two phases of research and discusses them in relation to the original research aims and propositions. The guidelines which follow in <u>section 10.3</u> sum up the best practice guidelines for technology partnering. These are based on the evidence analysed within this thesis and section references are given.

10.2 Technology development and the varying role of partnering

10.2.1 <u>Prior knowledge:</u>

Section 2.3 brought this area into focus and noted how organisations learn, ie through prior knowledge in order to assimilate and use new knowledge. It introduced the importance for small firms to develop good networks of technical expertise to enhance their technology base. The common theme that emerged was that by creating and maintaining informal alliances this may enable firms to better exchange technical know how which can then lead to significant quality improvements and the capacity for greater innovation. Trott (1993) observed that 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 organisation level this is enhanced through communication amongst individuals with diverse and different knowledge structures.

10.2.2 Internal and External Linkages

Section 2.4 summarised the main literature themes with regard to external linkages. Rothwell (1991) has shown that innovative SMEs have dense external networks (or linkages) in a variety of marketing and manufacturing relationships. These linkages are often informal alliances and industry associations. Nonetheless, they 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). However, it appears that not all firms have the foresight and capacity to forge and develop effective external linkages, formal or informal. Rothwell and Beesley (1989) suggest that the most significant factor determining an SME's propensity and ability to access external knowledge is internal to the firm; most notably,

"...the employment of qualified scientists and engineers and the outward-lookingness of managers."

In other words, SMEs appear to be disadvantaged in their ability to develop external linkages and informal alliances because they lack internal specialists.

Section 3.2 illustrated that for small firms, communicating with large purchasers within the context of a partnering arrangement can vary in effectiveness considerably. It argued the importance for a small to have good external linkages to enhance its technological base. It suggested that a major determining factor hinges on the time which senior management devote to establishing linkages with small firms. Segal Quince Wicksteed (1988) argued that the way in which the majority of small firm linkages were found not to derive from formal corporate planning processes had three main consequences. First, it meant that any partnership was inevitably peripheral and failed to command widespread support throughout the company. Second, it was critically dependent on being championed by individuals, and was likely to collapse if they were to move. Third, the partnership was narrowly based; it would, for example, be a link only between technical personnel, and would preclude links with the marketing function so valued by many small firms. It is crucial, therefore, that a lead is taken at the top and that the policy is embodied in all dealings with small firms to ensure that a consistent approach is taken. There is little point in one arm of the firm developing close links with key suppliers when another arm delays payments of invoices to the extent that problems are created within such suppliers.

The research findings within the six case studies, particularly those illustrated with chapter seven gave support to these views. The cases showed how SMEs supplier organisations had nurtured over several years some useful relationships with experts working in large firms capable of, amongst other things, directing them to other sources. For example, the management of AS8 were introduced to two machine tool experts in a German spinning machine manufacturer. These individuals were instrumental in the one piece engine fan pulley development.

10.2.3 Relationship Strategy:

It is naive to expect technology partnerships to be without problems. Managers have to think carefully about partner selection and how to share the commercial benefits arising from the technological development. The broad accent of this study has been on the 'managerial attitude' of the prospective and incumbent partners. While the impact of a small group of disinterested middle management within a large firm is of some concern, in the case of small firms, their managerial attitude especially to partnering is clearly of central importance. It was argued in chapter three that if the partnership is to work then apart from building up mutual trust between the partners, managers need to overcome the suspicion that collaboration is a zero-sum game, and that their firm is giving away its technology. SME management in particular need to deal with the antipathy towards collaboration which is felt by many scientists and engineers having to work with other organisations. Managers may need to assure staff that collaboration is not a reflection of their lack of skills.

Section 3.2 highlighted two research propositions that related to managerial attitude particularly the interface on the purchaser side. Semi-structured interviews used in Phase One of the research confirmed the importance of a firm displaying the 'right' managerial attitude if it is to become an attractive partner to other (larger) firms, (section 6.1). The identification of four distinct levels of partnering arrangement characterised along two axis showing managerial attitude and behaviour helped provide a better understanding of the role and extent of different partnering arrangements. A 'soft' level may be summed up as *informal knowledge exchange* ; a 'medium' level would represent a *formal/organised knowledge exchange*; a 'hard' level would resemble a *planned collaboration/shared risk* arrangement. In addition, an 'uninvolved' level represents a disbelieving and mistrusting group of firms, (6.3.1). The subsequent positioning of firms (7.2) into the various levels of partnering helped to discern the characteristics which make good technology partnering practice.

Chapter two noted that partnerships are likely to fail because of managerial rather than technical reasons, (Doz, (1988). For example, in larger firms, be they oil operators or vehicle assemblers, partnerships are usually decided upon by top management, but implemented by middle managers and by technical specialists. While the intrinsic ambiguity of partly collaborative, partly competitive relations can be easily understood and tolerated by top management who think long term strategy rather than hands-on day-to-day fire fighting, operating managers who bear the brunt of the actual interface may find this ambiguity difficult to integrate in their working relationships. Amidst all the hype about 'partnering' and the benefits that may flow from such arrangements, it became clear during the first phase of the research that the reality of partnerships is often more complicated than many firms first believe - the amount of effort required is often underestimated. The ultimate benefits/aims are seldom achieved principally because of firms' lack of appreciation of the difficulties of working together. Another reason why partnership relationships fail is because of internecine struggles for superiority, ie the power tussle. Furthermore, opponents to partnering argue that the concept is equivalent to 'technology imperialism' which *per se* leads to the subjection of SME's to the needs of the main purchaser. The notion of 'trust' is seen as one of subservience (or overdependence) in many supplier SMEs, but they consider that they have no alternative due to the *power* exerted by the main purchaser - providing some support for Proposition five, (chapter three).

The third proposition suggested that small firms continue to encounter problems of building working relations with a dynamic assembler management interface. Section 3.3 suggested that some managerial tensions were likely to cause a forceful barrier to otherwise progressive partnerships. For example, how the interface between some of the traditional European car plants and their supplier base was unstructured, often left to chance and to *ad hoc* adjustment, and how disenchanted middle purchasing management can present a block to otherwise progressive partnerships. These thoughts are supported with field research evidence. For example, section 6.3.6 highlights the greater level of 'stress' for supplier management in sustaining partnering-type arrangements while section 7.2 highlights the views of an MD in control of a plastics firm.

Further, the argument highlighted in section 3.2.4 (note (v)) that given purchasing management move jobs frequently then SME management quickly become disenchanted since it causes them to build new relationships with people who bring a different set of baggage/beliefs with them. This can only reinforce supplier skepticism of partnering borne out of organisational structural changes within the purchaser. Indeed, it was recorded during an interview with the MD at AS5 that they had even noticed favouritism of one of the senior buyers at one of the traditional car plants. This firm perceive many "obstructors" within their main customer. The supplier's response is to invite the new buyers to an early evening buffet at a local hotel where AS5 can present their capabilities. These views are given support by the authoritative evidence within section 7.2.3 - representing remarks by a purchasing manager within Rover.

This aspect leads to another fundamental difference in the motivations of the purchaser and supplier to partnering-type arrangements. The purchaser design their alliances between a group of their own people and the other partner firms to enhance flexibility. This is particularly true for purchasers at the start of the alliance management learning curve, ie they may see the small alliances as experiments in organisational innovation that, if successful, could be replicated elsewhere. Purchasers are establishing multi-functional teams, not present internally, to interface with the supplier. The career paths of the team members have been streamlined to increase upward mobility, motivation and creativity. The structure of incentives is also much finer in the Team setting than in the company itself. The point is that the internal structure of the alliances provides an appealing setting for young, energetic technical or commercial disciplined professionals at the junior and middle management levels who are also keen to rise up the corporate ladder. However, this only exacerbates the problem for small firms in building working relationships with a dynamic interface if managers are promoted or change roles after one or two years.

Figure 7.3 conveyed the four distinct groups of firms that have a differential approach to partnering. Some firms develop all or most of their technology in-house making full use of internal expertise, while others engage in a multi-disciplined and highly structured partnering arrangement that recognises the formal division of risks and rewards. The findings from the two measures of analysis were merged in chapter seven and strengthened by the independent authoritative evidence. The net result showed a group of firms regarded here as best practice technology partnering performers. Much of the guidelines that follow stem from this evidence. Indeed, seven of these firms have also recently earned a Supplier Service Award from Rover, (section 7.2.3). A remark noted in this section related to a purchasing director commenting on the potential benefits for a firm from winning an award,

"The likelihood is that the longevity of a business relationship will be enhanced and maintained by the winning of an excellence award. Longer term security is better, but there is no preferential treatment."

In addition to the collection of findings relating to the three core areas above, the data analysis of the two phases of research also revealed some *other issues* derived primarily from exploring the inter-relationships between the qualitative, semi-quantitative and quantitative data.

10.2.4 Other issues:

First, one of the surprising aspects of the phase two findings lay in the area of business objectives and motives for partnering, (section 8.4.5). The top TPPI offshore performing firms (identified in section 7.2.3) often remarked during interview about 'soft' performance factors such as keeping their firm in the business eye instead of other 'hard' factors such as profitability, market share or sales. In one sense, this may reflect the 'distance' they wish to keep from their contracting clients - having already experienced abuses of confidences and fears of losing control over the innovation element, etc. In other words, their remarks suggest arrangements which are consciously kept informal without agreements on risk and reward divisions, etc. The results also reinforce the importance of networ' ing especially given the changing contractual scene where the small firms are seeing their links with the operators slowly being severed. Indeed, several firms noted the challenge of bringing their technology to the attention of the operators, given that their clients occasionally appear to shield their source of innovative solutions from the operators. In a sector which relies heavily on informal contacts, this represents a major shift and threat to small firms' place in the market. Consequently, the motivation to create and sustain good partnerships with the contracting sector is reduced.

Second, section 6.5 considered the strength or otherwise of the relationships between input variables to technology partnering as defined within the TPPI and the independent evidence such as a firm's financial performance and the proportion of business a firm supplies to a customer. Through the use of a statistical software package, three points were observed: (i) There is no correlation between 'managerial attitude toward partnering (Variable H) and the level of business supplied to each customer. (ii) The extent of a company's internal and external linkages has no bearing whatsoever on the level of business supplied to each customer. (iii) Similarly, a supplier's relationship strategy' as defined here has no impact on the level of business. Furthermore, there is no statistical evidence to suggest that good partnering performance directly influences financial performance. Clearly, firms enter into partnerships for some commercial benefit yet, given the magnitude of variables that come into play and impact on sales growth or ROCE then we can not expect to see a strong, statistical relationship. However, as section 6.5 notes that in nearly every case of relating technology partnering performance to financial performance, the *trend is in the expected direction.*

Another factor explored in relation to technology partnering performance was company size, (section 6.5). Berg *et al* (1982) found that size of the firm has a positive effect on joint venture participation. This correlation can simply be explained by better and more opportunities to seek external linkages for instance through economies of scope. The finding in this research with respect to company size was mixed, (Appendix E). It was observed that small firms are either very good or very bad at technology partnering but large firms often occupy the middle-ground.

In other words, small firms display differential ability at partnering. Inevitably, for small firms attempting to work in partnership with larger firms with different strategies, structure, systems and cultures is a very difficult and time consuming process as well as tension ridden.

Finally, in terms of independent evidence to evaluate the impact of good technology partnering performance, a patent intensity measure was used. As section 6.5 discussed, it was anticipated that those firms with a high technology partnering performance indices score would also exhibit a higher than average patent intensity rate. However, the results indicate that there is only minimal correlation between patent intensity and the technology partnering performance indices and the financial measures. (for an example of an SPSS test, see Appendix I, figure 14).

10.3 Technology Partnering Best Practice Guidelines:

10.3.1 Introduction:

The aim of the points which follow is to provide guidance to help managers understand better the types of decisions they make at the strategic as well as tactical, day-to-day level with regard to partnering. The aim is not to produce some form of 'identikit' picture of a highly successful technology partnering player which can be copied by all aspiring firms to partnering. On the other hand, there are a number of characteristics and dimensions in which better firms differ from others of a similar size, age, and which operate in the same industry sector and compete in the same market segment. While these guidelines have been derived from a number of sources, including the literature, the two main sources are from interviewing a select group of firms in two industries located in the West Midlands and Aberdeen. To some extent these results reflect the character of the two regions. The West Midlands has a long history of industrialisation covering many different sectors whereas Aberdeenshire has mainly one dominant industry - the oil and gas sector - which has grown since the mid-1960s. Prior to this, the region was dependent on producing and processing fish and agricultural products and a declining textile industry. However, both regions have seen relatively high rates of new business start-up - generally promoted by attractive concessions - and where links between government and the private sector have traditionally been close.

The following points offer first, some broad strategic guidelines for SMEs and large purchasers alike and second, some tactical points for consideration during a partnership. While there is no division drawn here about supplier and purchaser features, the purchaser aspects are generally presented towards the end of each sub-section. Nevertheless, many of these guidelines relate to the supply base reflecting the greater proportion of field research interviews with SME suppliers than with purchasers. The guidelines pull together many of the points raised throughout the thesis and provide reference points. For example, the case studies presented in chapters seven and eight were chosen to illustrate the differing levels of successful technology partnering as well as distil some success factors to technology partnering. The common factor between all the case studies was that collaboration was fundamental to the technology development generally because access to the specialist skill was essential for the successful development. Further, the actual scale of collaboration varied considerably between the cases and other examples given in the thesis. Some projects involved little or no financial support from the purchaser, and infrequent contact while others were at the other end of the spectrum.

The *strategic* guidelines are divided into three categories: Prior Knowledge; Internal and External Linkages; Relationship Strategy. They largely reflect some 'precursors' to good partnering arrangements, ie what firms must have in place prior to engaging in a technology partnership. Given that a large part of the research centred on managerial attitude and behavioural aspects, the last category presents a greater number of points than the other two. This reflects the view stated earlier than partnerships are likely to fail because of managerial rather than technical reasons.

Section Reference

10.3.2 Prior knowledge:

All of these characteristics help the firm to better scan for and introduce new technologies into the company as well as steer new projects past the critical stages.

Design resources 6.3

• Suppliers have a significant design resource, both in terms of engineering expertise and of equipment. For the larger suppliers, this means a large engineering staff, Computer Aided Design (CAD) work-stations, contacts with technical specialists within their companies, technology agreements and joint ventures with other companies. For the smaller companies, it means specialist engineers and basic CAD equipment. Most suppliers in best practice league have product testing facilities.

Internal skills 6.2

• Employ a greater proportion of professional engineers and scientists than other companies, such as metallurgists, chemists, other experienced doctorates as well as engineering personnel with many years of experience within motor vehicle manufacturing facilities.

10.3.3 Internal and External Linkages:

Apart from those in technology-intensive areas. companies in this research study generally volunteered little information about any sustained contact with universities, except in their search for good recruits. However, a small group of firms appeared to manage collaboration in a much more positive way. They displayed a tendency to build relationships with leading academics, even world authority experts within national and international universities. More specifically, they all showed the characteristic of being more receptive to collaborating with others at whatever level of formality. They were, in most cases, active members of local and national industry-specific initiatives that enable them to build up their network of contacts. The following presents a selection of good practice features amongst supplier firms.

Trading information

8.3.1

• They trade enough information to make the collaboration work yet without compromising their independence and attractiveness to other partners.

Process orientation

7.3

• Best practice purchasers *orientate* themselves towards having a definite policy towards linkages with small firms supported by a good supplier interface providing continuity and structured communication channels. In supplier organisations people are generally ready to change. There is a growing recognition of the benefits of partnerships and the frame of mind to discuss new ideas with customers. In the customers organisation, however, there can be a great deal of skepticism and fear generated because partnership principles demand radical changes to traditional functional rigidities. In steering the business towards process orientation *rather than* functional orientation it may well be that accountants have to work in one office with engineers, purchasing people or with production people to break up these great silos of functional professionalism will naturally cause concern to some people.

8.3.2

• To succeed in alliances, small firms must be more creative in their approach to collaborating with other firms. Every alliance must have an internal structure which is agreed from the outset that enables swift introduction of new technology from outside the alliance.

