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Project Co-ordinator: **Professor Keith Dickson,**
School of Business and Management,
Brunel University, UK

Partners: **ARTEC, University of Bremen, Germany**
IST, Technical University of Denmark

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ABSTRACT

This is a report on a two year project funded by the European Commission which focussed on the issues involved in building collaborative networks for new product development. The project was carried out by university-based partners located in three European countries, Denmark, Germany and the UK. The main premise for the project was that new product development is increasingly reliant on the development of strong networks, both internal and external to the innovating firm. The aim of the project was to investigate the role of social processes through which active network builders form, develop and sustain such collaborative networking.

Although the selected case studies differed in all three countries, both the methodology and the thematic case analyses remained constant. The focus was on three levels of analysis, micro or internal organisational level of research, meso, or inter-organisational level, and macro or national and international level of network building. In total the findings are based on six detailed cases, representing one major and one minor case from each country. The cases cover a range of different technologies in a number of sectors, also focussing on different sections of the product development process. In all cases, however, the object of analysis has been the role of network building management and maintenance related to the product development under study. A major issue has been the role of the particular technology in the networks under study, in terms of changes in networking behaviour which takes place as the technology is developed.

The major theme throughout the analysis is the role of micro-political analysis at the level of the organisation, in building developing and sustaining product development networks. The cross case analyses explore a number of themes which relate to such network building, including issues such as the role of trust, contact and communication as well as issues relating to learning and expertise. General conclusions attempt to bring together the cross case analysis into a broad understanding of the network building activities that have been identified. The policy implications from each case are also drawn out in this section, along with specific recommendations for promoting the development of product development networks on a general level.

The report concludes with sections which draw out the ongoing dissemination activities of the three research teams, both on an intra-country case by case level and for a more general cross country analysis. The appendices contain additional material, including references, pertinent to the report in general.

1. EXECUTIVE SUMMARY

1.1 Background, Objectives and Perspectives

This project was a collaboration between researchers in three European countries, which was funded by the European Commission Targeted Socio-Economic Research Fund for a period of two years which commenced on January 1st, 1998 and ended on 31st December 1999. The UK partner, which was the principal co-ordinator for the project, was the School of Business and Management at Brunel University, West London, while in Denmark the collaborating institution was the Technical University, based in Lyngby, Copenhagen. The third institutional partner was the Forschungszentr-um Arbeit und Technik (ARTEC), at the University of Bremen. In total the project has involved five UK researchers, five people in Denmark and two in Germany.

The project title is 'Building Collaborative Networks for New Product Development' and the focus of the work was to identify and study network building that is involved in facilitating innovation in different sectors. The project sought to develop previous findings which have begun to articulate the crucial role of networks in innovation success. The premise is, therefore, that networks are built by the people involved and this requires new kinds of organisational, managerial and technical expertise. In particular, the aim is to highlight the role of socio-economic factors in collaborative innovation as well as broader policy implications which might be useful in directing and supporting such activities. Therefore, special attention has been paid to the social processes through which network builders form, develop and sustain both internal and external collaborative networking.

The distinct objective behind the original proposal is a view, shared by the three teams, that by focussing on this aspect of new product development will allow the development of a novel input to the literature which tries to explain the processes of technological change, comparable across different contexts, different industrial sectors and different country systems. Focussing on the role of networks in the process of change will allow a reinterpretation of the existing innovation literature in ways that might help to overcome some of the current limitations in understanding the reasons for the selection of new technologies and the ways in which new technologies are developed and factors influencing introduction of new products.

Initially, a number of theoretical perspectives were identified, all of which have their own strengths and weaknesses. An ***economic* view** of innovation offers an explanation why certain technologies are developed, but tends to see the process of development as rationalistic and independent from the influence of the rest of the organisation or society. It contains the concepts of 'path dependency' and 'technological trajectory', which has been criticised as being o-verly deterministic and failing to take into account the characteristics of different technologies or the social processes involved in its development. That is, technology is seen as having its own internal imperatives. The ***organisational theory*** perspective highlights the organisational context of innovation, especially factors internal to the organisation impacting on the research and development function. In particular we have adopted ideas in the model of the organisation as comprised of many micro-political processes helps to explain the individuals role in the process of change. The ***organisational theory*** perspective, also covers areas like the management and control of R&D and organisational learning issues. Its weakness is that this perspective can fall into the trap of viewing technology as a 'black box' in that it is something which is independent from the influence of organisational processes. A ***social shaping*** model of technology, which focusses on the firm as the organisational site of new product development, has tended to highlight the social, political and cultural influences both internal and external on the process of innovation. This is one perspective that brings in the content and characteristics of the

technology as influences on the rate and direction that a development can take. By placing stress on the non-determin-istic elements involved in technological change, and the influence of different social groups on the out come, it can help to explain choices made between competing technol-ogies, constraints on development and failures in their development. Even so, the weaknesses that have been criticised in this perspective still hinge on its tendency to marginalise the technical factors involved and reduce the process of change entirely to social political or cultural inputs. Finally we consider the ***spatial*** factors which are seen as important in analyses of regional innovation systems, and the influence of location on technological development, as in the debates surrounding the influence of 'national systems of innovation', and globalization of technology. This perspective has been important for highlighting the role of small firms in contributing to product developments and also identifying the role of mobility of technical labour. Its weakness is often in reducing the innovation process entirely to specific geographical influences.

The dominant BICON approach that has been developed concerns the analysis of the micro-political processes in networking. The cases show the operation of power processes in the building of collaborative networks for new product development in a number of ways. Winning resources (finance, technology, knowledge, information) is necessary for collaborative product development projects, programmes and activities to take place and progress. Creation of organisational processes and structures which enable collaboration to be built and sustained and establishment of clear linkages between inter- and intra- organisational collaboration is a means of new product development and overall organisational strategy. While these are all part of a process to build and sustain successful networks, problems may also be encountered such as in establishing a smooth flow of resources where project 'champions' had difficulty in building effective coalitions. Other problems can occur in changing existing organisational arrangements, procedures and routines which could act as a constraint on the capacity to develop and sustain effective collaboration. Finally it is necessary to consider problems in creating meanings which enabled others in the network to understand the strategic significance and value of a new product development and collaboration as a means to achieve it.

The objectives were achieved by studying three different levels of network interaction, interpersonal, inter organisational and spatial. At the level of the individual, factors involved in network building, imply a 'micro-level' study, looking at issues such as the implication for trust building between network members, communication issues, information flows, and special competencies and expertises that might be needed to ensure the success of networking. At the level of the firm, attention focuses on investigation of organisational barriers or other factors that can influence the process of networking, and the impact of the specific context, in terms of technology and its management, on the networks that develop. The wider regional, national and international contexts of the sectors under study, raise issues related to the cross comparison of cases from different countries and wider policy implications.

1.2 Methodology

The project methodology centred on a case study approach built up via semi-structured interviews with as many network actors as possible. The project planned to study two cases from each country, one of which was originally intended to be a short term 'snapshot' views and the other, a longitudinal study. Only the latter case study was planned to have interviews taking place over the two year duration of the project, with the aim of studying a network as it develops over time. In fact, the minor case study in all three countries developed into a more substantial case, which was followed over the duration of the project.

The issue of the validity of inter-country comparisons was included in the original proposal, with a stipulation that comparable cases should be selected in all three countries and the same methodology should be used by the three teams. In fact one of the first inter-country problems identified is on the question of method. It transpired that there were country (or institutional) differences in the development and progress of semi-structured interview techniques. Whereas in the UK we were interviews, rarely lasting more than an hour, open ended discussions with a general check list of areas to cover but no detailed questionnaire, but covering as many relevant people in the organisation as possible. The Danish team had spent a few months developing an extensive questionnaire with detailed questions which, on average, took two hours to administer and demanded more formal access to the firm and a greater commitment to the interview situation. This also meant a less responsive structure which made it difficult to enter informal discussions. The German team also had a shorter series of questions which they were obliged to send to the firm before the visit for answers to be prepared in advance.

The original proposal identifies network building as an essential activity in the innovation process. It allowed, however, flexibility for each country team to select their most promising cases for study rather than rigidly prescribing sector or type of research activity. This made the process of selecting promising cases from a range of possibilities much easier. On the other hand, this flexibility may have made cross country comparisons more difficult, because it has not been possible to ensure that all the cases will be comparable in straightforward terms such as type of network studies, comparable products or uniform sector. For example, one of the problems in the UK was not identifying viable innovation networks - (six potential candidates were found quite quickly) but actually in finding networks that were linked to a product development at least in the conventional view. Because of this the UK team ended up with preliminary data on six UK networks. On the other hand the Danish and German teams initially had much more trouble getting access to their firms. All the main cases are in different sectors - in the defence industry for the UK, the Danish have a major study in the development and marketing of software products and the main German case is in transport communications. Different sectors are difficult to cross compare because some are more innovative than others, they differ in level of investment in technology, in firm size and in importance of different types of networks

1.3 The Case Reviews

Six cases of networking for new product development were investigated. The UK cases comprised one major case in the defence industry and a second in software business solutions, the Danish cases were in software products and the food sector while the German cases concerned intra-organisational communications in the automobile industry and transport communications.