10.3.4 Relationship Strategy:

The 'relationship strategy' aspect relates to a cocktail of features that may ultimately determine the progression of a partnership. To illustrate, the establishment of an appropriate contact within the larger partner business who is able to appreciate the nature of the research as well as its value to the company, is very helpful, not least to overcome problems arising from cultural differences. Regular contact minimises the possibility for misunderstanding about the direction and results of the research. Such contact can be dealt with by the firm's research staff or with an individual who had a keen personal interest in the project - leading to a close working relationship. The following presents some of the best practice features displayed within a small firm and large purchaser at an early/preparatory stage that appear to have supported a successful partnership.

Relationship building

7.3.1

• Timetable several years into establishing a supply relationship enabling the two parties to develop a high level trust and mutual respect for each others' capabilities.

Networking

6.3

• The development of personal contacts and networks plays an important part in improving knowledge and identifying opportunities. Practical steps to develop such contacts and networks include active participation in 'industry initiatives' and various seminars run for businesses as well as participation in business training courses and contributions to conferences and trade journals.

Power

6.3

• Power does not appear to be used or even threatened in the relationship. It is not seen as a solution to most problems.

Customer-dedicated teams

6.3

• Have customer-dedicated teams: design engineer, production engineer, quality engineer and a sales/marketing manager. The effort and resources often appear to be disproportionate to the level of business from that customer.

Accent on moving forward through performance improvement and innovation

7.3.1

• Best practice companies are proactive rather than reactive. They know their markets and benchmark the performance of competitors, and of the world's best in a particular function irrespective of source. The accent is on 'trying to improve', rather than 'relaxing' when a quality standard is achieved.

Management attitude

7.3.2

• Identify and select the right partner: a realistic assessment of (and respect for) the supplier's capabilities as well as managerial attitude towards partnering. However, due to the nature of innovation, it may not be appropriate to be too prescriptive about how to set about finding the right partner. Firms may only have a partial understanding of the likely scope of development activity and the precise technical skills that will be needed down the line. Nonetheless, one of the most important factors is for both senior management teams to feel as though they *could work together.*

Management 'freedom' to develop association

7.3.2

• An important feature, perhaps idiosyncratic to the arrangement in South Wales, is the apparent lack of budgetary control - both in terms of set up costs and, more importantly, managerial time to lead and orchestrate the association. Further, a vast amount of effort goes into communications and coordination - where Calsonic keep the association members informed and aware of developments.

Inter-firm trust

7.3.2

• A considerable amount of trust and and confidence was displayed in the Calsonic case. With a two supplier associations running in parallel where some members of each were in direct competition calls for the utmost confidentiality by Calsonic. Much of this trust and confidence, particularly in the early stages of the two associations running together, hinged on good personal relationships.

Balance of technical competence

7.3.3

• The importance of the partnership team having an equal balance of technical competence thus avoiding delays and diversions of effort where the 'weaker' partner has to catch-up.

Clear aims

7.3.3

• Best practice companies demonstrate a clear sense of mission and purpose. They have a strategy balanced between the short, medium and long-term, thoroughly thought out at board level and communicated throughout the organisation. Innovation is an intrinsic part of the business strategy, and the philosophy is one of continuous improvement within a climate of total quality management and customer satisfaction.

Early agreement on IPR

6.3

• Although very time consuming, best practice suppliers tend to sort out the ownership of Intellectual Property Rights early on. They tend to ensure that any wider benefits they may be seeking to obtain from a relationship with a large company partner are embodied in its written agreement. To others, this may seem an unnecessary formality at the time when the agreement is being negotiated, but it could prove vital at a future date if there is a change in personnel within the large firm. For example, 'comfortable' verbal agreements between individuals on the provision of market intelligence and advice on standards and regulatory systems in overseas markets, may quickly disappear if there is a major upheaval in the large firm, such as it coming under new management. The problem will become exacerbated where, for example, the new owner controls a subsidiary which is in direct competition with the supplier. A legal agreement governing the relationship which establishes the responsibilities of both firms can often preempt these difficulties. Nevertheless, the supplier should carefully consider at the outset what is central to its decision in order to enter into the partnering relationship.

Tensions between partners can occasionally be reduced with due attention to more tactical considerations before embarking upon a collaboration. For example, decisions need to be made early on in a collaboration about who owns what of any results from the collaboration. Deciding this up-front saves considerable problems when something valuable emerges. Indeed, the agreement or contract ought to refer to: the content and timing of both the collaborative project and the results to be delivered; the resources - financial and otherwise - to be contributed by each party; payment terms; rights and restrictions on publication; ownership of intellectual property rights, etc.

Similarly, early agreement on review procedures can save subsequent problems. Review procedures should not be too loose (as projects may drift aimlessly), nor should they be too light (as these will restrict the ability of projects to change objectives). Agreed project milestones assist the review process. Conditions for termination should be agreed from the start. Getting the balance between flexibility in objectives and their supervised control is a major management task.

To sum-up, the top performing partnering firms are those suppliers that have demonstrated their specialist technical resources to existing and potential customers and displayed their innate ability to out perform their nearest competitors in terms of cost, quality and lead time. These firms persisted to emulate their customer's style of management and technical lead in order to 'match' themselves to particular assemblers which would then stimulate initial negotiations.

SME management within were further able to show to potential customers their willingness and capabilities to keep abreast of new technologies through active participation in collaborative ventures with universities and research institutions, and membership of professional associations as well as maintaining contact with other suppliers. The matching process extends to the supplier's JIT capabilities with the aim being to perfectly match the output of its manufacturing systems with the requirements of the market. These firms are more adept at internal inter-linkages, for example, between sales, engineering, planning and quality departments with tool, jig, fixture and preproduction manufacture which is more often supplemented by a remote datatransmission system and information exchange with the customer.

The successful SME component supplier is more likely to have a 'programme management organisations' (see case study - AS8 and Toyota) to help with the process of new product development from the original point of idea generation, through evaluation of alternative design ideas, the development and testing of prototypes and ultimately in market development. Such technically progressive firms display a less formal style of approach to their customers which appears to sustain continued and fruitful dialogue for both parties. Against this, the apparent informality, particularly between some of the larger SMEs serves only to weaken the direct line of communication between the decision makers, particularly where their are multiple contact points.

The clear impression arising from the component supplier visits was that the top performing partnering companies were found to have an intuitive understanding of their customer's requirements, which was earned through continuous dialogue. They took advantage of external help such as the customer's own technical resource base when scanning for technology as well as asking for assistance to install the technology. In addition, they would make arrangements either with the customer or OEM to train staff in advance to use that particular technology. Their management have no hesitation in sharing know how to solve common problems and meet on a regular basis to discuss their ideas, often involving HEIs where required. In addition, they will occasionally organise one-day exchange personnel visits.

10.3.5 Tactical considerations during a partnership:

Although the most important aspect of successful technological collaboration is the existence of benefits for all parties in areas which they value, there are a number of practical pointers at the tactical level to success illustrated in the case studies and comparison studies (chapter seven and eight). Identifying opportunities for collaboration often requires an opportunistic and entrepreneurial approach, since the origin and character of each project may differ - good fortune playing a part in many cases. However, simple steps may be taken to increase the range of potential opportunities and ensure that the working relationship is firmly rooted in benefits to both parties. The case study evidence provided a stepping stone to these best practice guidelines to a technology partnership.

Compatible MIS

6.3

- Best practice suppliers have compatible accounting systems enabling the two firms to compare notes. Further, incompatible costing systems present a barrier to cost transparency - the hallmark of good technology partnering arrangements. Like so many initiatives in the management of component supply, cost transparency requires high level management commitment on both sides - to enable the exchange of sensitive data and to prevent the opportunistic use of confidential materials.

Partnership Champion

7.3.3

- Ensure committed individuals become involved in the partnership and champion its cause. Indeed, from a day-to-day management point of view, the establishment of an appropriate contact within the business who is able to appreciate the nature of the research as well as its value to the company, is very helpful, not least to overcome problems arising from cultural differences. Regular contact minimises the possibility for misunderstanding about the direction and results of the research. Such contact can be with the business organisation's research staff or with an individual who had a keen personal interest in the project - leading to a close working relationship.

Open-book

7.3.3

• Declare profit levels to customer as well as providing detailed cost breakdowns to the assembler in return for information enabling better component production forecasts to be prepared.

Cost transparency

7.3.1

• When product cost savings are achieved through a joint effort, best practice suppliers negotiate with their customers about how these might be shared, on the basis of transparency of the supplier's cost structure and in the framework of mutual trust.

Willingness to share

7.3.1

• Willingness to share knowledge and respond to customer's needs. Best practice suppliers tend to display a managerial attitude that epitomises openness and flexibility. The accent is on 'trying to improve' rather than relaxing when a quality standard is achieved. Compatible partners often look to a supplier's ability to improve rather than their actual level of performance.

Management Skills

8.3.1

• Best practice suppliers demonstrate good project management capabilities. In addition to the usual skills of overseeing project objectives, budgetary control and man management, technological collaboration often demands special diplomatic skills and powers of persuasion. Getting things done in your own firm is often difficult enough, but it requires great diplomacy and powers of persuasion to get things done the way you want in other firms.

Genuine interest

7.3.2

• Best practice suppliers all *want* to be in the partnership - they view it as offering value for time spent. Best practice suppliers deftly demonstrate a level of commitment that separates them from those that pay lip service to the practice.

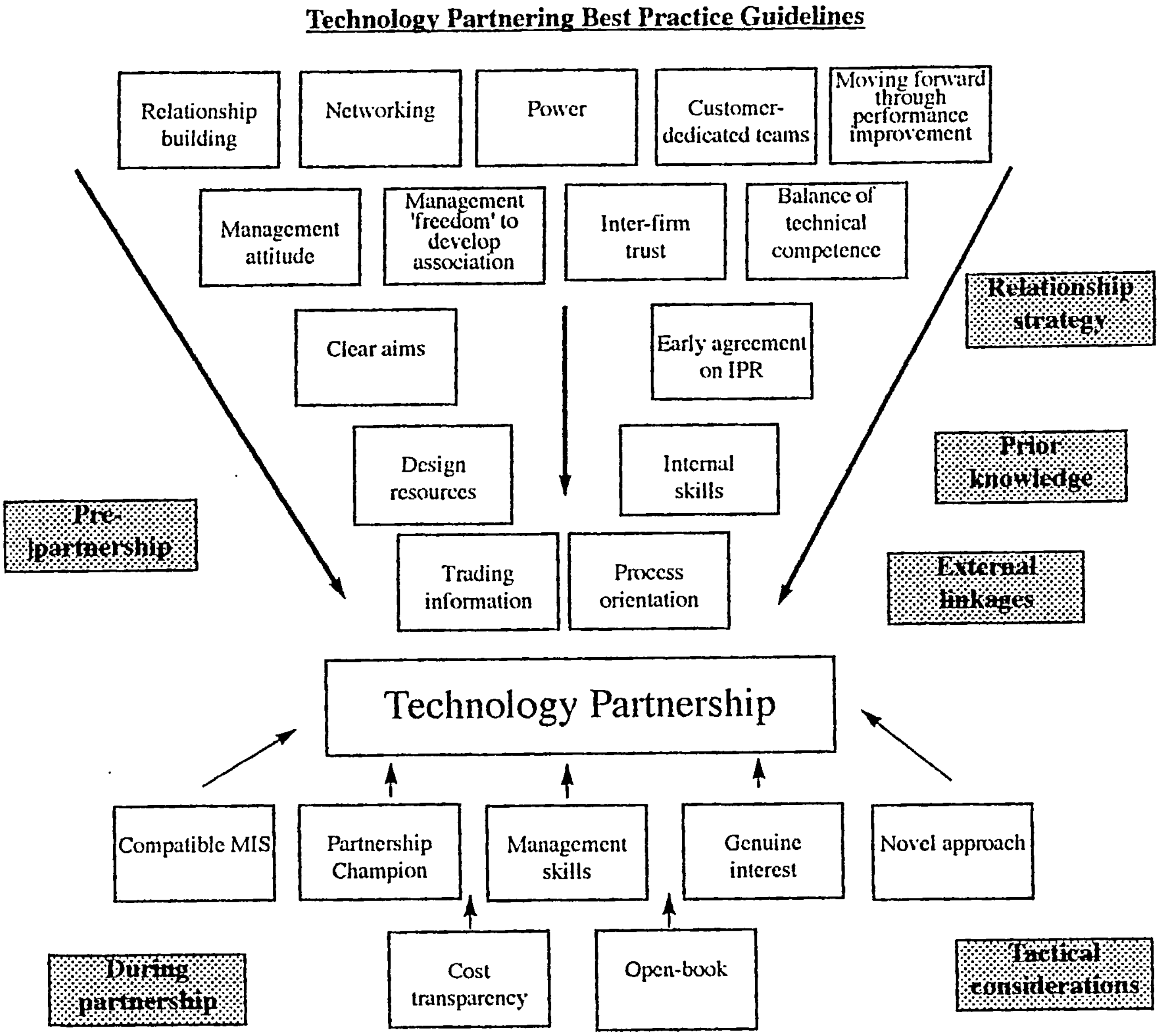
Novel approach

7.3.1

• Best practice purchasers show a tendency to take a novel approach to each partnership. This inevitably helps to prevent managers becoming dictated by earlier strategies that have become superfluous and only serve to hinder the current arrangement.

Figure 10.1 summarises the discussion.

Figure 10.1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Tactical considerations

While there are many advantages to partnering there are some causes for concern. Indeed, no matter how careful firms are to safeguard their technological assets in a partnership situation, there is also a real potential for loss. It is difficult to control exactly what goes on in the many meetings between technologists from the different partners. This is exacerbated by the fact that interactions between firms take place at different levels and in different functions. However, one solution is to ensure that a key member of staff leading the alliance educates all employees about the practical risks of collaboration so that they do not act as unwitting information conduits to the partner.

Finally, returning to the literature, Hamel (cited in the Economist, 1988) argues that companies which are best at learning all they can from their partners get the lion's share of the benefits. The author suggests several way companies can ensure they gain the maximum benefit from partnerships:

- "Guard the gate" (manage interfaces, monitor meetings, control requests for information and access within the company).
- "Pay attention to questions as well as answers" (record and analyse your partners questions).
- "Ask broad questions" (a lot can be learnt from answers to broad rather than focussed questions).
- "Teach" (seminars from executives returning from secondment to partnerships).
- "Be cheeky" (an apparently outrageous request may generate results)
- "Know when, and how, to quit" (agreeing on how to terminate a partnering arrangement at the beginning can ease the difficulties with terminating a long term partnership).

Murray, Mahon and Mahon (1993), advise that 'in order to protect yourself in an alliance, don't allow the partners to do all the learning and to absorb and digest all your technology, organisational skills, knowledge and competencies.'

10.4 Some factors which determine weak technology partnering arrangements

Much has been said so far about the 'soft', 'medium' and 'hard' levels of technology partnering but little specifically about the 'uninvolved' group. Indeed, although chapters six, seven and eight all refer to every company interviewed, there has been little collective discussion of this level and the factors which generally appear to characterise this group. Again, it ought to be noted that these remarks relate to this group's *response to partnering* in particular rather than their overall business performance.

Although technology change was seen by the bottom performing group (or 'uninvolved') management as crucial to their business in order to maintain their edge on competitors, improve product quality and help reduce costs, SMEs were generally not giving serious consideration on how to tackle such changes. Technologies appeared to be acquired by chance rather than through a structured scanning procedure making minimal use of other suppliers or external specialists to help that process. These firms appeared to make productivity improvements not through technology changes but through a reorganisation of staff shift patterns and hiring temporary workers, ie their existing resource base. It can only be inferred that this is due to their mistrust of their customers' *vision* of longer term partnerships, ie the suppliers' prefer to curtail their capital commitments during an otherwise punishing recession and until such time as they are convinced of their customer's plans or given clues to the content of their hidden agenda.

As companies accumulate experience in technology partnerships at whatever level and depth they also identify negative aspects. Indeed, no matter how careful firms are to safeguard their technological assets in an alliance situation, there is also a greater potential for loss. There is growing concern about several problems for which no general solution has yet been found. Nueno and Oosterveld (1988) observed how companies are concerned with the potential unplanned loss of knowledge through coalitions. It is difficult to control what exactly goes on in the many meetings between scientists from the different companies involved in a common project. Some companies indicate that it might be possible for a group of scientists from a company to gather elements of information which allow them to identify the position of another company within a technological field or its major lines of advance. However, the project interviews yielded some common practices and hints for protecting know how. One such solution in this case is to ensure good internal communication, ie ensure that the technology champion or the key member of staff leading the alliance educates all employees about the practical risks of collaboration. Another such solution is to *rope off* technology and resources so that the partner can not possibly gain access to them. For example, the case study describing OS12 (chapter eight) set up an alliance-responsibilities office acting as the central contact point between the partners. This allowed each technology transfer request to be treated with appropriate care. More generally, the alliance-responsibilities office can also assign and police personnel exchanges. In such circumstances the objective the the office is to manage and educate a firm's technical experts so they do not act as unwitting information conduits to the partner.

10.5 Summary:

Guided by the research propositions, Phase One of the research helped to identify four distinct levels of technology partnering activity in terms of the extent of knowledge exchange. These levels were then characterised along two simple dimensions encompassing managerial attitude/belief and behaviour stances. The development of this framework was supported by a performance measurement indices to gauge the partnering capability of each component supplier visited. This was supported by the identification of seven broad contributory factors to good technology partnering arrangements. These two areas enabled each firm to be positioned with respect to a partnering level and relationship field. The four levels of partnering were then further explained using case study evidence. This combined results (section 7.2.2) led to the identification of some best practice characteristics amongst the grouped firms.

Phase Two of the research followed the same research analysis path as that used in Phase One yet, in addition to some broad best practice guidelines, several idiosyncratic points emerged from the TPPI analysis. First, the range of external sources of technical assistance which offshore firms turn to is narrow yet they make more intense use of local facilitating organisations. This is primarily driven by their motive to build and maintain a dense web of informal interpersonal connections which may then enhance learning and support technology development.and the highlighted the important role of the facilitating organisation. Second, despite one of the key constraints perceived by small offshore firms related to technology adoption, external factors appeared to present the barriers rather than a lack of internal base of technical know how. Third, their motives to becoming involved in partnering-type arrangements, albeit informal, is in contrast to component suppliers. The points often related to 'soft' performance factors rather than reducing cost, improving market share or sales. The underlying point is that these factors reflect general benefits associated with a loose or floating partner and may reasonably be expected from such and association yet they are instinctively keeping their distance fearing loss of control.

Some significant differences between the automotive sector and offshore supply industry were presented in that last chapter. It considered how these differences directly impact on the opportunities for firms in either industry to participate in successful partnering arrangements.

Finally, while it was found that there is no real relationship between the TPPI scores and financial performance of each firm (section 6.5), when two 'like' firms are compared (as seen in sections 7.3.4 and 8.3.3) a difference emerges in *both* technology partnering capability and financial performance. This suggests that, when analysing two very similar firms in terms of product group, market, company size, etc there may be some correlation between technology partnering capability and financial performance.

Chapter eleven: Conclusions, contribution and implications of the study

11.1 Introduction:

While Doz (1988) highlighted some practical managerial difficulties involved in maintaining partnerships such as cultural distance, uncertainties, misunderstandings, hidden agendas as well as the importance of managing the partnership interface, little research was found during the literature review on the distinctions between different roles of technological alliance and the factors which lead to their success. Consequently, there were two general aims set out at the beginning of this thesis. First, to contribute towards a better understanding of the role of technology partnering between purchasers and suppliers in manufacturing and process industries and how that role changes over time. Second, to establish whether there are characteristics which could distinguish SMEs who are better at technology partnering than others.

The following section evaluates the research project findings in the light of the original aims. Section 11.3 evaluates the research method and approach while the limitations of the research project are discussed within section 11.4. Finally the implications of the research with respect to technology policy is considered in section 11.5.

11.2 Evaluation of findings

11.2.1 Introduction:

This study puts forward four levels which characterise the intensity of the knowledge exchange which itself is determined by the nature of the technology and the overall managerial receptivity towards sharing technical know how. The latter determinant is characterised along two dimensions: managerial behaviour and attitude. The following section considers these aspects in greater detail.

11.2.2 The role of technology partnering:

In a review of recent research work chapter one highlighted some author's observations about distinctions between technology alliance arrangements. Mowery (1988) suggested that the focus of technological collaboration between industries and technologies, ie in telecommunications, integrated circuits, commercial aircraft and robotics the focus of collaboration is product development while in automobiles and steel the focus is on the production process. Cairnarca, Columbo and Mariotti (1992) argued that the focus and form of such collaboration varied along with industrial and technological development. Based on extensive field research they developed a technology life cycle model and related collaborative activity to it. Dodgson (1994) clarified the position further sugg·sting that the forms of technological collaboration may include: Infrastructural, Contractual, and Informal. He noted that this latter type is very important for the innovation process in the way they occur between the 'invisible college' of peers, (chapter two). In this respect, Von Hippel (1988) described the way that 'informal know how trading' between peers occurs in a number of industries, adding

"Informal know-how trading is essentially a pattern of informal co-operative R & D. It involves routine and informal trading of proprietary information between engineers working at different firms - sometimes direct rivals."

The findings from this research have contributed to this area of the literature by distinguishing various types of technological alliances by reference to some key *levels*. Four levels were identified which characterise the intensity of a firm's knowledge exchange process within a technology partnering-type arrangement, (chapter five). Each level is characterised by the degree to which they exchange knowledge and ranged from an informal grouping ('soft')to a formal collaborative arrangement ('hard'). These levels were bounded by two managerial attitude and behaviour dimensions - making four '*partnering relationship fields*', (figure 5.1) and each firm interviewed was positioned within a field, (figure 7.3). This approach represents a way of reducing and representing the data to make better sense of it. In one sense, it is a diagnostic instrument to enable an analysis of the nature and level of technology partnerships. Overall, this aspect of the work represents a taxonomy of partnering - it is an attempt to map what is good and bad within partnerships. In one sense, this work has helped to de-mystify the term, 'partnering' - a buzz word of the early 1990s which is often over-used and its meaning misunderstood. This study has provided a better understanding of what partnering is about and what it means to firms and what it can achieve.

This latter aspect of the research project also extends the work of Bessant *et al* (1994b) in their review of some general characteristics that might be associated with Total Quality relationships in the supply chain, (chapter five, figure 5.3). Bessant's 'relationship states' correspond closely to the 'partnering fields' and 'levels' presented in this thesis, (figure 5.1). To illustrate, the 'hard' level of partnering depicts the most formal and advanced type of collaboration found here which resembles the 'developmental partnership' described by Bessant as 'a balanced and deliberate partnership relationship'. Similarly, the remaining quadrants relate closely to 'soft' ('Sleep'), 'medium' ('Strong sense of purpose but imposed from outside') and 'uninvolved' ('aimless').

The strong theme of managerial 'receptivity' to partnering was present throughout the thesis, (section 2.7, 3.2, 5.3, 6.3, etc) Hence, in this respect, these findings have extended the framework of Seaton and Cordey-Hayes (1993) to a consideration of knowledge transfer in technology partnering.

Similarly, Nueno and Oosterveld (1988) distinguished between the various types of technology alliance. The author's distinctions were from a competitive position and supply chain point of view, (chapter two). This research project has contributed to the literature and introduced other qualitative aspects that may determine the relative position of such alliances, (chapter five). The aspects related to (i) Managerial attitude and behaviour, (ii) How and where firms develop technology, (iii) Technology alliance organisation and structure.

The study of matched pairs (chapter seven) highlighted the relationship, albeit tentative, between a firm's financial performance and its technology partnering capabilities. This part of the research study provided some insights into the differential capability of some firms, with very similar characteristics, to partnering as an mechanism to enhancing their knowledge base. The main facet which sets each pair of firms apart is their managerial attitude and response to sharing technical know how. The results are helpful when considering what might be regarded as good management practice.

Overall, this thesis has advanced an understanding the *nature* and *role* of technological collaboration as well as contributing some of the qualitative characteristics that determine the *level and intensity of knowledge exchange* in the partnership. Although it was not a primary aim, these findings have also contributed to the understanding of networks/alliances at a more micro level. While the current process literature tends to centre on either the general or very specific case approach, this research focuses on the micro level exemplifying some widespread as well as idiosyncratic features of good technology partnering arrangements.

To summarise and clarify the different concepts developed and used in this research project:

(i) The <u>four distinct levels of partnering</u> aim to characterise the intensity of a firm's knowledge exchange process Section 5.2).

(ii) The <u>partnering relationship fields</u> aim to better describe the managerial attitude and behavioural stance to partnering ranging from a firm belief in the concept to continuously skeptical (section 5.2).

(iii) The TPPI measure of data analysis serves to allow an assessment of a firm's technology partnering capability (section 5.3). In addition, a collection of broader contributory factors to technology partnering have been identified and characterised using field research evidence (section 6.3).

This work has also contributed to the understanding of technological change as a knowledge transfer process and complemented the work of Cordey-Hayes, Gilbert and Trott (1995). Here, the authors discuss, through a comparison of two case studies, the characteristics and processes necessary for successful knowledge assimilation and how it can lead to effective organisational learning.

11.2.3 The factors which cause best practice technology partnering:

Chapter two highlighted several key questions: What can be learnt from those that are better at partnering? What are the important determinants of a small firm's ability to make technology partnering work for them? What factors represent best practice? The identification of various input variables to technology partnering both measurable to some degree (Technology Partnering Performance Indices - chapter five, table 5.1) and broad contributory factors to

Technology Partnering (chapter six, table 6.2) offer an explanation of what factors firms should display which may help them participate in technological collaboration with greater success.

While there is no definitive formula for success, a set of best practice guidelines based on the three key areas (Prior Knowledge, External Linkages and Relationship Strategy) offer a set of operational and strategic guidelines for small and large firms, (section 9.3). They specifically aim to help managers understand better the nature of partnering while providing clear pointers to firms looking for ways to trigger their own partnering arrangements. These guidelines were derived mainly from the evidence collated during the field research and subsequently analysed using the three measures.

11.3 Evaluation of the research method and approach:

The field experience used in this research has involved a number of research techniques including: documentation analysis, semi-structured interviews (face-to-face and telephone) and developing a novel approach to analysing the data. As chapter three noted, the aim of the interviews was not to achieve statistical significance in terms of sample size, but to interview a wide spectrum of people in order to gain a richness and quality of understanding of the process of technology partnering. The unparalleled benefit of undertaking the fieldwork interviews meant that it was possible to gain an insight into how management think; their motives, attitude and behaviour towards partnering. Consequently, this provided greater confidence in determining the levels that each firm visited was at and their relative position with regard to their behaviour and attitude. Despite the breadth of interviews and the number of firms visited, the actual duration of each interview was between one and one-and-a-half hours. Indeed, the case studies within chapter eight were based on interviews of this duration which limits the amount of information that may be gleaned. However, as table 4.1 indicates, nearly 45 per cent of the firms in the sample were visited more than once.

The blending of qualitative, semi-quantitative, quantitative analysis and case studies to provide theoretical and practical insights was a pragmatic and novel research approach that has worked successfully and which may be recommended for consideration by researchers working in a similar context.

One line of enquiry that may have proved very interesting but made impossible given the lack of data revolved around manager's personal networks. Most interviews commenced with a preamble to the purpose of the interview, the research project and the progress to date before easing into the semi-structured questions. The Researcher often listed the component suppliers' interviewed including names yet without divulging what each manager had said. Managers often then remarked that they knew six or seven of those mentioned but were unwilling to state which! Instead, if it were possible to map managers' relationships within one large firm at an informal networking level. This map would inevitably convey a rich, dense web through which tacit know how passes regardless of any formal organisational barriers. It may have revealed a central nervous system driving the collective thought processes, actions, and reactions of the managers.

11.4 Implications for Future Research:

Several areas offering opportunities for additional research have emerged from this study. For example, it was highlighted earlier the concern that the actual sample of firms evaluated in the first and second phase is generally too small to allow generalisations. However, a comparative study using a postal questionnaire involving a survey across a wider selection of design and manufacturing firms to investigate the extent of technology-specific partnering activity followed-up by a select number of indepth high level interviews may prove insightful. It may be possible to map the supplier chain network of technical contacts perhaps revealing some hidden influencing forces on a technology partnership. It may even be possible to map trust and advice networks to get a clearer picture of the dynamics at work in an industry sector or perhaps a geographical location such as the West Midlands or North East. Indeed, this type of study involving advice networks could be performed from within one large organisation and may uncover the source of political conflicts and failure to achieve strategic objectives. On the other hand, trust networks often reveal the causes of non-routine problems such as poor performance by temporary teams. Similarly, mapping communication networks can help identify gaps in information flow, the inefficient use of resources and the failure to generate new ideas, (Krackhardt and Hanson (1993)).

The findings from such a survey would enable greater generalisations to be made. Part two (second year) of this study may then be to undertaken a range of interviews with managers 'at the partnership interface' within both the supplier and purchaser that are engaged in partnership. Following interviews with one 'partnering organisation' (purchaser or supplier) the opportunity often arose in this research to meet one or two of the other partners. For example, following a visit to AS26, an interview was set up with an association member, ASMP in Tamworth. Similarly, the component supplier AS21 bought fine blank plates from AS6. AS21 invited the Researcher to accompany their Industrial Engineer while conducting a supplier assessment at AS6. However, some partner visits may not always be as easy especially where the partners are based abroad, eg AS18's partners were based in Everberg, Belgium.

An interesting piece of research was started in Autumn 1995, at INTA, Cranfield University. The project is initially focussing on a select number of existing innovation and technology transfer case studies considering the local development implications within the context of sustainable development, defined with social, economic and environmental dimensions. The case studies will be considered within the context of local development in the East Midlands. From these case studies and the literatures relating to the importance of industrial clusters, the project will then focus on the needs of knowledge based organisations, locally and viable communities, as well as develop an initial conceptual framework linking innovation and sustainable local development.

Other areas of future research may centre on a wider perspective such as establishing the role of technology partnering in the construction industry. This study may centre on the evolving process of inter-firm technology networks and linkages in the industry and the extent to which ideas and culture prevalent in mainstream manufacturing can be transferred into the UK construction sector. It may relate closely to human factor research on current supply chain activity between firms and sectors in order to identify the prospects for closer integration. Functional partnerships, ie functional supply chain integration linking firms covering single elements such as warehousing, order capture and distribution, have begun to evolve in the construction industry. For example, Laing Homes have adopted a number of original approaches to the demand-driven house building business. One approach is the central warehouse from which components are dispatched to building sites in 'house packs' rather than being delivered by merchant or manufacturer direct to site. Another approach is the evolvement of a partnership with a prime timber supplier in order to receive quality mouldings all the same length with no knots. The Timber Research and Development Association were introduced to help develop a specification which met Laing's needs at a cost which was reasonable. Consequently, Laing reduced waste by nearly 20 per cent. Whilst it is encouraging to note such partnerships, minimal evidence supports the belief that the industry is collectively creating a wider learning network to support the transfer of ideas from other firms and industries. A related research project recently commenced at Westminster University entitled 'Towards Positive Partnering - Managing Client-Supplier Relations in Construction'. The main aim is to evaluate the factors behind successful partnering arrangements, focussing on the 'cultural' and managerial processes in a series of case studies.

In addition, the relationship between a firm's technology partnering effort and the direct or indirect impact on its profit and loss statement and balance sheet could be explored specifically. Although, chapter six and eight explored this relationship, this was not a primary aim of the research. A study that has as its central aim to establish the relationship between technology partnering and financial performance using case studies may determine a stronger relationship.

The role of intermediaries in promoting technology partnering in the early stages may also be result in some interesting insights and implications for technology policy. Chapter nine noted the importance and intensity of use of such intermediary organisations in the offshore industry particularly when the partnering concept begins to gather momentum.

Other research in the offshore industry is currently underway and may be complimented. For example, an interesting study at the Offshore Management Centre is exploring the extent and depth of collaborative relationships between the major oil operators and the service sector, Green (1994). A future study may centre on measuring the benefits of collaborative working in the offshore industry and measuring and developing trust between groups of people from different companies.