1.3.1 UK Case Study One: Product Development in the Defence Industry

This long term case concerns a collaboration between two firms in the defence industry (one UK-based, the other US) over the development of an electronic receiver technology. The network under study comprises employees from the two firms who fulfil different functions. The network is located in an industry that is fairly unique in the way it develops and markets new technologies. The type of defence contracts awarded in both countries means that the collaborating firms have to spend many years in discussion, developing the contract bid before they are even awarded the contract which itself will require many years of collaboration before a final product is developed.

The long history of collaboration between these two firms has been beset with problems, especially when the US firm pulled out of agreements to pay royalties on a previous product. This led to a period of acrimony between the two firms, with the UK firm attempting to develop

the technology in-house and set itself up as a rival. This strategy eventually became too expensive, and the two started to collaborate again. The UK firm recently made a successful takeover bid for the other, in a bid to improve relations and to stop the US firm going into receivership. The network is still not working as smoothly as it could. While the two contract teams seem to be very friendly, the engineers hardly communicate and feel very threatened by each others' presence. The network seems to work because the firms have become dependent on the same technology and the same contracts. Buying the US firm was a tacit acknowledgement that there is no other way to get access to the technology, but network relations have not improved for the engineers as a result. This is a case where managers are very adept at managing cross boundary collaborations - the UK firm is enmeshed in a number of these inter-firm technology collaborations but it appears that they may have done so at the expense of developing their own internal technical expertise. This case indicates important issues in the relationships between internal and external networks, in terms of why they are set up and the functions they serve.

1.3.2: UK Case Study Two: New Product Development in Software Business Solutions

The software firm (referred to in the text as ABC) is the focus of this case study which illustrates well that firm's networking experiences, particularly in a specific example of a network-based project with a client in the UK utilities industry (termed XYZ in the text). The ABC / XYZ network consists both of people in the two firms who came together in a novel 'hybrid' form of organization and of a number of organizations that were brought together to manage the collaboration. The early 1990s saw the privatization of the UK's electricity industry with the aim of achieving complete de-regulation of the industry by 1998. This case concerns the role of ABC in the strategic development and customization of one such supplier's (XYZ) computer and information systems as privatization meant developing a strategic response to competition in the newly deregulated market and, like other energy supply companies, developing technological systems and infrastructure was identified as a key source of competitive advantage. As in the case of most of its client partners, ABC was very different to XYZ in its management and organisational culture so ABC developed strategies to 'bridge' such management, operational and culture 'gaps' with potential partners. In particular, this involved developing an inter-firm organisation. *XYZ* in effect ceded control of its entire IT function to the 'hybrid' organization.

A major review of the collaboration, took place as a re-evaluation after four years. The new contract terms allowed XYZ to purchase computing services from other suppliers if required, as part of a deliberate strategy on the part of XYZ to exercise more control over the collaboration with ABC. A consultancy firm was brought in to manage a particular project in which there had been friction between the two parties. In early 1999 XYZ, now under new ownership, gave notice of its intention to terminate the relationship with ABC as permitted under the original terms of the contract. The collaboration has now ended five years short of the agreed 12 year arrangement.

1.3.3: German Case Study One: CATS

CATS, CArgo Tracking System, is a customised fleet management solution for transportation services, an innovation belonging to the broader field of communication and data transmission systems. Compared with other similar products, CATS is very simple to use and less expensive, a major factor in the success of the product. Regional proximity was also important for the initiation of this development. The network consisted of four parties:- (i) a high ranked employee of the Bremen Senator for Economics; (ii) the CEO of the Bremen Goods Traffic Centre; (iii) the head of TELEDATA, a 'high tech' telecommunications firm; (iv) the head of CL (City Logistic). The whole episode had its roots in the close links between (ii), (iii) and the

Bremen authorities; (i) heard from (iii) about their high potential in the fields of telecommunication and that they are searching for customers. (i) spoke about that to (ii) who informed (iv) and then (iv) and (iii) started the innovation project. It was also very important to note that Bremen financed 45% of the estimated costs of the project; especially since CL did not have enough capital to finance its part of the innovation project.

There are two main drivers in this innovation network who have different resources (knowledge, expertise, etc): one (a) is an expert concerning the software development, working in an organisation offering a high degree of self-determination of work and self-responsibility; the other one (b) is familiar with the practice of city logistic. Other actors, like truck drivers, Telekom ,etc. are playing minor roles in the networking process in the sense that they are not defining the programme. Nevertheless, the truck drivers (c) are important for the development because they test the system in its daily practice. However, this innovation project was successively developed and realised primarily by the two individual actors. It is a very important factor to note that the truck drivers are subcontractors as this is the reason why there have been few conflicts between the two main actors on one side and the truck drivers on the other side.

1.3.4: German Case Study Two: EDI in the German Automotive Industry

The development of Electronic Data Interchange (EDI) systems in German car industry is the result of two interrelated networks. The first or "primary" one is the "VDA Network", a network developing so-called VDA standards under the direction of the German Automobile Industry Association (VDA). The second or "secondary" networks are concerned with the realization of the data interchange using these standards. Secondary networks consist of car producers, suppliers and software companies. This case study embraces both types of networks.. The automotive industry in Germany is one of the pioneers in EDI use. What began as a proprietary project (within VW) in the beginning, rapidly evolved into an industry-wide movement because the other car manufacturers, had the same interest in EDI as VW. Since the end of 1970s, the use of EDI was being promoted by VDA, and EDI messages were defined step-by step to be implemented in the whole industry.

The so-called ‘electronic business group’ within VDA became the very centre of the EDI development in German car industry and consisted of delegated experts from seven car producers and five (very large) suppliers. However, that meant that, from the beginning, smaller suppliers were not part of the EDI development. Also the use of non-unified standards, and the fact that top management of the car producers and large suppliers didn’t realise the future strategic importance of EDI were further problematic issues. The consequence of these were high implementation costs. The German Automobile Industry Association turns out to be a facilitator of the early development of EDI in the industry. The tradition of "co-operation between rivals" concerning topics of overall interest was the key factor for the development of common standards, even though the result are open standards. The VDA network illustrates well the price of exclusion of key actors – in this case small suppliers – from the network. At first this exclusion seem to be necessary to facilitate standardisation. But in the longer term the exclusion was responsible for the resistance of a lot of small suppliers concerning the use of EDI.

1.3.5: Danish Case Study One: New Process Technology for the Food Industry

In 1994 the first steps were taken to initiate a project which four years later resulted in a innovation which has yet to result in a new commercial product. The artefact is a continuous process wok for the food industry. The scene of this innovation network is the Danish food sector including research and development institutions. The actors are:- *Fast Food*, a manufacturer of ready-prepared dishes; *Bio Institute*, a university department at a technical university; and *Food Engineering* is a small firm specialized in design and production of

stainless steel equipment for the food, chemical and pharmaceutical industry. The wok project is linked to the Danish national innovation system by being funded by a national research and development program-me for food technology, FOETEK.

The network is seen as being built by one person - the inventor of the continuous process wok - namely a professor at the Bio Institute. During the early years he became the spokesperson for the network. In the autumn of 1994 the quality manager at Fast Food contacted Bio Institute because he had difficulties in processing vegetables for the ready-prepared dishes, and he had a vison of new products in which the customers easily could see and identify crispy vegetables. The inquiry to Bio Institute encouraged the professor visit Fast Food to be informed of the problems. On his return to the department the professor started to solve the technological problem raised by Fast Food. The professor's idea was that continuous frying could be achieved by using an iron frying tube with an open upper front. To transform the vision of the continuous process wok into an artefact, Bio Institute and Fast Food made an agreement of cooperation and then successfully applied the FOETEK programme for financial support.

The goal was to build a pilot plant prototype thereby demonstrating that the new principle was capable of functioning. At Bio Institute the professor mobilized an *internal network* of resources. However, two new external actors had been enrolled in the network. The professor addressed a patent agency and the consultant from this agency became an important discussion partner challenging the professor's ideas and concepts. The result was a patent application including a broader specification than the original idea, different forms of frying principles, and a new batch wok as well. The unfinished prototype was presented at a yearly open house event at Bio Institute. In the autumn of 1998 the Bio Institute was prepared to demonstrate the functionality of the prototype to representatives from Fast Food and Food Engineering. At the end of the year the patent application was extended to comprise these ideas and Food Engineering was given the exclusive right to the patent.