Further research in the area of technology partnerships may take a different slant, for example, exploring the aspects which influence the cooperative/competitive intent of a firm before it becomes involved in a partnership (entrant). More specifically, the level of transparency of the partner firm. The extent to which a partner firm allows the entrant firm access to its key resources or capabilities has been defined as transparency (Hamel (1990)). There has to be a degree of sharing in any partnership, even those who are characteristically protective enough to provide an incentive for the partnership to occur. However, the openness which is assumed by each partner may differ. Where the level of transparency is high, access to information and information sharing is relatively straightforward. Consequently, a higher transfer of skills or competencies than was either agreed or wanted may occur (Hamel (1990)). On the other hand, where access is very restricted, transference of even highly valued skills may prove problematic to the entrant firm. Further research in this area may address the question, to what extent does the level of transparency of a partner firm support the competitive or cooperative intent of an entrant firm?

11.5 Summary

To summarise, this research project has made a contribution towards defining the role of technology partnering and discerning a set of best practice guidelines. Through interviews with over 150 managers this thesis confirms that the issues facing management before and during the partnership are multiple and complex, while the pitfalls are many. Indeed, the review of the collaboration literature in chapter two revealed that the major reason why technological collaborations between large and small firms fail relates to the sheer management effort required to make it work. There is an obvious mismatch between the management and other resources available to a large firm compared to an SME. For example, it was clear from the interviews with small offshore firms that the process of finding a suitable partner, managing the arrangement, and ensuring mutual benefit - puts great strain on the small firm management. Hence, they opted for informal links avoiding the often cumbersome and bureaucratic procedures involved in many partnering arrangements.

This study found that while technology partnerships can bring significant benefits to the active participants, they are not a panacea. There are islands of technology partnering success that have varying life cycles. The lifetime of each island appears to depend on the nature and complexity of the product or project. The speed in which that island evolves depends, in part, upon the partners' ability to 'unlearn' obsolete and misleading knowledge, and assimilate new know how through collaboration.

Appendix A

Semi-structured discussion questions with automotive suppliers: Phase One

Note: The smaller print notes were used as an interviewer guide.

1. Relations with customer and communication channels.

1.1 What in your view facilitates an effective partnership with your customers?

1.2 What do you perceive as the main advantage/disadvantage of working closely with your customer and suppliers?

1.3 Do you have a formal contract which specifies the basis for a cooperative relationship with your customers?

1.4 How do you know that you are working to the agreed level of performance and a level which is beyond that of your competitors?

Obtain an idea through asking if the supplier receives any feedback, for example:

- the number of defective parts found on the assembly line,
- the percentage of on-time deliveries,
- the proper quantity and sequence,
- performance in reducing costs.

1.5 If a defective batch of parts is found after it has been delivered to a customer which is below the accepted tolerance level, what help will the customer offer to rectify the defect in order to ensure it doesn't happen again?

1.6 In your opinion, to what extent are the assemblers such as Toyota and Nissan committed to improving and developing their supply base?

How does the style of collaboration observed and the technical support received from the European assembler differ from that experienced with you Japanese customers?

1.7 What type of technical assistance would you most welcome from either your customers or third party organisations?

2. Technologies.

2.1 What motivates you to introduce new technology in the first instance?

2.2 How do you keep up to date on technological developments?

2.3 What are the problems in introducing new process and product technology into your company?

2.4 When did you last make a technology change to your components and/or machinery?

2.5 Do your customers and suppliers help you to acquire the technology?

Do they use the supply chain as a source of technology?
What do they think their customers and suppliers could do now to help them improve their own technology base?

2.6 What do you consider to be the main technological problem areas in your company?

2.7 Once the technology is in place, how is it then communicated to others in the company?

2.8 What criteria do you assess new technology against?

Aim to establish some idea if they have a clear unambiguous reason why they want the technology, instead of acquiring it, (internally or externally) for the sake of it through following others.

2.9 What steps do you take to identify a market need and then obtain the technology to meet that need?

2.10 Overall, are there any technological constraints which prevent your company:
- meeting customers' exact requirements?
- expanding its market share in the existing market?

3. <u>Research and Development</u>

3.1 Do you have an R & D programme?

3.2 What drives your programme, ie is it market demand or technology push?

3.3 How do you finance the R & D? (internal or external funds).

4. <u>Staff Training</u>

4.1 Do you participate in customer training programmes?

4.2 Are there any conditions that the customers establishes that you must fulfil either before or after the training sessions?

4.3 Have any of your staff participated in formal Project Management training whilst employed in your company?

5. <u>Competitors and second/third tier suppliers</u>

5.1 How do you coordinate your activity with other component suppliers?

Explore how they communicate with other suppliers to share knowledge and problem solving, ie to disseminate know how on: TQM, Value Engineering and analysis techniques, Statistical Process Control, etc.

Do they belong to any supplier clubs/associations, ie informal groupings within supply chains aimed at improving logistics and technical factors through collaboration? If so, what do they perceive as they benefits and risks of such Associations? Specifically, what technological benefits do they perceive as accruing from active membership?

5.2 How much interest do your customers show when you select and assess your own suppliers?

6. <u>Costs</u>

6.1 Is cost a major determinant in your relationship with your main customers?

6.2 How do you monitor your own costs?

6.3 How do you arrive at a cost for a component?

7. <u>Market Strategy</u>

7.1 Are you aiming to become the main or dual source supplier?

Appendix B

Semi-structured discussion questions with offshore suppliers
Phase Two

The following questions were used to guide the interviews with small firm management.

1. Suppliers' priorities and strategies in the new era:

1.1 What are your company's chief technological priorities for this year and next?

1.2 How do you view your technological priorities changing within the next five years?

1.3 What strategies are in place to meet those priorities?

1.4 What is your company's role in shaping partnering events of the future?

2. Technology Partnering:

2.1 What do you perceive as being the three main benefits to becoming integrated team partners with the contractors, and what are the problems or deficiencies?

2.2 Could you talk me through a recent example of how an technology partnership began with a major contractor and how it is progressing, (how is it managed, and what problems have arisen)? **(Note 1)**

2.3 What, in your view, are the key factors involved in sustaining a longer term relationship with such contractors?

2.4 What real future in technology partnering is there for small and medium size (SME) suppliers?

3. Key Technologies:

3.1 In your opinion, what scope is there for the manufacturers like yourselves to independently and in collaboration with other suppliers, to engineer and deliver the key technology enhancements which will directly influence costs?

Note 1

1. How is the technology alliance managed on a daily basis?

2. What were the unforeseen problems?

   eg communication channels with other partners,
   assimilating the partners' technology and expertise
   cultural barriers

3. How were they overcome?

   In practice, poor internal communication produces difficulties in the adoption of partnering: Do the suppliers perceive widely differing attitudes to partnering across the levels of operator/contractor management?

4. How was the momentum sustained throughout the alliance (after initial start up)?

5. What technology was (or is being) developed?

6. How did the component supplier know what technology to develop and then how did they arrive at the decision to develop the technology within or outside an alliance?

7. What were/are the quantifiable benefits arising from this technology,

   eg cost reduction,
   improved product, etc.
   Can the supplier management point toward the evidence that can demonstrate how the internal knowledge base of the firm has been enhanced and is directly attributable to the technology collaboration?

8. What were the qualitative benefits arising from the partnership?

Appendix C

Glossary

Assembler: A company whose principal activity is manufacturing (assembling) vehicles.

Black box: a concept promoted by suppliers capable of carrying out full programmes of R & D. This implies that the customer does not need to know what happens within the component, merely that it does the specified job.

Collaborative R & D: This can take three main forms: (i) horizontal collaboration between actual or near competitors to develop standards or new technology which both will be able to apply in their chosen markets, (ii) collaboration with companies with complementary skills to facilitate new products or processes, (iii) vertical collaborations between customers and suppliers, sometimes at a number of different levels in the supply chain.

EC: European Community

EDI: Electronic Data Interchange

Gatekeeper: Keeps informed of related developments that occur outside the organisation through journals, conferences, colleagues and other companies. Passes information on to others; finds it easy to talk to colleagues. Serves as an information resource for others in the organisation. Based on Roberts and Fushfield (1981)

Greenfield site: A new industrial (manufacturing) plant, built on a site not previously used for such purposes, possibly in a geographical region not traditionally associated with manufacturing.

Grey box: See Black box; the customer knows some of the inner details of the component, but not all.

Guest engineers: Employees of the customer who are located within the supplier's plant, working on a long-term basis towards developments in process and product improvements. Similar arrangements may be made for employees of the supplier to work at the customer's premises. The perspective gained by the individual may be transferred back to the home organisation and may be expected to provide the basis for further improvements, eg design for manufacture.

Just-in-time (JIT): The philosophy associated with reduction of waste and improvement in product and service quality and personal motivation through a reduction of inventory and buffers (contingency allowance for errors). The term was invented (in English) in Japan to describe a system in which materials and parts are made available just at the point at which they are required.

Operators: The companies which license the rights to oil and gas extraction from governments are known as operators. In addition to the operators, the industry encompasses a large number of oil-related companies contractually engaged in one or more of the many activities required by the central exploration and extraction functions of the operators. When the UK became a major oil producing country, the industry was dominated by companies already active in the oil industry elsewhere, Harvie (1994). Although, two of the operators were based in the UK, in the early 1970s virtually all of the companies in the oil-related sector were non-UK companies. Since then, many existing UK companies have addressed the varied market opportunities created by the local extraction industry and many new companies have been formed.

Partnering: A long-term commitment between two or more organisations for the purpose of achieving specific business objectives, by maximising the effectiveness of each participant's resources. The relationship is based on trust, dedication to common goals and an understanding of each other's individual expectations and values. The expected benefits include improved efficiency and cost-effectiveness, increased opportunity for innovation and the continuous improvement of quality products and services.

Partnering fields: These fields emerged from an early run through the data (Chapter six) to determine any distinguishing characteristics. Within each field is positioned a different level of partnering activity ranging from 'soft' (informal knowledge exchange) to 'hard' (Planned collaboration/shared risk). Each field is bounded by managerial attitude and behaviour actions.

Partnership sourcing: A purchasing strategy based upon partnership rather than traditional competitive tendering processes.

Product Champion: Sells new ideas to others in the organisation. Gets resources. Aggressive in championing his or her cause. Takes risks. Based on Roberts and Fushfield (1981)

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. Based on Roberts and Fushfield (1981)

Sponsor: Provides access to a power base within the organisation a senior person. Buffers the project team from unnecessary organisational constraints. Helps the project team to get what it needs from other parts of the organisation. Provides legitimacy and organisational confidence in the project. Based on Roberts and Fushfield (1981)

Sub-assembly: Group of components which are fitted together and identified as a unit for subsequent fitting into a system.

System: Group of components which together form the physical means of effecting a specific function within the vehicle. Thus the radiator, hoses, sensors, fan assembly and bracketry might be grouped together as a 'cooling system'. The major implication is for supply - one supplier is asked to provide the entire system as one unit, rather than several suppliers delivering all the individual parts. Design integration may follow, with consequent increases in responsibility for the supplier. Also called a 'corner' (hence 'corner engineering').

TPPI: (Technology Partnering Performance Indices): This is a research tool used to measure each firm's level and receptiveness to technology partnering practice. The TPPI incorporates seven input variables that, if they are a strength within the supplier organisation, could support a technology partnering arrangement.

Technical Innovator: Expert in one or two fields. Generates new ideas and sees new and different ways of doing things. Also referred to as the "mad scientist". Based on Roberts and Fushfield (1981)

Technology partnering: A process where two or more firms successfully combine their unique technological strengths enabling them to deliver innovative and lower risk solutions quickly and at less cost to the end user. It includes any activity where two or more partners contribute differential resources and know how to agreed complementary aims. It may include: i) Collaborative research programmes or consortia, ii) Joint ventures and strategic alliances, and iii) Shared R & D and production contracts.

Tier: The terms 'first-tier' and 'second-tier' have been used for some time in the motor industry, with tacit reference to the Japanese industrial structure. The rationalisation of supply bases has strengthened this use of terminology, as vehicle manufacturers have sought to reduce the number of suppliers with whom they deal directly, in some cases transferring some responsibility for systems to their immediate suppliers, (see 'system'). In fact, the presence of a 'tier' is not accomplished by traditional sub-contracting: the suppliers which are referred to collectively as a tier *only* function as such is they have some form of common bond to give meaning to shared activity in the supply chain. Thus, direct suppliers to the vehicle manufacturer form a tier *when* they collaborate either in the development of a system, or in lobbying for some industry practice. By collaboration, the first tier of suppliers may help to develop the value chain of one assembler or the progress and competitiveness of a national or regional industry. (Lamming (1994)).

Transplant: Assembly or manufacturing plant (factory) built in one country by a firm based in another country. Applies especially to best practice manufacturers setting up new facilities to manufacture in a sub-best practice country.

Vendor rating: The technique employed by customers to assess the performance of their suppliers in terms of product quality, on-time delivery, etc.

Appendix D

SMMT GUIDELINES ON CUSTOMER AND SUPPLIER PARTNERSHIPS IN THE UK AUTOMOTIVE INDUSTRY (April, 1994)

Partnership

These guidelines concentrate on those common and core elements of the partnership which are:

A consistent understanding and adoption of the philosophy of partnership by all functions in all companies in the customer/supplier interface.
A clearly stated strategy and practically implemented commitment between the companies concerned to work together to achieve mutually agreed objectives in all aspects of world class performance must be put in place. This commitment, which has to be multi-functional needs to be understood across all interfaces throughout the supply chain. Direct communication between staff of the relevant functions on both sides of the partnership should be encouraged.

Management of relationships.
It is impossible for the vehicle assembler to manage his suppliers effectively or the component supplier his sub-suppliers with too large a number of relationships. There is likely to be a continuing reduction in the size of each firm's supply base. The objective should be to achieve the optimum number of suppliers which can be managed to meet overall business plan requirements.

Commitment to continuous improvement and shared benefits.
Both partners must work together towards improving products and processes. An understanding on the sharing of benefits is fundamental to the success of the partnership.

An open exchange of all relevant information.
The benefits of the partnership will only accrue from an open exchange of information in which confidentiality is respected and handled appropriately. The information needs to be **relevant** and the commercial needs and implications must be recognised.

Complete understanding of the real costs in both parties.
Throughout the supply chain the total cost of products and processes should be understood and the real opportunities for improvement identified.

Establishment of common objectives focussed on customer needs.
The whole supply chain should recognise and focus upon satisfying the needs of the product of the vehicle.

Establishment of world class targets through benchmarking and clear performance evaluation.
To aid the improvement process and the targeting of world class performance, benchmarking activities should be used to direct activities and establish targets. Targets should be mutually agreed and their achievement monitored by straightforward measures of performance with feedback in both directions.

Agreement on a checklist or criteria to evaluate the capability and performance of a supplier.
There should be an open exchange and dialogue on the criteria by which the customer fairly measures the effectiveness of a supplier against competition.

An agreement or understanding.
This could be in many forms and in some cases could be a legally binding contract recognising from the start that the relationship is a partnership. Both parties should independently and freely decide the type of arrangements to be entered into and refer any agreement or arrangement to their lawyers for an assessment of compatibility with national and European Community competition laws.

Accurate forward forecasts and continual dialogue to update/amend.
It is recognised that to be truly world class, companies must respond quickly to changes in market demand. However, whilst the emphasis is on flexibility and rapid set-up times, the benefit of overall stable scheduling to the planning and running of a business is immense. Throughout the supply chain, from product planning and marketing to component manufacture, everyone should work to minimise unexpected schedule fluctuations whilst working to manage changes so that they meet the needs of the market.

Early involvement in new projects.
Better development solutions can be achieved through involvement of suppliers at the earliest appropriate time in new projects. To obtain maximum benefits it is essential that customers and suppliers have the capability to carry out their respective development responsibilities in sufficient depth, based on a full understanding of the inter-relationship of the vehicle and component development procedures. Both parties must have a thorough knowledge of the current and

potential needs of the end customer.

Combined resources to tackle problems.

Problems should be tackled jointly for mutual benefit, thus creating a proactive rather than a reactive environment. The temptation to change the source of supply when difficulties are encountered should be resisted. It is important to acknowledge the principle of mutual interest. The abuse of a dominant position is not acceptable.

Appendix E

Examples of early spreadsheet analysis work

During the early stages of the research fieldwork analysis, a series of attempts were made to analyse the data using a spreadsheet. At this stage of the research, the semi-quantitative data, ie the TPPI had been completed and all the input variables had been assigned scores (between 0 and 5 points). Similarly, the quantitative data or in this case, predominantly financial data for nearly every firm visited, had been collated.