1.3.6: Danish Case Study Two: Hansen

The new product developed in this network is the XAS-module, one of 20 main modules in the MARK III software package. The network is international though the key institutional actors are the large Danish software company Hansen, more than 280 value added resellers (VARs) located in Denmark and abroad, and over 65,000 customers located mainly in Denmark, but also in over 20 countries abroad. The context for the network is Hansen's strategic decision to have a layer of VARS between Hansen and the product's 'end-customers'. The 'value added' aspect of the VARs ' activity is that they derive their main income from customising the product. Therefore, new product development in this network is distributed between Hansen and the VARs. Generally speaking, Hansen develops a product that is both standardised and flexible, whilst the VARs customise this product to meet the specific needs of the customer. Product development increasingly involves reshaping the customer, a task which is undertaken by the VARs. In this respect, the customers themselves are also new products developed in the network.

The product itself plays an important role in shaping the identities, relationships and conduct of actors in the network. The quality of the product is important in the maintenance of network *trust*. The product must also be, at different times, standard and flexible, or customised and tailored. Whilst this dual product profile creates mutual dependency and cooperation around product development, it also creates the potential for competition between Hansen and the VARs. In order to develop a standard and flexible new product and enrol both the VARs and the customers, Hansen needs to collaborate with the VARs. But interacting with the VARs engenders a risk for Hansen that the VARs will learn the knowledge and contacts to take over Hansen's product- and market-space within the network. In other words, in order to develop a

successful product, Hansen must expose itself to the risk that the VARs will exclude Hansen from the product loop.

1.4 Cross- Case Study thematic analysis

These six cases have been subjected to a cross-case analysis based on network building themes as noted earlier. Four themes have been identified which we articulated in a context-free manner (ie, especially with respect national factors). This comparative analysis initially focuses on the theme of 'power/process', and identifies how this impinges and influences network function. The other themes focus on issues that help to elucidate the political processes that affect network building, its sustainment and support for innovation. These themes are trust, contract, and communication; knowledge and learning; and the role of the artifact in network building. This analytical framework was then used as the basis for discussion of policy implications.

Policy recommendations have been made under the following headings: National Systems of Innovation; Civilian and Military funding for network development; National and international networking; Development of strategic approaches to new product networks.

This project has examined new product development activities in various network types. These networks, once they have been initiated require building and sustaining as they develop change and adapt over time. Such process skills need to be acquired in order to manage both instances of co-operation and of conflict in the network. In new product development both formal and informal networks are involved. Formal networks are linked to legal contract as well as established routines in the organisation while informal network processes are based on communication and trust building and are influenced by existing organisational cultures and embedded behaviours. All these network processes require appropriate management strategies and expertises. The policy recommendations reflect this aspect for encouraging successful new product development networks.

2 PROJECT BACKGROUND

This project was a collaboration between researchers in three European countries, which was funded by the European Commission Targeted Socio-Economic research Fund for a period of two years, commencing on January 1st, 1998 and ending on 31st December 1999. The UK partner was the School of Business and Management at Brunel University, West London, while in Denmark the collaborating institution was the Technical University, based in Lyngby, Copenhagen. The third institutional partner was the Forschungszentrum Arbeit und Technik (ARTEC), at the University of Bremen (see the Appendix for individual details of the researchers based at each organisation).

The project set out to investigate the role of networks in new product development, aiming to develop previous findings which have begun to identify the crucial role of networks in innovation success. The objectives of this study, therefore, sought to examine the building processes involved in establishing such networks by evaluating and comparing such practices in three European countries, based on the premise that networks have to be built and this requires new kinds of organisational, managerial and technical expertise. In particular, the aim was to highlight the role of socio-economic factors in collaborative innovation as well as broader policy implications which might be useful in directing and supporting such activities. It was therefore proposed that special attention would be paid to the social processes through which network builders form, develop and sustain both internal and external collaborative networking.

In particular the specific objectives were to focus on three interrelated themes and policy implications:

a) The formation and development of internal collaborative networks
b) The formation and development of external collaborative networks and interaction with internal collaborative activity
c) Roles of 'network builders' in forming, developing and sustaining internal and external collaborative activity

In terms of internal networks, the aim was to compare and contrast collaborative activities in the three national settings. Attention would be paid to the commonalities and variations found in the formation, development and continuity of internal networks and factors that facilitate or act as barriers to internal collaboration in different contexts. The aim also was to investigate the process of establishing external collaborative networks and their points of interaction with internal collaborative activity. A particular focus of the study would be to compare and contrast, in three national settings, the role of micro-political processes involved in 'network building' in forming, developing and sustaining collaborative networks both internal and external to the innovating organisation, and the role that industrial/regional/national institutions may play in establishing and maintaining such networks.

The project aims to advance existing knowledge, within a comparative perspective, by enhancing understanding of inter-personal factors which are critical to network formation, including identification of instances of building mutual trust and reciprocity to facilitate collaboration. One major issues for investigation would be the development of competences and expertise required for network building. Going beyond the content and control agendas, to investigate the process agenda of Buchanan and Boddy (1992) - the capacity of network builders to confront and resolve issues arising from the political interactions and conflicts between the interests of different stakeholder groups within internal/external network

In addition, attention would be given to identifying the influence of specific local, regional and national settings and their associated frameworks for innovation on the process of network building. In particular, geographical influences on the processes of technology transfer and the sharing of know-how between network partners would be examined, as well as different approaches to organisational design, and management style in different national settings.

In terms of research methods the collection of data was to be primarily via semi-structured interviews. Although all interviews would follow an agreed structure, focussing on common themes related to the research objectives, researchers in each country would be responsible for developing a questionnaire suitable for use with domestic firms. Each team also had the opportunity to develop and pursue particular lines of enquiry which appeared applicable to a particular case. In terms of selection of the case studies, the original aim was to pursue one major, long term instance of network building for new product development and two much shorter, ‘snap shot’ cases. In the primary case study a series of longitudinal interview programmes with both internal and external actors involved in relevant networks were envisaged, throughout the two year lifetime of the project. This would result in between 30-40 interviews with relevant personnel at a number of levels in the firms involved as well as interviews with actors 'outside' the network used to corroborate views of actors within the network. In the two shorter case studies, two sets of visits were to be undertaken, at the beginning and towards the end of the project, comprising between 15-20 visits.

In fact, it turned out that, in all three countries, two case studies were developed, both of which had a longitudinal element, rather than one long and two shorter cases. The final report was to contain a full resume of the case studies, as well as a cross country comparative analysis of results and conclusions from the project relating to network building processes. In addition, a

section detailing the main policy implications arising from the project was to be included. A number of outcomes were expected from the project, including some advancement in the academic understanding of the process of internal and external network building. This would be particularly in respect of the contribution of interpersonal factors to the process agenda in network building, and also the comparative influence of national context in network dynamics. This would lead to the provision of an enhanced knowledge base, to inform and assist, at the regional, national or European level in the promotion, facilitation and support of network building activities.

3 SCIENTIFIC DESCRIPTION OF PROJECT

3.1 Theoretical background

3.1.1 The networking paradox

In this section we outline the theoretical basis for our treatment of collaborative networks from a political process perspectives. Our starting point is what we term the 'paradox of networking'. That is, technological (and indeed other forms) of collaboration are normally presented as predicated on organisational intentions to seek a reduction in uncertainty in changing and unpredictable market and technological conditions markets (Aoki, 1984; DeBresson and Amesse, 1991; Child and Faulkner, 1996). Given the manner in which technological advances increasingly derive from novel synergies and combinations of scientific and technical knowledge, such collaboration has also been identified as an essential aspect of a successful innovation strategy. Indeed, Ford and Thomas (1997) claim that a new product development strategy is now inevitably a networking strategy and Tidd (1997) claims that technological innovation is now best understood through a focus on networks of collaboration rather than the traditional single enterprise unit. More generally, collaborative relationships have been identified as a key source of new knowledge and, through innovative activity, variety in the economic system (Coombs et al, 1996).

However, on the other hand, such behaviour exposes the organisation and its incumbents to new risks and uncertainties. These are associated with the complexities of forging collaborative relationships and the potentially novel (for the participants) organisational arrangements that may arise. Thus, whilst being a source of risk reduction, collaboration in innovation networks may expose collaborators to new sources of vulnerability associated with building and managing network relationships and new organisational forms. Indeed, these issues have been highlighted as a specific factor in the success of new product development in terms of the effectiveness of collaborative alliances *within the firm* (e.g. Dougherty and Hardy, 1996) and in terms of participation in *external* networks (Steward and Conway 1996). Vergragt et al (1982: 244) go as far as to state that technological development, 'is made possible through the creation of internal coalitions or networks and by extension of these networks to include other organisations in the environment'.