One aim was to determine what, if any correlation was there between a firm's technology partnering performance and its financial performance. A spreadsheet and matrix diagram was subsequently produced that indicated where each firm was positioned with regard to their TPPI overall score and ROCE. Figure E1 summarises the picture.

It ought to be emphasised that this exercise was undertaken early in the analysis and, consequently, only serves as a 'rough' indicator of relative performance. However, one the evidence of this diagram alone it appeared to suggest that a cluster of firms, namely, AS11, AS25, AS16, AS3, and AS7, showed a tendency toward a strong overall technology partnering performance coupled with a good ROCE record. As chapter six showed, this relationship howsoever 'close' is fundamentally flawed.

Another aim was to establish if there was any, albeit tentative, relationship between a firm's technology partnering performance and its main customer. For instance, do some supplier's show a tendency to be more adept at technology partnering when they supply a particular assembler? As far as the TPPI is concerned, which customers do the 'better' companies supply and in what proportion. Figure E2 illustrates.

Bearing in mind the limitations of this early analysis, this figure illuminates three points:

(i) Those companies that appear to be more adept at technology partnering, ie have a good overall rank on the matrix, generally have an even customer base.

(ii) Better companies (above) tend to show a greater trading involvement with the Japanese transplants.

(iii) The weaker firms, ie lower rank, show a tendency to be more dependent on one vehicle assembler.

The SPSS results highlighted within chapter six and the illustrated examples within Appendix I provide a more rigorous analysis of the inter-relationships.

Inevitably, the question arose during this research about whether company size was an important consideration as far as technological collaboration is concerned. A similar 'spreadsheet analysis' exercise was undertaken to establish any relationship given the sample of firms under study. Figures **E3**, **E4**, **E5**, and **E6** present the results. Company size here has been measured by annual sales turnover, staff employed in each firm, amount of capital employed, and actual profit levels reported. All of this refers to the most recent data available - 1992. *The preliminary conclusion drawn at this stage was that small firms are either very good or very bad at technology partnering but large firms often occupy the middle-ground.*

FIGURE E1

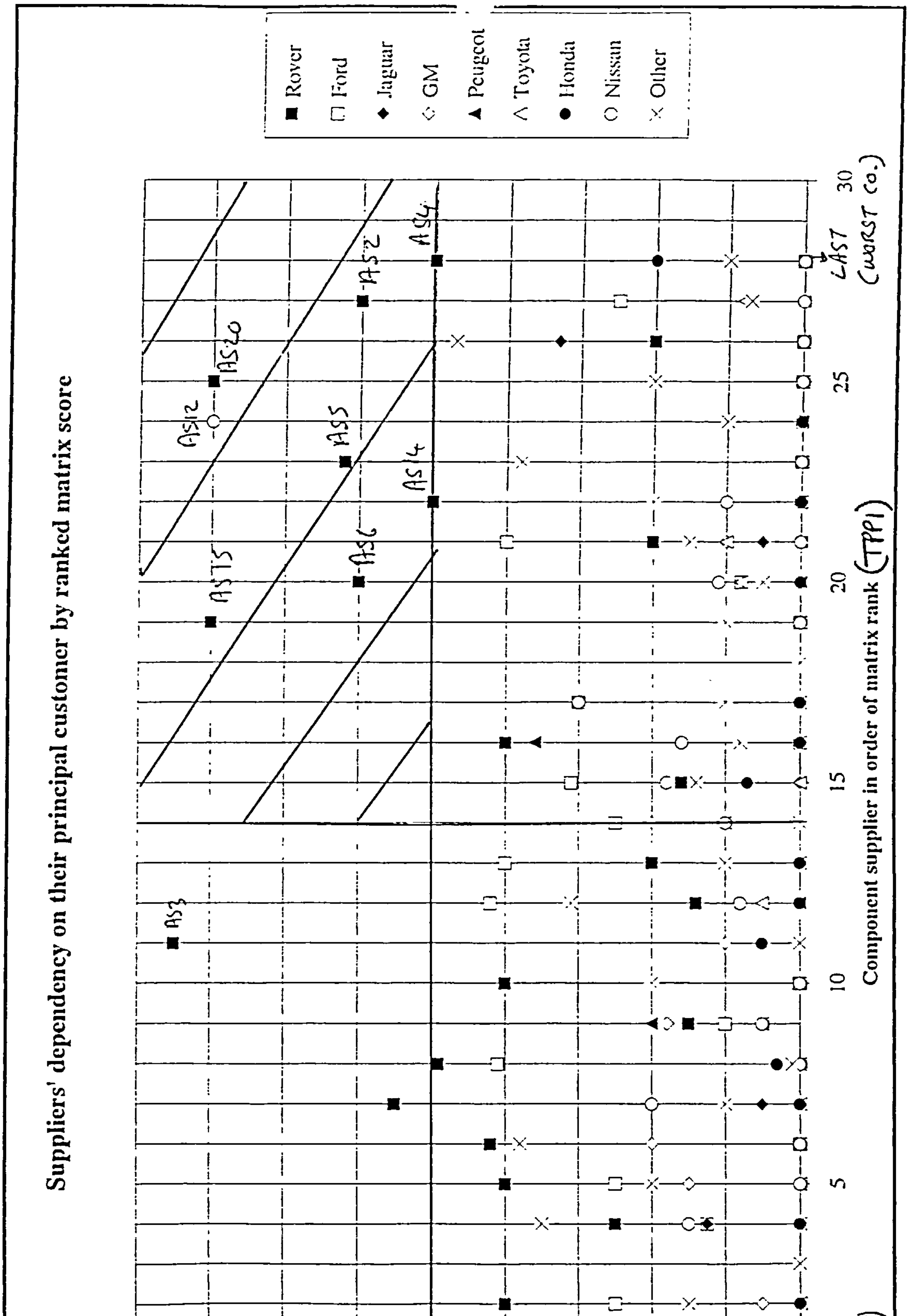
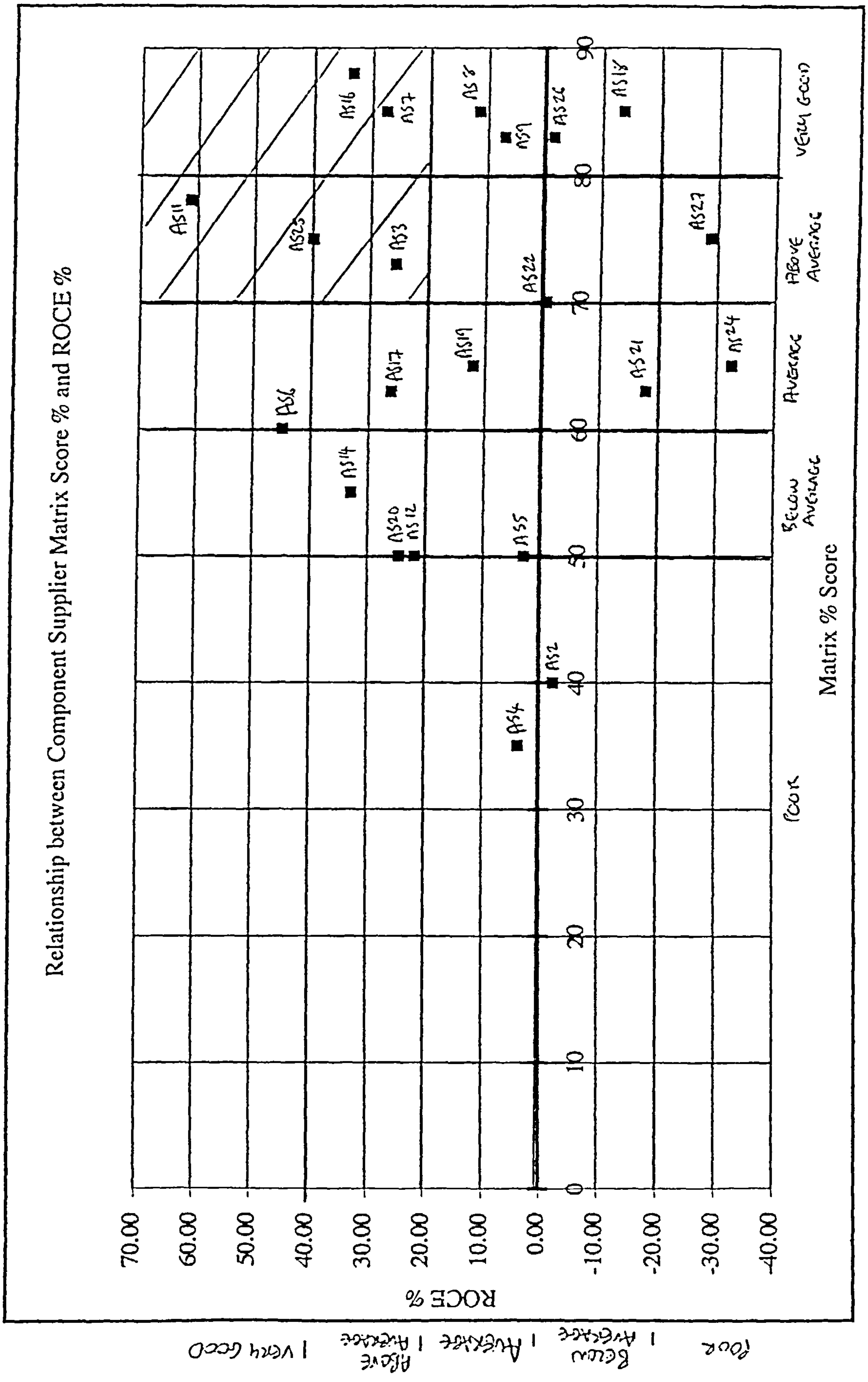

Suppliers' dependency on their principal customer by ranked matrix score
Rover
Ford
Jaguar
GM
Peugeot
Toyota
Honda
Nissan
Other
% dependency
Component supplier in order of matrix rank (TPP1)
1ST (BEST)
LAST (WORST CO.)
AS3
AS12
AS20
AS15
AS5
AS6
AS14
AS2
AS4

FIGURE E2



Relationship between Component Supplier Matrix Score % and ROCE %
ROCE %
70.00
60.00
50.00
40.00
30.00
20.00
10.00
0.00
-10.00
-20.00
-30.00
-40.00
0
10
20
30
40
50
60
70
80
90
Matrix % Score
POOR
BELOW AVERAGE
AVERAGE
ABOVE AVERAGE
VERY GOOD

FIGURE E3

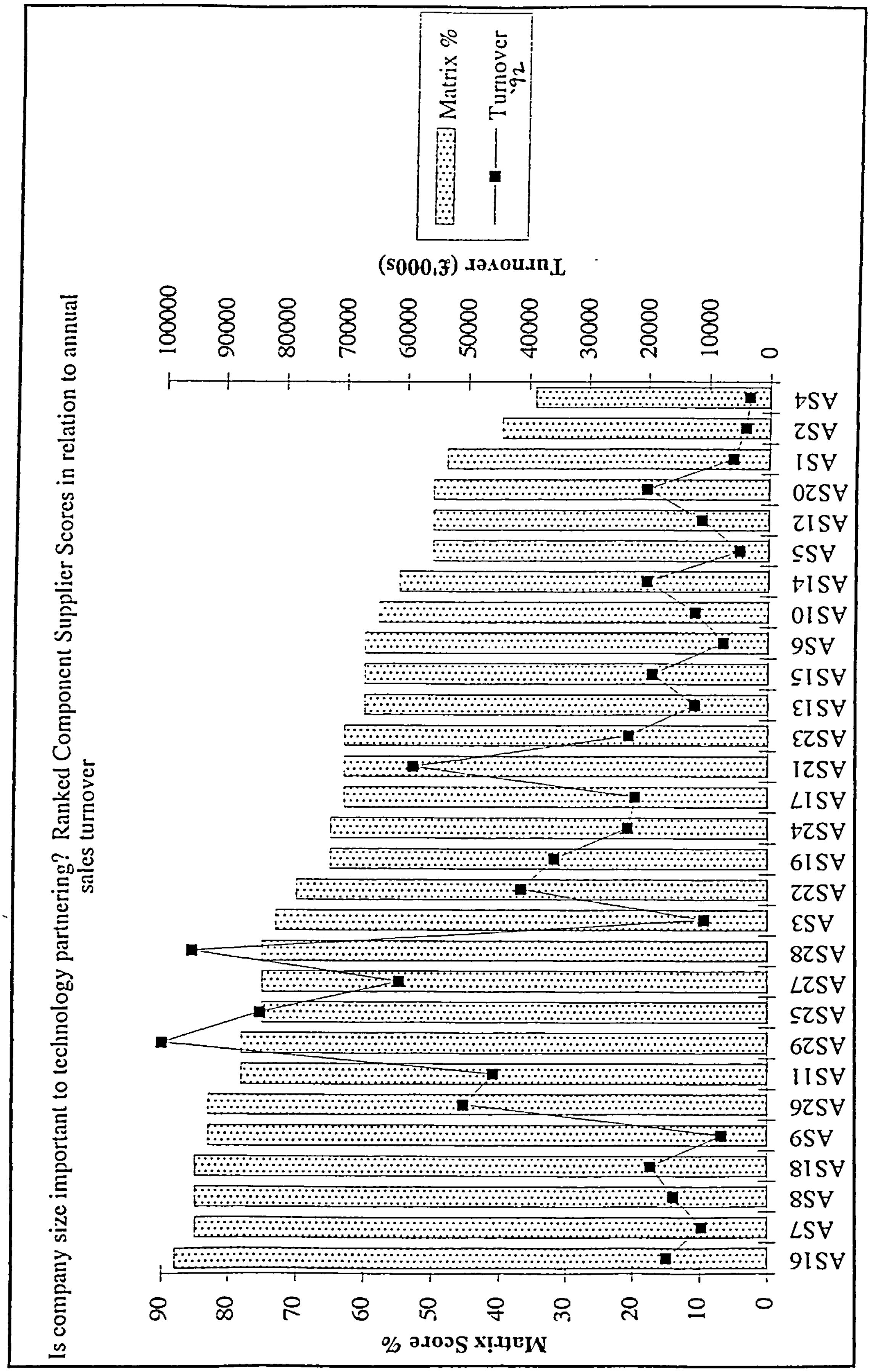
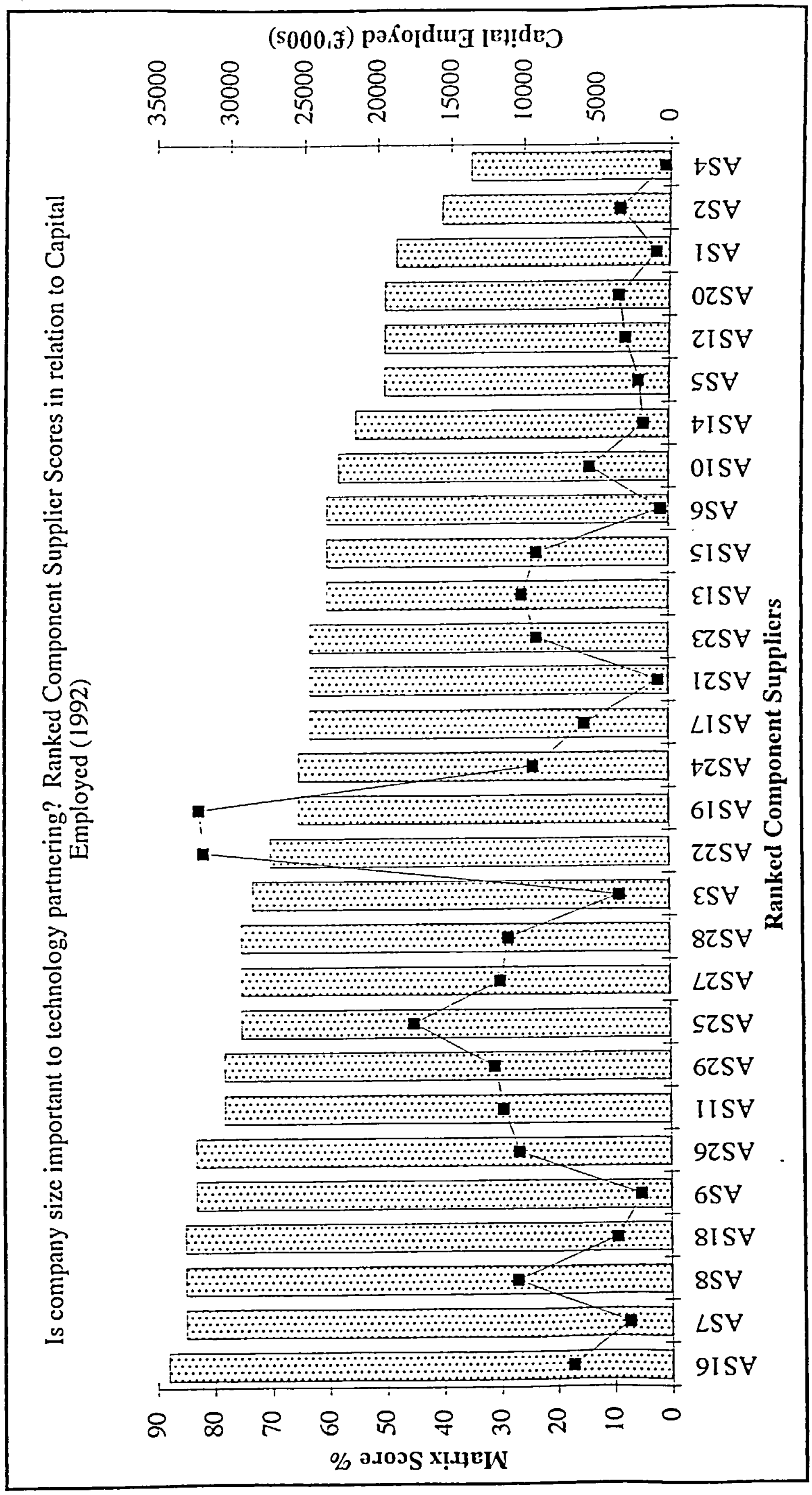
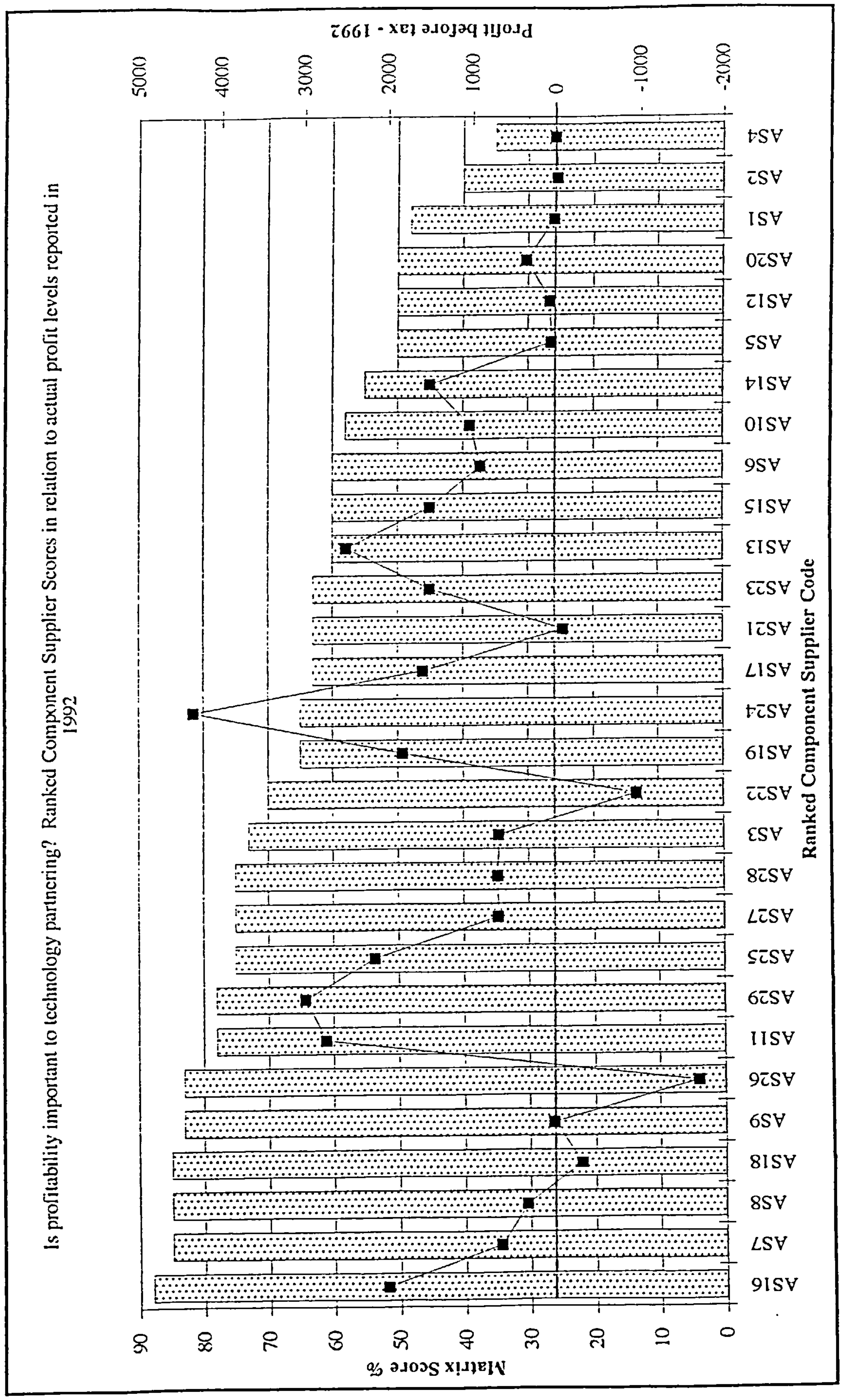

Is company size important to technology partnering? Ranked Component Supplier Scores in relation to annual sales turnover
Matrix %
Turnover '92
Turnover (£'000s)
Matrix Score %
0
10
20
30
40
50
60
70
80
90
0
10000
20000
30000
40000
50000
60000
70000
80000
90000
100000
AS16
AS7
AS8
AS18
AS9
AS26
AS11
AS29
AS25
AS27
AS28
AS3
AS22
AS19
AS24
AS17
AS21
AS23
AS13
AS15
AS6
AS10
AS14
AS5
AS12
AS20
AS1
AS2
AS4

FIGURE E5



Is company size important to technology partnering? Ranked Component Supplier Scores in relation to Capital Employed (1992)
Capital Employed (£'000s)
0
5000
10000
15000
20000
25000
30000
35000
Matrix Score %
0
10
20
30
40
50
60
70
80
90
Ranked Component Suppliers
AS4
AS2
AS1
AS20
AS12
AS5
AS14
AS10
AS6
AS15
AS13
AS23
AS21
AS17
AS24
AS19
AS22
AS3
AS28
AS27
AS25
AS29
AS11
AS26
AS9
AS18
AS8
AS7
AS16

FIGURE E6



Is profitability important to technology partnering? Ranked Component Supplier Scores in relation to actual profit levels reported in 1992
Profit before tax - 1992
5000
4000
3000
2000
1000
0
-1000
-2000
Matrix Score %
90
80
70
60
50
40
30
20
10
0
Ranked Component Supplier Code
AS16
AS7
AS8
AS18
AS9
AS26
AS11
AS29
AS25
AS27
AS28
AS3
AS22
AS19
AS24
AS17
AS21
AS23
AS13
AS15
AS6
AS10
AS14
AS5
AS12
AS20
AS1
AS2
AS4

Appendix F

Examples of SPSS tests

Following the early data analysis using spreadsheets, it was was thought that a better and thorough route to analysing the inter-relationships was through a statistical package. SPSS was selected since it offered the a comprehensive range of options to present and analyse that data.

A considerable number of relationships were assessed between the qualitative, semi-quantitative, and quantitative data. Table 6.5 and 8.4 presented the results. The findings indicated that in nearly every case of relating technology performance with financial performance, the trend is in the right direction. However, the relationship is weak and, consequently, no statistical conclusions can be drawn from them.

To illustrate these findings, a selection of SPSS tests are presented below. (Figure F1 - F6).

FIGURE F1

SPSS Test: Relationship between TPPI (overall) score and Sales Growth

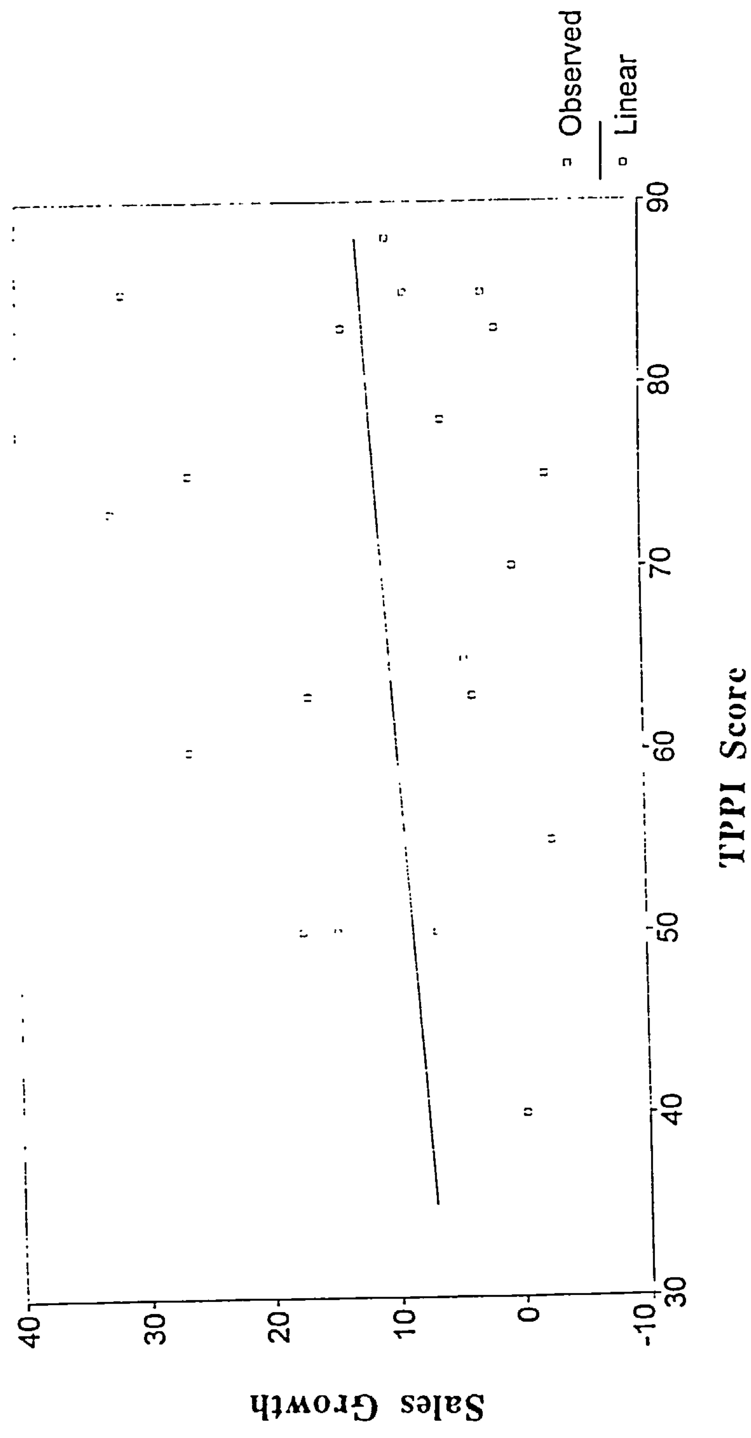


FIGURE F2

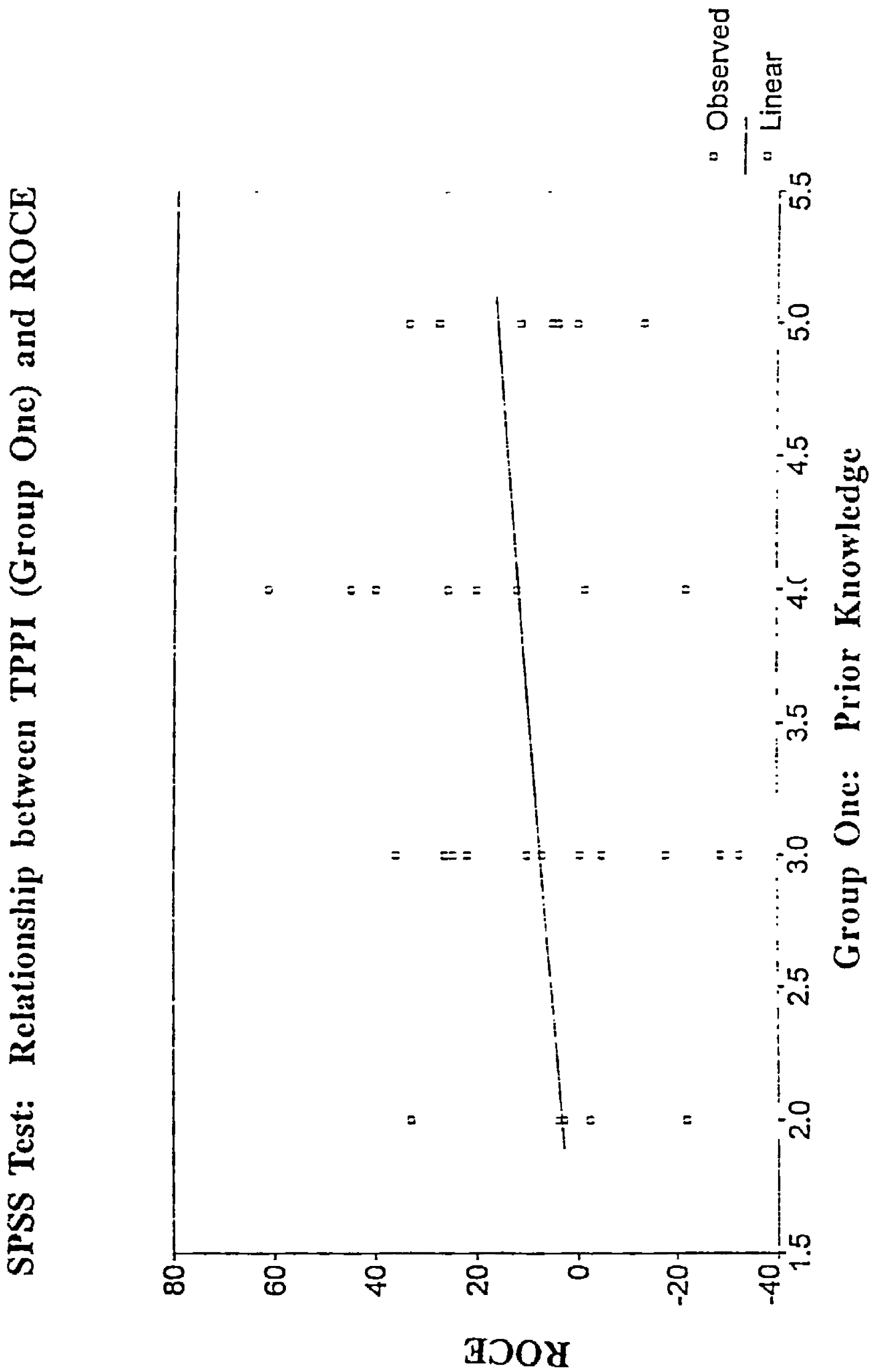

SPSS Test: Relationship between TPPI (Group One) and ROCE
ROCE
80
60
40
20
0
-20
-40
1.5
2.0
2.5
3.0
3.5
4.0
4.5
5.0
5.5
Group One: Prior Knowledge
Observed
Linear

FIGURE F3

SPSS Test: Relationship between TPPI (overall) score and the proportion of each component supplier's business to the Ford Motor Company Limited.