Certainly, for some, innovation networks, as a specific rather than generic form of technological collaboration, provide a particularly potent model for new product development. This is because, in their most developed form, they may avoid many of the conventional problems of inter-firm collaboration – for example 'cultural mismatch' between collaborators (Child and Faulkner, 1996). As such, networks – defined in these terms - can be regarded as new 'hybrid' organisational forms which are able to both use and deploy new technologies to change inter-sectoral relationships as well as relationships between firm functions, suppliers, other

network actors, etc (Freeman, 1991). In organisational terms such 'hybrids' can be regarded as an 'agile ' or even 'virtual' forms, temporary networks formed 'to exploit new market opportunities through the mutual exchange of skills and resources' (Campbell, 1996: 83).

Overall, the prevailing image is one of collaboration in new product development being built on values and relationships characterised by mutuality and trust. In contrast conventional product innovation in 'mechanistic' firms is portrayed as difficult to sustain and one best characterised by adversarial relationships between functions, hierarchies, employer/employees, suppliers, customers and so on. The latter is politicized the former is politics-free. The research findings we report below do not enable us to subscribe to such a position. Rather they suggest the usefulness of a different theoretical position which views collaborative relations as political and as imbued with power-processes as much as adversarial ones. This leads to our conclusion that the building of collaborative networks requires – in highly significant ways - political action. We believe this has considerable implications for training in technology and innovation management and for policy development to encourage product innovation through collaborative networks.

3.1.2 Existing Conceptual Frameworks

In our 12 month progress report we presented a review of the 'state of the art' in studies of innovation networks as they relate to collaboration in new product development. We classified the literature under seven headings:

1) ***Evolutionary*** **–** views of networking behaviour as an observable adaptation by firms to changing environmental circumstance where collaboration rather than competition becomes a means of organisational survival and growth through innovation.

2) ***Social Shaping*** **–** a broad category of perspectives which share a common theme of seeking to 'open the black' box of technology in the innovation process and thereby show how networking behaviour shapes both technical content as well as the social dimensions of inter-and intra-firm networks. The boundary between the technical and the social itself can be seen as an outcome of this network building activity.

3) ***Organisational Learning*** **–** focuses on knowledge creation through the interaction of groups within an organisational structure concerned with a particular technological development. The dynamics of network building are seen to be mainly experiential. Individuals can adapt and make changes in behaviour as a result of learning experiences gained through participation in networks and network building

4) ***Political Process*** **-** The political process perspective views networks as constituted by temporary and continuously shifting alliances and coalitions between individuals, groups and institutions. It is their political action in bringing about alliances, compromises and (on occasion) conflict resolution that enables the product development process to be sustained and outcomes produced.

5) ***Product Design/development process*** **–** focuses on the development process itself and provides and analysis of the relation between social interaction of - for example design teams – and issues of learning and the content of development process.

6) ***Technology Management/Strategy*** – focuses on the development process in itself. In this way the design process perspective gives a description of the relation between the process as social interaction, a process of learning and the content of the product development process.

7) ***Spatial approaches*** – focussing on national and regional dimensions of network behaviour but also the implications of electronic mediation of network interactions over time and space.

Table 1 below provides a schematic exploration of the main dimensions of the above approaches and what we see as key exemplars of the approaches are indicated.

3.1.3: Convergence in Socio-economic analysis of innovation?

The BiCoN project can be seen as an attempt to foster a greater convergence between social/sociological and economic approaches in the analysis of innovation (Coombs et al, 1996, Progress Report 1998, Mcloughlin et al 1999). We contribute to this development by giving priority to a political process perspective the analysis of innovation networks – specifically to the case of collaboration between organisations engaged in new product development. We see this perspective of providing additional insight to help us explicate the nature key thematic issues in networking, collaboration and new product development which concern other social and economic perspectives. In particular, issues of trust, learning, knowledge creation, the strategic management of collaboration, the detailed interactions within and between product development teams; and the significance of regional/national institutional arrangements. We therefore do not suggest this approach as an alternative to the other perspectives we have identified but rather, by giving it more analytical emphasis, a useful complement to the insights offered by the other approaches.

Having said this we would emphasis the following key corrective elements of the political process approach when compared to some other perspectives:

i). The behaviour of organisations is not seen as determined by environmental imperatives, rather such contingencies are 'reference points' for decision-making within political processes

ii).The organisation is viewed not viewed as 'one actor' but rather as a coalition of potentially competing interests and temporary coalitions.

iii).Technology is not treated as an exogenous variable but is itself seen as a product of political processes (an insight that owes more to the social shaping literature than most political process research)

iv). Behaviour and intentions perceived as political or as involving the exercise of power are not seen as inevitably negative (Pavitt, 1990) in their consequences for innovation and indeed we would argue have a positive role.

Thus, where behaviour or actions of or within organisations seem to challenge the logic of a technological trajectory this is not best explained in terms which question the actors underlying rationality (e.g. conflicts between institutions or actors experienced in the innovation process are frequently framed in terms of 'communication failures' which prevent, for instance effective relationships between suppliers and users). Similarly, opposition or resistance to change, for instance on the part of trade unions or work groups, is not inevitably misguided or 'politically' motivated action to preserve short term sectional interests rather than the long-term collective interest of progress through innovation. Rather, we need to explore the intentionality of the actors concerned to establish the rational basis for their action as they see it.

The political process perspective starts from the assumption that it is not enough to consider the organisational outcomes of technological change (the 'impact of technology'). Rather, the 'power-processes' within organisations through which these outcomes are produced must also be considered (Thomas, 1994: 10). This leads to a consideration of the way outcomes of change are shaped through the mobilisation of power by organisational actors and the influence of context in defining the 'design space' in which they act (Pettigrew, 1986; Clark et al, 1988; Clausen and Koch, 1998; Dawson, 1994; Thomas, 1994). More recently attention has been given to the role change agents and change agency and the problems and possibilities of engagement in political processes within organisations as a means of seeking to influence outcomes (Boddy and Buchanan, 1992; McLoughlin et al, 1997; Buchanan and Badham, 1999). The core argument of this perspective has thus been that understanding the consequences of technological change requires a focus on the political shaping of decisions concerning the *use* of new technologies within adopting organisations. Increasingly it is realised that such arguments

must not only be applied to the process by which the organisational outcomes of technological change are shaped, but also to the manner in which technological outcomes are produced as well (Koch 1999, McLoughlin, 1999).

3.1.4. Political process in new product development

Most studies of new product development do not directly concern themselves with 'political processes' as a significant element or driver of the activity. Brown and Eisenhardt (1995) identifies three approaches in the literature:

· The *rationalistic perspective* based on the assumption that 'a product that is well planned, implemented and appropriately supported will be a success' (1995:344). From this viewpoint there is little room for consideration of the political other than a potentially disruptive barrier to innovation as noted above.

· The *decision-making process perspective* which views successful product development as 'disciplined problem solving'. This requires the exercise of 'subtle control' by senior management who must create a strong vision for a new product to ensure outcomes fit with corporate objectives but at the same time leave sufficient ambiguity for 'experiential improvisation' within the development team. Accordingly, this research highlights the role of 'heavyweight' team leaders as 'linking pins' between corporate vision and the problem solving activity of teams and stresses the importance of 'product integrity' – that is 'a clear vision of the product's intended image, performance, and fit with corporate competencies and customers' (Brown and Eisenhardt, 1998: 351). However, whilst suggestive of some kind of political process, as Brown and Eisenhardt point out, concepts such as 'heavyweight' team leaders remain vague and lack 'political realism' in the sense that such leaders are portrayed as almost 'superhuman'. Similarly, key questions of how project team members are actually motivated to work in a disciplined yet creative way are not addressed.

· The communication perspective stresses the role of communication within development teams and between them and the context in which they operate to successful product development. This perspective goes further in highlighting the significance of political activity in some sense as a means of securing the resources required for successful product development. In particular, 'politically orientated external communication' is shown to increase the resources flowing to a product development team and the new information that follows from boundary-spanning activity (e.g. getting development teams to talk to customers) aids the process of product development. In similar fashion, high levels of internal communication are seen to improve team performance

Dougherty and Hardy (1996), argue that sustained new product development requires:

a). The winning of resources (finance, technology, knowledge, information) to be made available to development projects, programmes and activities;
b). the creation of organisational processes and structures which enable collaboration; and
c). the establishment of clear links between product development and organisational strategy.

However these requirements are not easily fulfilled, especially in 'mature' organisations which have hitherto not been particularly innovative. In particular problems may occur in:

- establishing a smooth flow of resources since this requires project 'champions' to build effective coalitions of support;
- changing existing organisational arrangements, procedures and routines which may act as a constraint on the capacity to develop effective collaboration;
- creating meanings which enable others to understand the strategic significance and value of a new product development.

From their own research Dougherty and Hardy suggest that, the most successful product innovators are those who were able to solve a high proportion of the resource, change and

creation of meaning problems. However, the cases that achieved this did so in spite of, rather than because of, broader organisational support. When it came to tackling these problems at an organisational level there was much less success.

3.1.5 Implications for collaboration in new product development.

Whilst Dougherty and Hardy are primarily concerned with internal collaboration and conducted research that focussed on mature firms who hitherto had not engaged in sustained product innovation, their analysis provides a number of pointers to the nature of the power-processes that may be involved in new product development in general, including those involving inter-organisational as well as intra-organisational collaboration. They suggest that:

- a focus on the personal power of individual managers to control resources (budgets, information, expertise etc.) 'only scratches the surface of power dynamics' (1996: 1147).
- power can also reside in the processes through which innovation occurs and that for sustained innovation organisational systems are required which permit effective collaboration which is not dependent upon the actions of powerful individuals whose actions are readily subverted or isolated
- the power of the meaning supporting innovation is 'crucial' since without this the power embodied in processes and manifested in the possession of resources 'easily unravels' (1996: 1148).

3.1.6. Power Processes in inter-firm relationships.

As already noted, there is no reason to suppose that inter firm interactions should not be shaped by power-processes and, to the extent that the behaviour in innovation networks of this type is seen as aimed at achieving overall network efficiency regardless of individual participant positions, then there is considerable opportunity to develop such an analysis. This point is taken up by Elg and Johansson (1997) who develop upon earlier work by Frost and Egri (1991). Their concern is to examine decision-making processes in asymmetrical relationships in inter-firm networks. The starting point is the proposition – based on resource-dependency models - that network participants will seek to influence the decision-making process in ways which advance their specific interests and enhances their position within the network. For example, organisations with more powerful positions in a network will seek to exploit and preserve this position whilst weaker organisations will seek to alter the conditions of their dependency. Network participants will seek to advance such motives by seeking out potential sources of network support and then seeking to control interactions within the network in order to use these supportive structures. Much of this will involve the 'observable' exercise of power by one party over another, for example as they use the resources derived from their structural position within a network to advance or defend their position. However, in a similar argument to Dougherty and Hardy, it is suggested that more subtle political activity will involve the non-observable 'hidden' exercise of power and the power embedded in 'deep structures' of 'taken for granted' norms, expectations and beliefs.

3.1.7 BiCoN perspective on political/power process in collaborative networks.

The extent to which the work highlighted reveals the political processes in collaborative networks and new product development is useful but limited. We believe that, firstly, the analysis of the distribution of power between network participants provided by a resource-dependency model is too static (as Thomas notes, whilst adequate for a single decision-event at a particular point in time, when examining the unfolding pattern of a series of decisions over-time which, such notions of the structural sources of power are less realistic). Secondly we believe that attempts to examine political processes need to conceptualise power as operating at a number of levels. This points to the relational characteristics of power and the importance of coalition building, enrolment and legitimation in mobilising and exerting power.

More detailed conceptual discussion of these issues is beyond the scope of this report. However we will explore the role of power processes in presenting and analysing our data in terms of the following themes/implications which structure the discussion of our case studies in the following sections:

Table One: Typology of Literature on Innovation Networks (Part A)

	Evolutionary	**Social Shaping**	**Learning Process**	**Political Process**
Network Definition	Linkages between firms	Heterogeneous links	----------	Alliances & coalitions
Perception of Object	Evolutionary, Abstract	Concrete, Specific	Externalistic	Interna-listic, ex-ternalistic
Actor Concept	Firm	Heterogeneous	Organisation and individual	Competing interests
Network Dynamic	Biological variation and selection	Social inclusion exclusion	Problem solving	Conflict resolution
Level of Analysis	Mainly meso	Micro, meso, macro	Micro	Micro
Learning Issue	Enables adaptation	Not addressed	Enables Change	----------
Management Issues	----------	Central, Contingent	Develop. Competencies	Strategic choice
Policy and Practice	best practice	----------	Best practice	Process Prescription
	Structural-Dynamic explanation	**Agency Internalist**	**Knowledge creation**	**Building processes**
Limitations	Determinist Linearity	Social Determinist	„psycho-logism"	Conflict obsession

Table 1: Typology of Literature on Innovation Networks (Part B)

	Design	**Management**	**Spatial**
Network Definition	Linkages between individuals, professionals, firms around a product development process	Linkages between individuals, firms and institutions around an innovation project	Individual actors, groups, organisations identified via location

Perception of Object	'internalist' , detailed description, incremental or profound change	Mainly 'externalist'	'externalist'
Actor Concept	Individuals, groups, enterprises	Individuals, groups, enterprises	Individuals, groups, enterprises, institutions
Network Dynamic	Coalitions, team building, separation of actors in time and space	Economic or social	Social, fruitful combination of global and local
Level of Analysis	Micro, meso	Micro, meso	Meso and macro
Learning Issue	Collective, multi-disciplinary, co-ordination learning	Collective, multi-disciplinary	Development of networking potential via increased knowledge of potential actors
Management Issues	Project management	Focus on internal firm strategies and change. Decision-making possible via external networks	Focus on factors which facilitate communication (esp. over distance) between networks
Policy and Practice	Suggests 'best practice' for firms and actors	Suggests 'best practice' for managers	May suggest regionally based solutions to encourage networking
	Building processes of coalitions leading to networks	**Building processes amongst managers**	**Introduces spatial effects into analysis of networks**
Limitations	Tends to focus heavily on internal processes	Tends to focus either on rational choice or evolutionary models	May treat innovation as a 'black box'

3.1.8 Theoretical Aspects of Trust, Contract and Communication in Networking

In the cases from the three countries, there often appears to be a link between three aspects in the network: trust, contract and communication, although in the literature, few studies have explicitly considered these issues together. What has been discussed at length are the roles of trust and contract as co-ordination mechanisms. The category communication is being used in this section in its role as an enabler of trust building. Their discussion below, aims to develop concepts which are used to compare the case studies of BiCoN..

Meaning and Role of Trust:

The existence of trust in an inter-firm relationship implies some level of expectation between the firms involved both in formal terms with regard to compliance of a contract, as well as with respect to informal behaviours and competencies. Analysis tends to hinge around the concepts both of differing levels of trust present, and the particular location of the trust. Fox (1974) talks of ‘low’ and ‘high’ trust levels, in different employment situations, while Zucker (1986) identified trust as being identified in different settings, such as institutional, interpersonal and competence as areas in which the process of trust building takes place. In terms of networks low trust in external relationships is seen as a problem to be managed and controlled, and does not necessarily prevent the development of working links with other organisations, high trust situations are deemed more suitable for collaborations where there is a high level of specialised knowledge to share (Dodgson, 1993). Following Burchell and Wilkinson (1997, 218) three dimensions of trust (in business relations) are differentiated: (a) the meaning of trust; (b) the role

of trust; (c) and the process by which trust is established and maintained. (a) and (b) are discussed now, (c) in the context with communication and contract.

a). Different aspects of the meaning of trust: Risk and (expected) advantage of trust: "Trust is, in its broadest sense, the trust in one' s own expectations" (Luhmann 1989, 1). This implies that a truster can never be sure that a trusted person will not abuse the trust. Trust is not necessarily reciprocal, it is a "risk investment" (Luhmann 1979, 26). But trust implies both positive expectations and risk/ vulnerability: Trust involves "expectations of benign action and acceptance of vulnerability" (Govier 1994, 238).

Trust as personal and/or organisational trust: It is important to notice that trust is a relationship including at least one *person* or *individual*: a person can trust in another person, a thing or in an organisation. "Organisational trust" seems to be a questionable category. Blois (1999, 203) offers the following solution for the problem: "...one way of interpreting the phrase 'inter-organizational trust' is to accept that this is a short-hand for 'two sets of individuals each of which is trusting the organization of which the others are members'". Up to now the focus has been on persons – individuals or actors representing organisations. System trust (Luhmann 1979, 1989) means that institutions are playing an important role for the existence of trust and for mutual trust relations between actors. This is equivalent with Zucker's (1986) notion of 'institutionally based trust ' meaning – as Lane and Bachmann put it (1996, 371) – that "trust is tied to the existence of formal structures in society, which are independent of the momentary preferences and actions of individuals".

(b) Role of trust: The main role of trust is to reduce social complexity and uncertainty (Luhmann 1989). Network relationships as social relationships between actors are without exception exposed to time and information problem. The former means that most performances of actors are exchanged with time lag sequentially. The sequential character causes the information problem, namely, uncertainty and/or risk, whether the interaction partners would make the implicit or explicit agreement (Preisendörfer 1995). Trust can be seen as a mechanism, which serves to overcome the time problem and to tide over the uncertainty of information in a such way that an actor, namely truster, trusts the others one-sided ex ante (or many actors mutually trust each other ex ante). This action is based on expectations that others will do things which will favour him (or them).