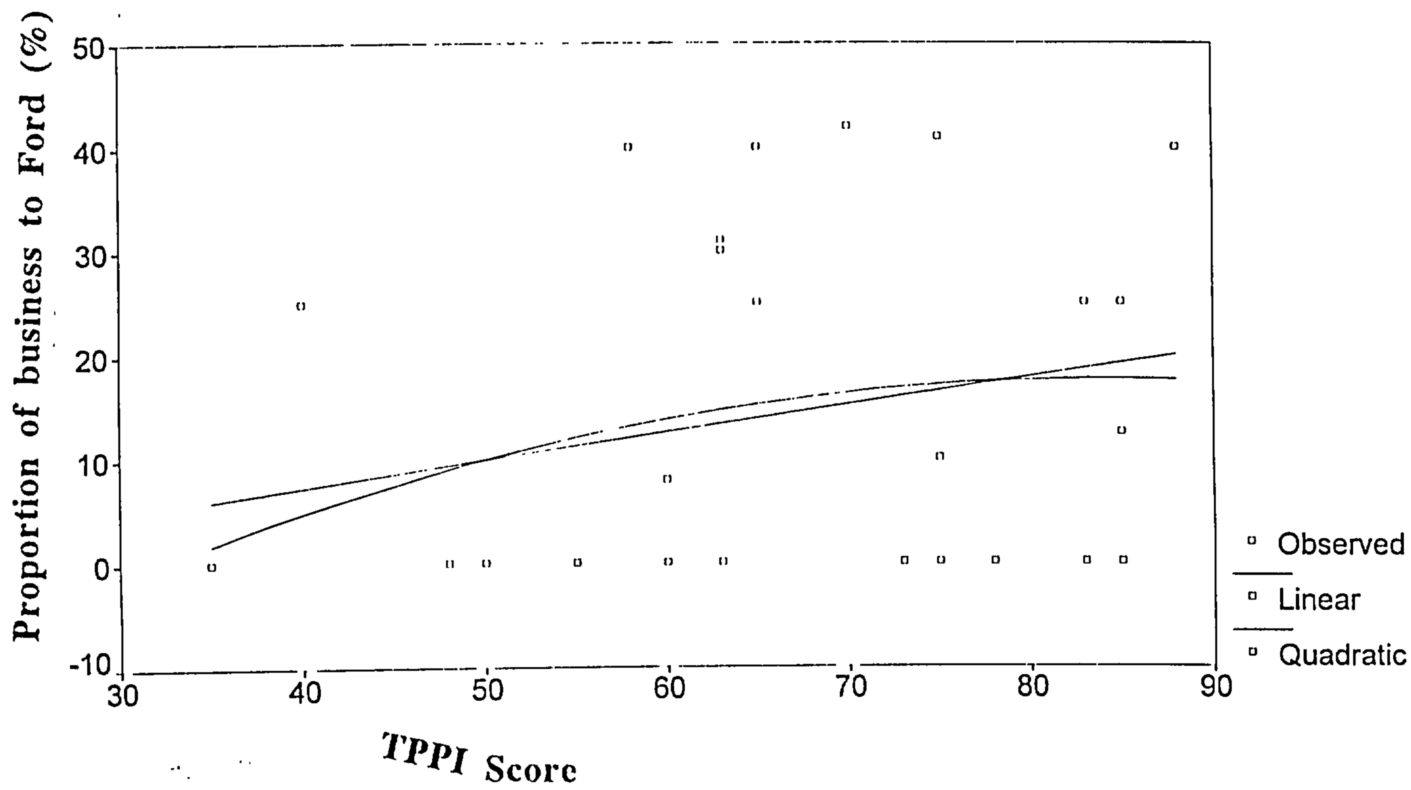


FIGURE F4

SPSS Test: Relationship between TPPI (Group One: Prior Knowledge) and the Patent Intensity measure of each component supplier.

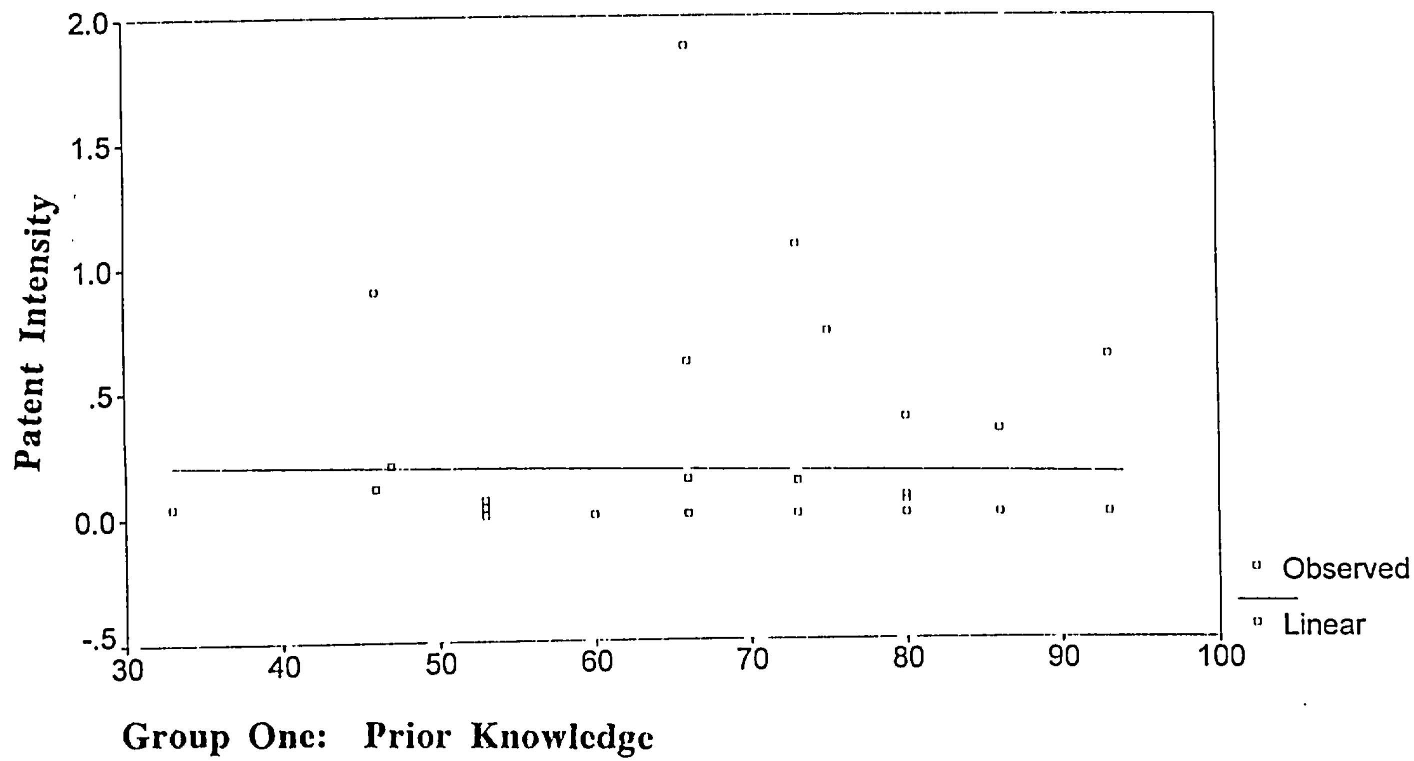
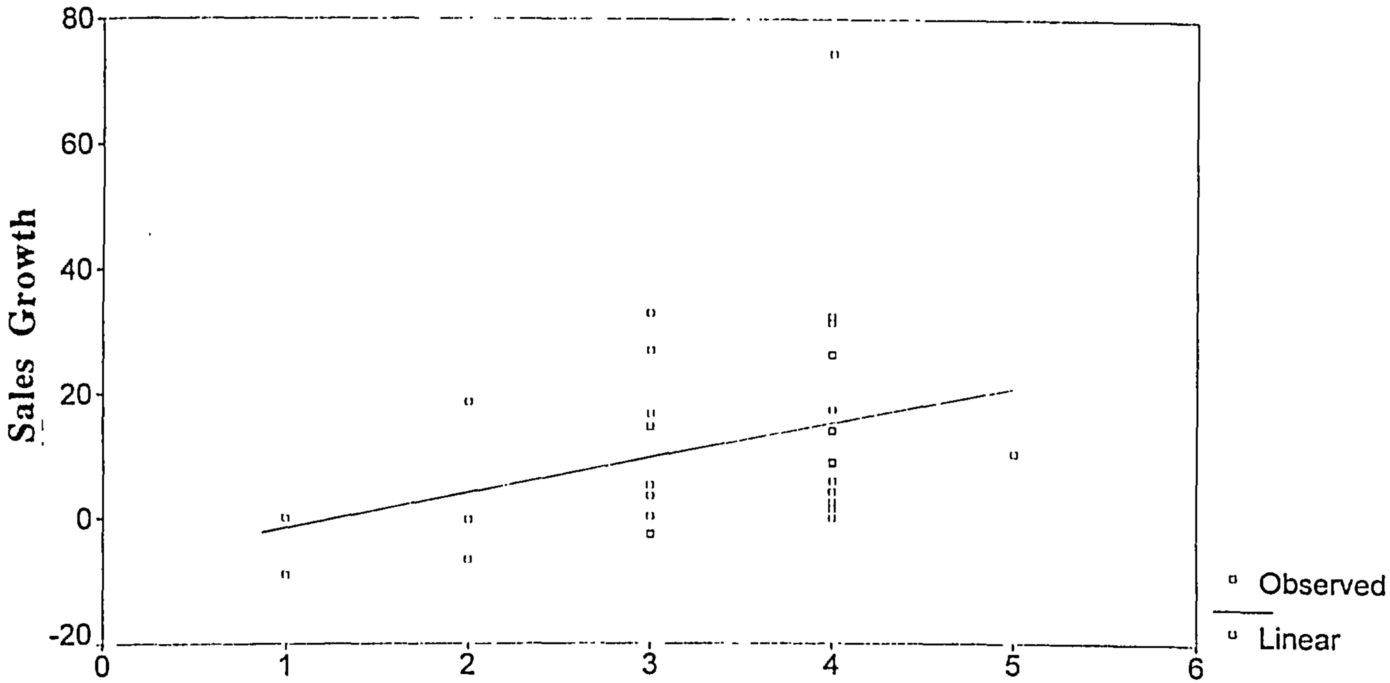


FIGURE F5

SPSS Test: Relationship between TPPI (Variable A: Degree and depth of technology scanning) and Sales Growth of each component supplier.



Variable A: Scanning ...

SPSS Test: Relationship between TPPI (Group Four: Overall impression of supplier's strategy and managerial attitude toward partnering) and Return on Capital Employed of each component supplier.

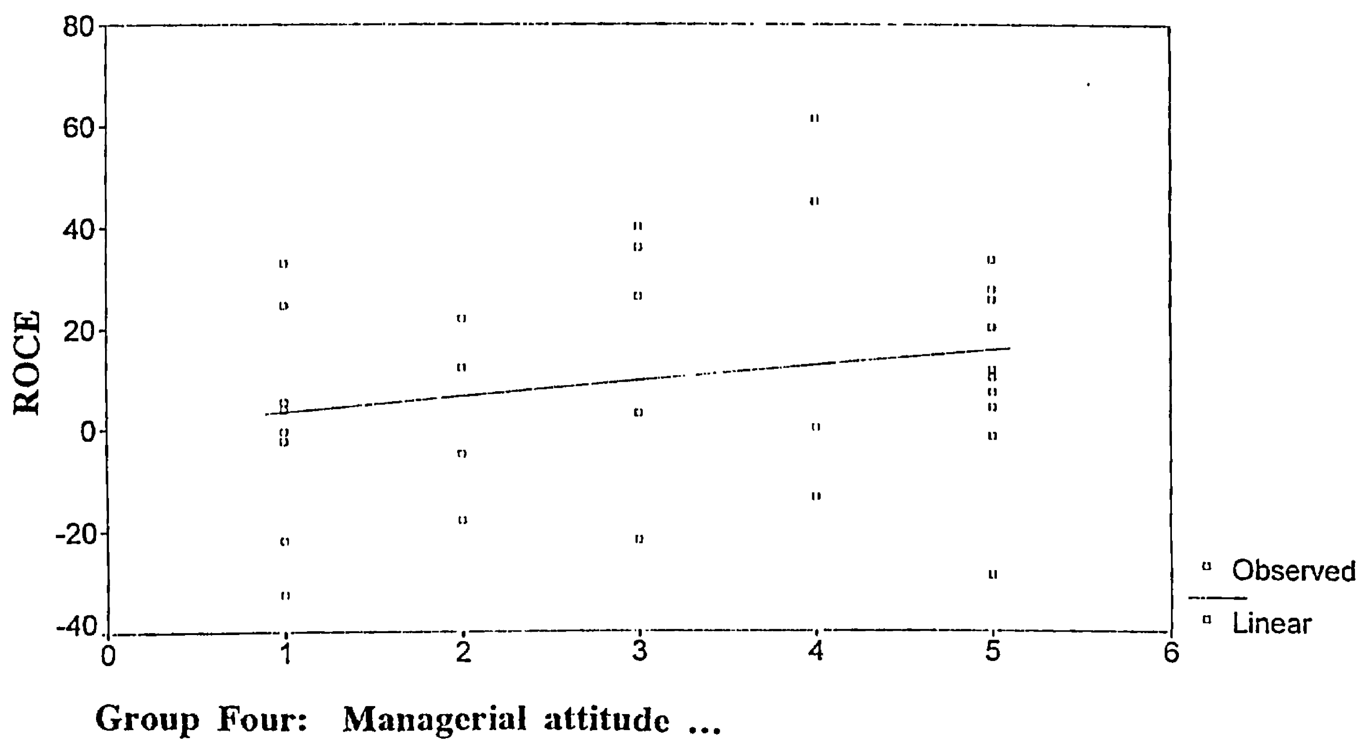
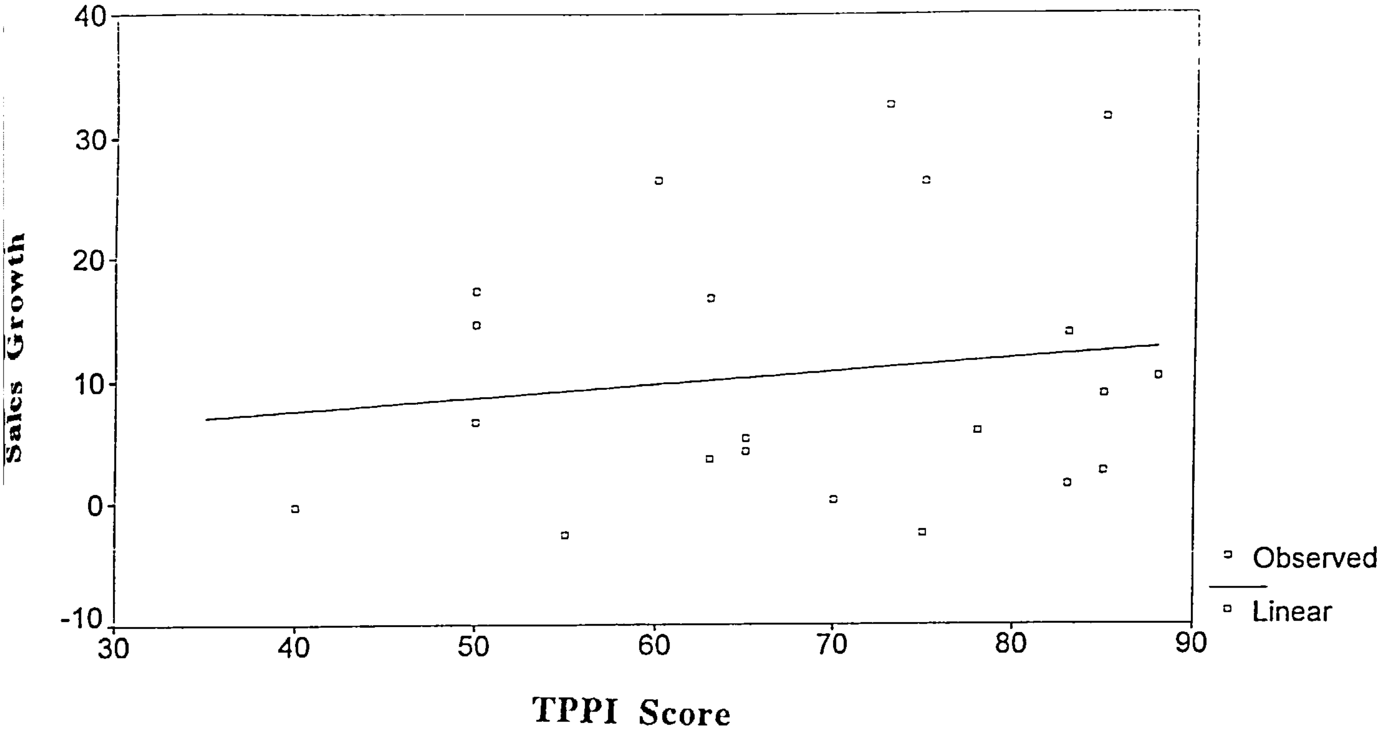