Sako (1992) divides between contractual trust, competence trust and goodwill trust. Contractual trust exists such that each partner adheres to agreements, and keeps promises. Competence trust concerns the expectation of a trading partner performing his role competently. Goodwill trust occurs when "someone .... is dependable and can be endowed with high discretion, as he can be entrusted to take initiative while refraining from unfair advantage taking" (Sako 1992, 39). Goodwill trust can be understood to represent a higher level of trust than the other two forms.

Contract and Trust: Contract and trust are parts of a complicated mechanism that is used to reduce the risks of co-operation, especially of the uncertain and often highly risky processes of new product development. The main questions, dealt with now, are: (a) What is the importance of contracts for networks or business relations in general? And (b) Concerning the relationship between contract and trust, Is contract complementary to trust or even supporting trust building or are contracts contradictory to trust?

(a) Under the influence of Macaulay (1963, 1985) one important view is that the non-contractual elements of business relationships, including loyalty, co-operation, trust, are important. By contrast, the role of contract law in these relationships is thought to be minimal, since legal

sanctions for non performance are seen as too blunt to be of much use in promoting co-operation based on flexibility and give and take; equally, formal contractual documents, which lay down the parties' future obligations, cannot by their nature capture the parties' open-ended commitment to the success of the venture on which co-operation is built (Sako 1992; Campbell, Harris 1993). But Fitzgerald and Willcocks (1994) point out the ambivalent role of contracts. On the one hand, uncertainty and openness of the situation set limits to precise and comprehensive contractual regulation, on the other hand a reasonable reconciliation of interests is an ex ante necessary prerequisite of co-operation. The contract 'in the drawer' is then the last device in a relationship to avoid sufficiently opportunistic behaviour. Incompleteness of contracts seems to be unavoidable and necessary in networking.

(b) However, although contract, just showed, is commonly thought to be one of the principal mechanisms for enhancing the security of economical exchange, its precise role remains somewhat obscure and particular unclear is the relationship of law to trust. One position is that the introduction of law can be detrimental to the establishment of trust within a business relationship (Macauley 1963). Inherent in the view of trust as personal or cultural is an opposition between trust and contract, the former being seen as largely non-existent when the terms and conditions of exchange are formally laid down and agreed in contractual terms to be monitored and enforced by legal contract.

But the dichotomization of trust and contract is questionable, at least in a business context (Lane and Bachmann, 1996). For, whatever the network actors' mutual interests and their facilities for progressing them, each retains clear and separate interests of his/her own, which may mean that they have the need for formal, legally binding agreements. Instances in which contracting network actors actively seek to avoid placing their agreements in some kind of legal form are rare (Arrighetti, Bachmann and Deakin, 1997). Although both parties know that going to court to resolve a dispute will effectively end their relationship, a formal contract specifying rights and obligations in the event of certain contingencies can be used as a means of averting litigation. Such a contract may well be a sign of an already existing relationship founded, at least partially, on trust. What is important is the co-existence of trust and the more formal use of contractual documents. And even more: contract and contract law can be assumed to play a part in building and maintaining trust and network relationship (Arrighett, Bachmann, Deakin 1997).

Communication, Contract and Trust Building: Development of communication links between network members is obviously a critical issue. Jones et al (1998) noted how communications within informal networks underpinned successful innovation. Steward and Conway (1996) considered that the information flow through networks is a function both of formal processes such as meetings or conferences and informal links via person-to-person visits, e-mail and telephone, while Nye (1997) identifies the use of communication technologies as a matter of personal choice indicating the existence of interpersonal issues in network building. Coombs and Hull (1998) investigated the role of communication through established, firm specific routines and suggest that both formal and informal networks are involved in the transfer of information.

Before dealing with the relationship between communication and trust other mechanisms of trust building are briefly mentioned. It are law, contract and institutions: Law is, as follows from above, one important mechanism for dealing with the essential riskiness of trust: Legal arrangements which lend special assurance to particular expectations and make them sanctionable lessen the risk of conferring trust (Luhmann 1979, 34). Both, contract law doctrine and the more complex types of contractual agreement provide a function for systems trust and for trust building in general (Lane, Bachmann 1996; Deakin, Wilkinson 1996; Wilkinson,

Burchell 1997). The same is true with institutions (like, for example, associations etc., see Luhmann 1979, 1989). As Zucker (1986) states it, trust is process-based and is as such depending on the existence of adequate, stable institutions.

But despite the fact of the embeddedness of trust existence and trust building in law, contract and institutions the building of trust or trustworthiness is, not least, created by the every day processes of communication between individuals: This means normally long-lasting relationships which may (or may not) create mutual trust. In the case of success "continuing economic relations become overlaid with social content that, apart from economic self-interest, carries strong expectations of trust and abstention from opportunism" (Granovetter 1992, 42). Trust building 'begins with small risks and builds on confirmation" (Luhmann 1995, 129). Trust evolves through the process of a growth of knowledge and mutual understanding of the people with whom we interact plus the actual experience of working with them.

3.1.9 Knowledge and Learning in networks

Knowledge and learning must be considered in terms of both technical development and in the management and control of networks. The literature in this area does not necessarily draw links between the process of learning and knowledge, nor does it acknowledge the links between technological development and its management and organisation. A brief overview will illustrate these points.

In some literature the process of innovation has been seen as a communal activity in which technical knowledge, is shared by an external community and, under certain conditions, can be exchanged between firms without encountering problems of intellectual ownership or confidentiality (Rappa and Debackere, 1994, Shrader, 1991, Von Hippel, 1987). In other cases, however, technological knowledge is highly contested, commercially confidential and secret, forming a barrier to the necessary flow of information within a successful network (Hausler et al). Innovation studies have considered the development of technological knowledge in an organisational setting, in terms of the components to knowledge required for such changes at the organisational level. This approach identifies a role for tacit knowledge as well as formal scientific knowledge in development of new technologies, it also places the development as contingent on its organisational setting in terms of the necessity for local and social knowledge needed to facilitate innovation (Fincham et al, 1994). Technical knowledge is, in a sense, a component of the concept of a firm-based competence which has been raised in the literature, and has been identified as a factor in the technical choices open to a particular firm (Patel and Pavitt, 1994). The role of managerial competence has also been implicated in this, and attempts to define the components of managerial knowledge have appeared to deliver a very similar set of ideas to that in the innovation literature, in terms of formal, tacit, social and local knowledge (Spender, 1994).

Learning: In terms of innovation, technological learning has been identified in terms of action. Experiential learning is a concept that has been used to explain on-going changes to an existing system although the precise nature of learning is not well described. It has also been recognised that innovation often involves a search for knowledge external to the firm, and both social and technical knowledge-bases come into play in this arena (Pisano, 1990). The process of utilizing external knowledge and incorporating it into an ongoing innovation has also been identified as an area where technical learning of some kind is taking place, and this should be linked to ideas about directing the flow of information to specific people within the firm in order for the process to be useful in innovation (MacDonald and Williams, 1994). Communication and other barriers to the uptake of new knowledge have also been identified in terms of a failure for some firms to learn. In particular, both networking and, more importantly, close technological collaboration

between firms have been identified as places where learning about new technologies, methods and techniques can take place. Although the learning process is poorly described the outcomes are identified in terms of changes both to their knowledge bases and managerial procedures and practices (Dodgson, 1993).

In terms of organisational-based learning that in not specifically directed towards innovation, three approaches can be identified, individual workplace learning, managerial and organisational learning (Levit and March, 1988). In terms of small firms, regional learning effects have also been noted (Keeble and Lawson, 1998). In general 'the learning organisation' is held up as a desired outcome from a mixture of different levels of learning, especially in terms of developing and updating a technological base, but it is not clear how all these processes interact to achieve such a desired outcome. In addition, a discussion of learning processes is often missing from these analyses.

3.1.10: National Systems of Innovation

Introduction

The first use of the concept of 'national system of innovation' (NSI) in a major publication is attributed to Freeman (1987), and subsequently developed in Dosi *et al.* (1998), Lundvall (1992), Nelson (1993), Patel & Pavitt (1994), Freeman (1995) & Edquist (1997). However, 'what national systems of innovation encompass and what they actually do is still subject to varying interpretations & debate' (Patel & Pavitt 1998 p. 4). In this section we give an overview of this debate.