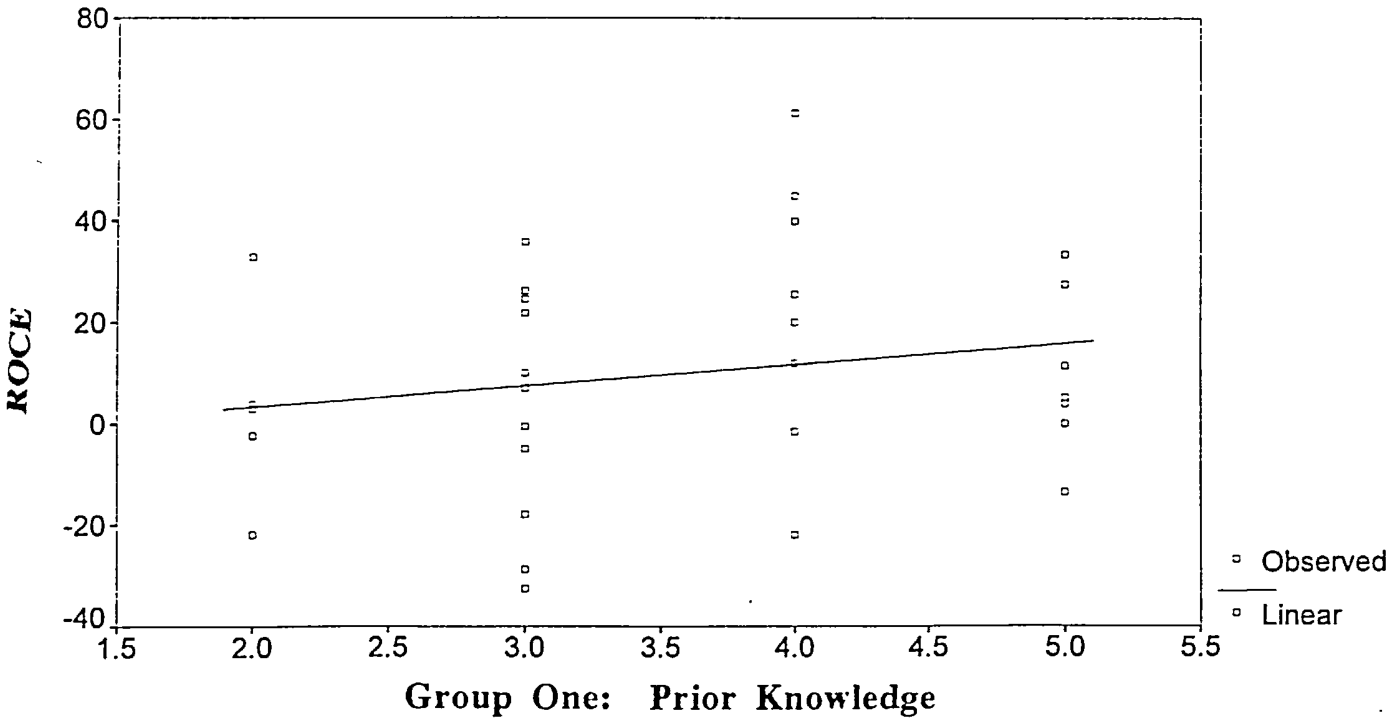
FIGURE F6

SPSS Test: Relationship between TPPI (overall) score and Sales Growth

FIGURE F7



SPSS Test: Relationship between TPPI (Group One) and ROCE



Appendix G

Engineers to Japan

Chapter seven highlighted the Engineers to Japan initiative. It suggested that the membership was drawn from component suppliers with management who were very "receptive to a learning opportunity". In other words, their attitude and behaviour were the deciding factor to being invited to join in. To confirm this, the following table provides the average financial performance indicators spanning a four year period from 1989 - 1992. In some cases, financial records were not available. Companies in bold type indicate firms' visited.

Four Year Average	ROCE	Sales Growth
1. Burdon & Miles Limited	-	-
2. Cardale Engineering Limited	30.20	22.50
3. Cromwell Rubber Company Limited	4.16	-6.00
4. Frederick Woolley Limited	8.34	-1.50
5. INA Bearing Company Limited	12.00	4.21
6. Lander Automotive Limited	7.05	13.85
7. Midland Industrial Glass Limited	4.43	5.00
8. Moulded Plastics (Birmingham) Limited	34.77	13.90
9. Presswork (Metals) Limited	-	-
10. Senior Flexonics Automotive Group Limited	-	-
11. Stadium Limited	11.43	25.00
12. Vita-Achter Limited	-	-

(Source: Kompass Financial Directory, 1994/95)

Appendix H

Example of an integrated team

Kvaerner H & G Offshore & Phillips Petroleum Integrated Team on the Judy/Joanne Development

The Judy/Joanne integrated team shows that there are 'key' members and 12 people are employed by Phillips Petroleum Company Limited. Various reports on the progress of the project suggest that the team is working well. For example, Phillips' *Performance* corporate magazine remarked,

"... Teamwork and co-operation between the Phillips drilling team in Aberdeen and the contractor really paid off when Dril-Quip suggested a design modification. The original intention was to have not only the 12-well slots, but three additional slots to use for piles to hold the template in place during drilling operations. Discussions between client and contractor confirmed that three of the existing slots could be modified to accommodate the piles, thus negating the need for additional slots. This modification saved not only time and money but had a positive size and weight benefit, as less steel was used."

Figure H1 presents the organisation of this core personnel inter-firm team.

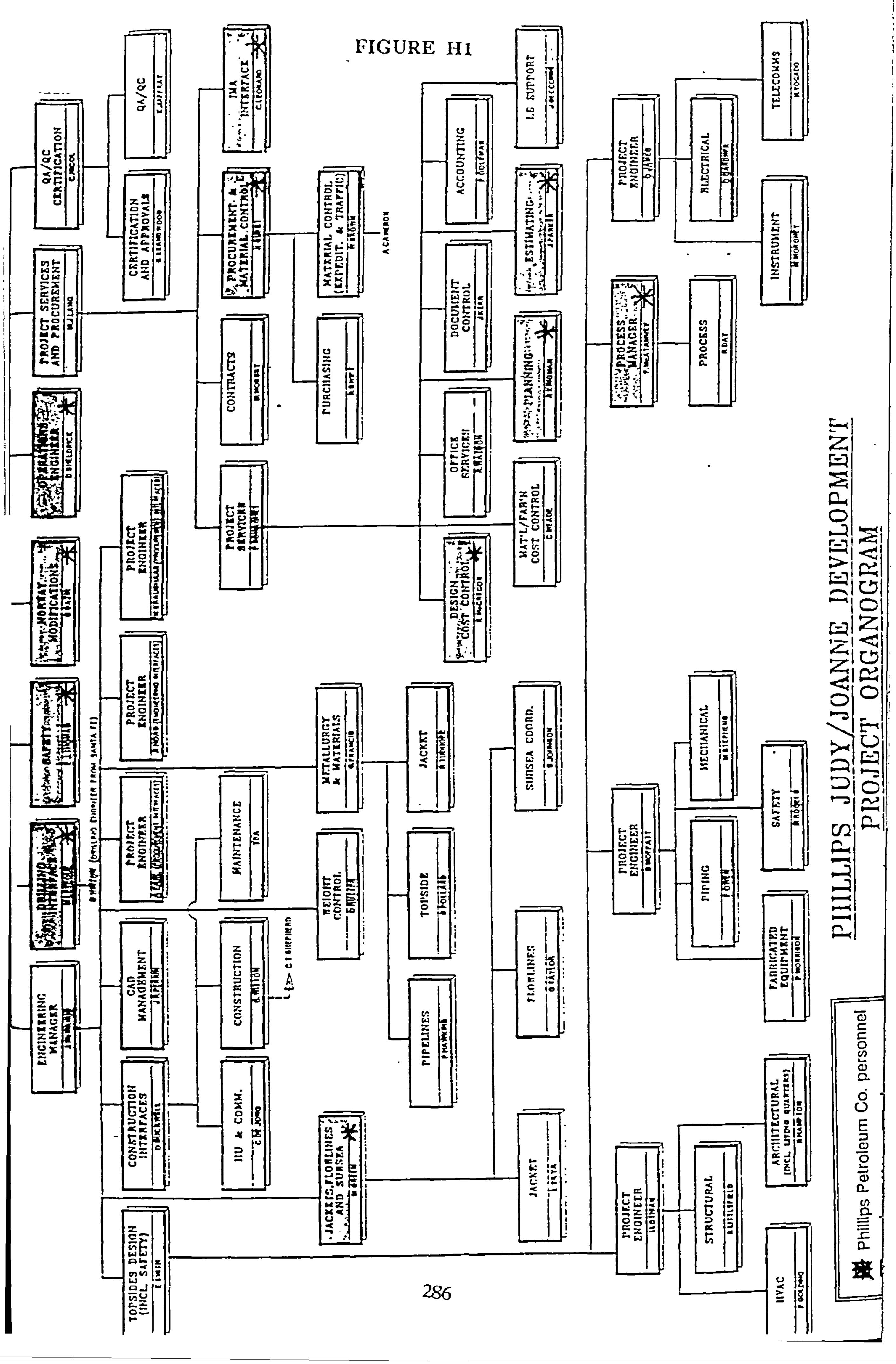
Another example of how an oil operator has restructured itself to support better internal communication channels is given by Texaco. Here, an extract from the operator's monthly in-house magazine, 'Agenda' describes the position, (Texaco (1995))

'When the upstream part of Texaco reorganised, people from different disciplines were brought together into teams. This move appeared to work well. Projects that had languished for years suddenly found new life as interdisciplinary teams worked to find new solutions that had eluded the old organisational structure. There is one downside, however.

In the days when geologists, petroleum engineers and seismologists were organised into a homogeneous group, they would sit together, think together and talk together. But now that they have been scattered to the four winds, there is less chance for the people in any given discipline to talk shop. Enter networking.

There are seven networks (one for each major upstream discipline) led by a facilitator. The idea is that the facilitator can help organise events for people to get together and talk about their *mutual interests, sharing ideas gleaned from their teams. In addition, networking is about encouraging phone calls and e-mail notes between professionals in a particular discipline so that the flow of information runs swift and sure, and new ideas that work in one team can quickly be shared with the others.'*

FIGURE H1


PHILLIPS JUDY/JOANNE DEVELOPMENT
PROJECT ORGANOGRAM
Phillips Petroleum Co. personnel
ENGINEERING MANAGER
DRILLING INTERFACE
SAFETY
MONTAY MODIFICATIONS
OPERATIONS ENGINEER
PROJECT SERVICES AND PROCUREMENT
QA/QC CERTIFICATION
CERTIFICATION AND APPROVALS
QA/QC
TOPSIDES DESIGN (INCL. SAFETY)
CONSTRUCTION INTERFACES
CAD MANAGEMENT
PROJECT ENGINEER
PROJECT ENGINEER
PROJECT ENGINEER
PROJECT ENGINEER
HU & COMM.
CONSTRUCTION
MAINTENANCE
CONTRACTS
PROJECT SERVICES
PROCUREMENT & MATERIAL CONTROL
IMA INTERFACE
JACKETS, FLOWLINES AND SUBSEA
WEIGHT CONTROL
METALLURGY & MATERIALS
PURCHASING
MATERIAL CONTROL (EXPEDIT. & TRAFFIC)
PIPELINES
TOPSIDE
JACKET
DESIGN COST CONTROL
OFFICE SERVICES
DOCUMENT CONTROL
ACCOUNTING
JACKET
FLOWLINES
SUBSEA COORD.
MAT'L/FAB'N COST CONTROL
PLANNING
ESTIMATING
I.S SUPPORT
PROJECT ENGINEER
PROJECT ENGINEER
PROCESS MANAGER
PROJECT ENGINEER
STRUCTURAL
HVAC
ARCHITECTURAL (INCL. LIVING QUARTERS)
PIPING
FABRICATED EQUIPMENT
MECHANICAL
SAFETY
PROCESS
ELECTRICAL
INSTRUMENT
TELECOMMS

Appendix I

Example of scoring a TPPI input variable:
See section 5.3.3:
'Range of External Organisations Consulted'.

The Matrix Score Process: An example of how Input Variable D was scored

SUPPLIERS	Range of External Organisations Consulted: Purchasers	Own Suppliers	Other suppliers	Companies in other industries	Universities	RTOs	Local colleges	Business Link	TECs	Specialist organisations	Regional Technology Centres	Technology Transfer Agents	Parent	Total no of sources	Score
Offshore															
OS1	1	1	1	0	0	0	0	0	0	1	0	0	1	5	2
OS2	1	1	1	0	0	0	0	0	0	1	0	0	0	4	2
OS3	1	0	0	1	0	0	0	0	0	0	0	0	1	3	2
OS4	1	0	0	1	0	0	0	0	0	0	0	0	0	2	1
OS5	1	1	1	1	0	0	0	0	0	1	0	0	0	5	2
OS6	1	0	0	0	0	0	0	0	0	1	0	0	0	2	1
OS7	1	1	1	0	0	1	0	0	0	1	0	0	1	6	3
OS8	1	1	0	0	0	0	0	0	0	0	0	0	1	3	2
OS9	1	1	1	1	0	1	0	0	0	1	0	0	0	6	3
OS10	1	0	0	0	0	0	0	0	0	0	0	0	0	1	1
OS11	1	1	1	1	0	1	0	0	0	1	0	0	1	7	3
OS12	1	1	1	1	0	1	0	0	0	1	0	0	1	7	3
OS13	1	1	1	1	0	1	0	0	0	1	0	0	1	7	3
Automotive															
AS1	1	1	0	0	0	0	0	0	1	1	0	0	1	5	2
AS2	1	0	0	0	1	0	0	0	1	1	0	0	1	5	2
AS3	1	1	1	1	1	1	1	1	1	1	0	0	0	10	4
AS4	1	0	0	0	0	0	0	0	1	1	0	1	0	4	2
AS5	1	1	0	0	1	0	0	0	1	1	0	1	0	6	3
AS6	1	1	1	0	0	1	1	0	1	1	0	0	1	8	3
AS7	1	1	1	1	1	1	1	0	1	1	0	0	1	10	4
AS8	1	1	1	1	1	1	1	0	1	1	0	0	0	9	4
AS9	1	1	1	1	1	0	0	0	1	1	0	0	1	8	3
AS10	1	1	0	0	0	0	0	0	1	1	0	0	1	5	2
AS11	1	1	1	1	1	1	1	0	1	1	0	0	1	10	4
AS12	1	1	0	1	0	0	0	0	1	1	0	0	1	6	3
AS13	1	1	1	1	0	0	0	0	1	1	0	0	1	7	3
AS14	1	1	0	0	0	0	0	0	1	1	0	0	1	5	2
AS15	1	1	1	1	1	1	1	0	1	1	0	0	1	10	4
AS16	1	1	1	1	1	1	1	1	1	1	0	0	1	11	4
AS17	1	1	1	1	1	0	0	0	1	1	0	0	1	8	3
AS18	1	1	1	1	0	1	1	0	1	1	0	0	1	9	4
AS19	1	1	0	1	1	0	0	0	1	1	0	0	1	7	3
AS20	1	1	0	1	1	0	0	0	1	1	0	0	1	7	3
AS21	1	1	0	1	0	0	0	0	1	1	0	0	1	6	3
AS22	1	1	1	1	1	1	1	0	1	1	0	0	1	10	4
AS23	1	1	0	1	0	0	0	0	1	1	0	0	1	6	3
AS24	1	1	0	1	1	0	0	0	1	1	0	0	1	7	3
AS25	1	1	1	1	1	1	1	0	1	1	0	0	1	10	4
AS26	1	1	1	1	1	1	1	0	1	1	0	0	1	10	4
AS27	1	1	1	1	1	1	1	0	1	1	0	0	1	10	4
AS28	1	1	1	1	1	1	1	0	1	1	0	0	1	10	4
AS29	1	1	1	1	1	1	1	0	1	1	0	0	1	10	4

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