One way in which NSIs are conceptualised is in terms of institutional structures and their functions. For example, Nelson & Rosenberg (1993) define the NSI concept as, 'the set of institutions whose interactions determine the innovative performance of national firms' (p. 4). As summarised in the literature review by Koch (1999), a typical list of major institutional actors in NSIs would be:

- Firms
- Industrial research laboratories (often the R&D division of a firm)
- Universities (basic & industry-specific research)
- Government laboratories, including military laboratories
- Industry or technology specific facilitating institutions, including govt defence departments
- Financial institutions

There is a notable difference between NSIs as characterised above and NSIs as characterised by Lundvall. In contrast to the list of organisations above, Lundvall (1998) describes NSI institutions as 'norms, habits & rules ...deeply ingrained in society', and rather than a *function*, Lundvall defines NSIs from an academic or policy-maker's perspective as a *tool* for 'analyzing economic development & economic growth' (p. 415). According to Lundvall (1998) there exist two contrasting approaches to NSIs. One, inspired by the US, is rooted in neo-classical economics, and conceptualises NSIs as a form of national S&T policy. The other, the 'Aalborg-version', where Lundvall is located, places knowledge & learning at the centre of the NSI concept. Uhlin (1999) distinguishes these from neo-classical economists by calling them 'innovation economists'.

Knowledge & Learning in National Systems of Innovation

One of the central hypotheses of the innovation economists' NSI concept is that *knowledge* is the most fundamental *resource* in the modern economy. From this it follows that *learning* is the

most important *process*. The other central hypothesis is that learning is an *interactive* process that can only be understood in its institutional and cultural context (Lundvall 1992).

Innovation economists argue that important parts of the knowledge base for innovation are developed through learning activities which occur outside of the formal education system. Such learning occurs through learning-by-doing, learning-by-using, and learning-by-interacting rather than through science & technology search activities. Evidence for this is that new product specialisation is strongly correlated to the knowledge base rather than resource allocation (see Lundvall 1998). Indeed, for Lundvall, one of the basic intentions behind the concept of NSIs, is 'to change the analytical focus away from allocation to innovation, and from making choices to learning' (Lundvall 1998 p. 408).

NSIs as Networks

Patel & Pavitt (1998) define NSIs as 'the national investments in the knowledge-generating activities that are a necessary complement to investments in equipment in increasing efficiency & in maintaining or increasing competitiveness' (p. 4). However, this is not to say that they are advocating a simple resource-allocation model of innovation. Rather, they argue that there is a growing recognition by policy makers and academics that the main economic benefits of basic research are not codified knowledge, but research skills, problem-solving techniques, and membership of research networks (Patel & Pavitt 1998 p. 17).

A focus on learning through interaction brings *linkages* into the frame of analysis, and lends itself to the conceptualisation of NSIs as networks. For example, Patel & Pavitt (1998) state: 'An essential feature of all effective "national systems of innovation" are the linkages (networks) between their component parts: between disciplines, between corporate functions and between institutions' (p. 5). Similarly, Freeman (1987) defines NSIs as a network of institutions in the public and private sectors whose activities and interactions initiate, import, modify and diffuse new technologies.

NSIs & Globalisation

A debate exists concerning the status of NSIs in an increasingly globalised economy (for a recent review see Koch *et al* . 1999). One criticism of the NSI concept is its focus on the nation as the level of analysis. Rather than being national, it is argued, innovation systems operate at other levels, for example, transnational, regional, local, technological, & sectoral. The focus on learning as an interactive process has an input into this debate, as will be discussed below.

One argument put forward, which focuses on the conventional institutional dimensions of NSIs, is that the globalisation of regulatory bodies and corporations will increasingly emasculate the impact of NSIs on national innovation performance (see Ohmae 1990; Johnson 1975; cited in Freeman & Soete 1997). The policy implication of this argument is that in a globalised economy, the activities of a *national* system of innovation are of diminishing relevance to national innovation performance. However, this still leaves open the question of the role of basic research activities, which, even in a globalised economy, have a specific geographical location. The implication of the view that the output of basic research is codified information that is costly to produce but virtually costless to transfer and reuse is that such information can flow easily out of the country of origin and thereby benefit another country cost-free. By contrast, the view that the main economic benefits of basic research are not codified knowledge but research skills, problem-solving techniques and membership of international networks implies that a nation's basic research activities remain important to its innovation performance in spite of, or even because of, globalisation. *Where* research happens matters, even in a globalised world, because important aspects of the knowledge it produces are embodied, and also because

person-embodied linkages are critical for learning - for the exchange and transfer of such knowledge - and such linkages are sensitive to linguistic & geographic constraints (see Patel & Pavitt 1998 p. 5).

This viewpoint is supported by research by Patel (see 1995) that found that the overwhelming proportion of the technological activities of the world's largest firms – which it is argued play a major role in NSIs – continues to be performed in their home country. On the basis of this research, Patel & Pavitt (1994) argue that 'trends towards globalisation notwithstanding – national systems of innovation still matter' (p. 86). Research by Patel & Vega (1998) confirmed this finding, namely that firms perform a high proportion of their innovative activities in their home country. Furthermore, the proportion of firms' innovative activities performed domestically *increases* with the technology intensity of the industry (see Patel & Pavitt 1998).

However, even Patel & Pavitt (1998) acknowledge that NSIs are coming under increasing strain, and predict that NSIs will increasingly involve linkages between the local science base and foreign firms. A policy recommendation in a recent OECD study embodies this predicted trend (Welfens *et al.* 1998). In this study the authors argue that EU Member States should adopt a more active role in R&D as an intermediary between companies, scientific communities, consumers, employers and trades unions. Furthermore, these authors argue that the state's role as intermediary should include encouraging transnational cooperation. This, of course, raises the question of whether a hybrid network such as this, comprising national & foreign actors, can properly be described as a *national* system of innovation?

An important consideration in the context of the research by Patel (1995) and Patel & Vega (1998) is that it was based on a study of the world's largest, technologicall active companies. However, as was stated in section 3.2 of this report, some academics argue that new product strategy is inevitably a networking strategy (Ford & Thomas (1997), and that technological innovation is now best understood through a focus on networks rather than on a single enterprise unit (Tidd (1997). Moreover, multinational companies are not the only players in globalisation and innovation; small and medium enterprises (SMEs) also play a role.

The NSI in Germany

This and the following two sections comprise a brief overview of NSIs in the three countries participating in the BICON project. They are based on the review by Koch (1999). Germany has a rather strong industrial base, as indicated by huge export surpluses, particularly in recent years. The largest and most successful industries are automobiles, mechanical engineering, electrical goods and chemicals. All in all, the Germany economy can be characterised as innovative. One example is the automobile industry where, in 1997, R&D expenditure accounted for 24% of the R&D expenditure of all German industry. Since 1990, there has been 66% growth in R&D expenditure in this industry. In terms of international patenting activity in the car industry, the German car industry leads overall followed by Japan. In Germany, only 8.4% of industrial R&D expenditure is financed by the state.

Among European countries, Germany was a latecomer in economic terms. It was a feature of its early development that 'Germany' was a collection of politically independent, smaller and bigger states, each trying to develop its economy. One outcome of this was that economic development was rather similar in different regions. Thus, today, there are many industrial regions in Germany. Another characteristic is that in the relatively small regional markets there was room for handicraft production and small scale production. This is one reason why 'Facharbeit' (skilled work) is now such an integral part of the 'German model'. It is also the reason for the co-existence of big enterprises and rather innovative and strong SMEs in German

industry today. Another feature of the German system which facilitates innovation is the relatively high consensus between employees and employers.

Another important factor in Germany's economic development is an education system consisting of different levels of education including the vocational training system ('Berufsbildungssystem'). This education system gave opportunities for workers to make a transition to engineering degrees. In 1991 63% of all engineers having a degree from a 'Fachhochschule' are former 'Facharbeiter', and 34% of the engineers with a university degree are former 'Facharbeiter'. Thus, from an early stage of development, there have been close links between industry and the education system, so that the position of engineers and 'Facharbeitern' in society in Germany today is rather strong. All this results in the following 'stylised' strengths and weaknesses of the German system:

- A sophisticated and effective education system offering many possibilities for employees to make careers during their working life;
- The intensive co-operation of 'Farcharbeitern' and engineers is the reason that the products of German industry are both on a high technological level but also easy to use. (The 'Facharbeiter' bring 'practical knowledge' to the innovation process.);
- The strong position of these two types of work is the reason for the high ability to innovate; they are the basis for R&D;
- The weakness is that products of German industry are often 'over-engineered' and therefore too expensive to be competitive.

The NSI in the UK

The UK has experienced a long period of industrial decline (Wiener 1991; Grint 1995) since its relatively early industrial development, although it still retains considerable strengths in chemical, engineering, biotechnology and computer software. Nowadays the distribution of the workforce is mainly characterised by employment in large companies (about 33.8% are employed in companies with more than 500 employees (Abligreen *et al*. 1996)). Self-employed count for 27.1%, while family capitalism within SMEs prevails. However, the financial market is strong within a state *laissez faire* policy (Harvey 1990).

The national context of innovation is a reflection of both cultural values and historical relationships between institutions involved in innovation (Ettlinger 1994). The UK system is characterised by a lack of 'collective integration' with respect to fragmentation between scientific institutions, industrial R&D, product development and financial backing. A decline in support for strategic research areas has been identified, which may be linked to factors such as a decreasing national investment in R&D, and a general failure of industry to invest in the general development of a skilled workforce (Walker 1993). 14.8% of industrial R&D expenditure is financed by the State. One of the key characteristics of the UK NSI is its relatively low expenditure on basic research combined with an unusually high public expenditure on defence R&D. Indeed, among Western nations it is surpassed in this respect only by the USA (Walker 1993). In addition, there appears to be a decline in the importance of localised, regional linkages (Curran & Blackburn 1994). On the other hand, UK firms have developed international partnerships and, with respect to European-funded schemes, the UK has an extremely large involvement in collaborative projects (PREST/SPRU 1992). In particular, there is a very high participation by higher education institutes in such European projects, which may reflect structural differences in the location of research in the UK and also the more recent pressure to look for non-governmental sources of funding.

The NSI in Denmark

Measured in gross economic figures, Denmark is one of the most successful countries in Europe. However, this coexists with around 1 million immigrant people living on various levels of social welfare. The most important development block within the Danish economy is the agro-industrial complex (Lundvall in Nelson 1992). Other major sectors are construction, dairy equipment and electronics. Some sectors in Denmark, like the software sector, are almost entirely dominated by foreign companies. A significant success story in recent years has been the wind-turbine industry, which arose from the social movement for alternative energy, and is now a multinational sector with around 2000 employees (Jorgensen *et al*. 1995).

The main characteristic of firm size is the absence of large companies (only 19.7% are employed in companies with more than 500 employees (Abilgreen *et al.* 1996)). 34.8% of employees work in firms with less than 100 employees. Singular ownership and family capitalism within SMEs are widespread. R&D spending in Denmark is relatively low (Nelson 1992), and low-tech sectors actually have a significant success (Froslev Christensen 1994). Furthermore, the national institutional support system and government subsidies generally play a peripheral role (Froslev Christensen 1994). Only 3.6% of industrial R&D expenditure is financed by the State. There are exceptions, like the small firm network programme (DTI) and the occupational training system of labour market education centre (AMU-centres). A number of former medium size niche producers have been taken over by foreign capital in the machine tool industry, in IT and in manufacturing (Lundvall in Nelson 1992). The financial markets are relatively liberally regulated. A relatively strong diffusion of high trust industrial relations enables small and medium size enterprise to mobilise factory workers as part of the innovation process. Career patterns within the industry are supposedly similar to Germany, although empirical studies of this are yet to be conducted.

3.2. Methodology

Introduction

The methodology adopted by the BICON project played a number of roles. In particular, adoption of a common, core approach to constructing the case studies from interviews attempted to ensure that the data collected in the three countries would be cross comparable in terms of the network processes studies. Equally important, in terms of method, was development of the commonly agreed, BICON theoretical approach and analytical methodology. These two issues were discussed and developed during the three country meetings, which took place at regular intervals throughout the duration of the project. These meetings served as on-going fora to collectively discuss and evaluate interpretation of the data that was being collected separately. This enabled a close focus in terms of analytical approach to be maintained on the development and on-going interpretation of case study material as it was being collected.

Inter-country Team Meetings

In total there were six inter-country meetings of the three teams, two took place in each country. The meetings lasted two days on average, and were organised as workshop sessions. An initial session, attended by everybody was used as a feedback session to report on updates to the progress of the case study interviews. The sessions then tended to be split into small group meetings to discuss and develop an on-going, interactive approach to the interpretation of networks processes that were being identified. The meetings then ended with a general feedback session to the whole group. In addition, these sessions were used as an opportunity to initiate comparative discussions of the case studies, which developed into two collaborative, inter-country conference papers, presented during the duration of the project.

Case Studies and Interviews

In terms of research methods the collection of data was to be primarily via semi-structured interviews. Although all interviews would follow an agreed structure, focusing on common themes related to the research objectives, researchers in each country would be responsible for developing a questionnaire suitable for use with domestic firms. Each team also had the opportunity to develop and pursue particular lines of enquiry which appeared applicable to a particular case. In terms of selection of the case studies, the original aim was to pursue one major, long term instance of network building for new product development and two much shorter, 'snap shot' cases. In the primary case study a series of longitudinal interview programmes with both internal and external actors involved in relevant networks were envisaged, throughout the two year lifetime of the project. This would result in between 30-40 interviews with relevant personnel at a number of levels in the firms involved as well as interviews with actors 'outside' the network used to corroborate views of actors within the network. In the two shorter case studies, two sets of visits were to be undertaken, at the beginning and towards the end of the project, comprising between 15-20 visits.

The project methodology was centred on a case study approach built up via semi-structured interviews with as many network actors as possible. In fact, it turned out that, in all three countries, two case studies were developed, both of which had a longitudinal element, rather than one long and two shorter cases. In fact, the minor case study in all three countries developed into a more substantial case, which was followed over the duration of the project. The issue of the validity of inter-country comparisons was included in the original proposal, with a stipulation that comparable cases should be selected in all three countries and the same methodology should be used by the three teams.

Problems Faced

In fact one of the first inter-country problems identified is on the question of methods. It transpired that there were country (or institutional) differences in the development and progress of semi-structured interview techniques. Whereas in the UK we were interviews, rarely lasting more than an hour, open ended discussions with a general check list of areas to cover but no detailed questionnaire, but covering as many relevant people in the organisation as possible. The Danish team had spent a few months developing an extensive questionnaire with detailed questions which, on average, took two hours to administer and demanded more formal access to the firm and a greater commitment to the interview situation. This also meant a less responsive structure which made it difficult to enter informal discussions. The German team also had a shorter series of questions which they were obliged to send to the firm before the visit for answers to be prepared in advance.

There are a number of problematic areas when considering the possibility of a three country BICON comparison. Other inter-country research has tried to hold something constant between the countries involved such as the sector being investigated, the technology or organisation, but we have none of these more obvious points of contact. Furthermore, we have wide variations on an interpretation of the term 'product development', except in a very diffuse and general sense, we also have three levels of analysis, micro, meso, meta and seven analytical perspectives.

Outcomes, resolutions and the BICON approach to network processes

Within the BICON project it was acknowledged that there are limitations to the process of collecting interview data on networks in organisations, which present problems in interpretation and cross country comparisons. These problems, however, are present in all case study based projects on networks. Therefore the three team meeting sessions were devoted to the problem of developing a complex analysis of network processes that would allow comparison of networks across different sectors and countries as well as across different phases of the development

process. This common approach was achieved by focussing on the micro-political processes at work (the theoretical underpinning to this approach is discussed further in the theoretical section).

In terms of analytical methodology, a number of themes were drawn out which formed that basis of the cross case comparison of these micro-political processes at work in the BICON case study networks. Although these are discussed in greater detail in the section on thematic overview, they are presented here in brief. the major comparative theme of power process applied to each case encouraged identification of the enrolment activities in the network and the forces shaping its development. Trust, communication and contract focuses on the formal and informal means of communication and responsibility throughout the network, while knowledge learning and expertise identifies processes of adaptation of the network to changing internal conditions and external environment. Analysis of the role of the artefact in the innovation network identifies the dynamic processes which both influence the social factors which shape and direct the technology and the network changes which result from this shaping. Finally identification of the context in which the networks are formed and the apparent paradoxes found in adopting network forms of organisation demonstrate the contingent nature of the networks studies. This analytical approach has been applied to all six BICON case study networks.

3.3 Case Studies

Details of the six cases are presented below. Schematic diagrams of the networks in each case are attached in Annex 7.3

3.3.1: UK Case Study One: New Product Development in Defence Industry

Introduction

This case centres on two firms working in the defence industry which have been engaged in a technological collaboration since 1985. The project concerns development of a sonobuoy receiver technology, which is designed to become a component in a state-of-the-art, integrated military tracking and communications system. There are two firms involved, one situated in the UK (referred to here as HCo and itself part of a larger group to be called BigHCo), the other in the USA (termed FCo in the text). HCo, one of 12 firms in the group, was founded in 1920 and is now well established in the UK defence electronics market. BigHCo is based mainly in Southern England and the USA, employs 1800 people in total, while in 1997, Group turnover was £143 million, and net profit was £18 million. With regard to networking, it is HCo in particular that has developed a strategy of networking and collaboration with other firms over new product development (see Harris et al, 1999 for a discussion). In contrast, FCo is a much smaller, innovative 'high tech' firm which has faced ongoing problems both with funding and technical staffing problems, resulting in a reputation for poor delivery and deadline slippage.

The finance for their joint receiver project has been solely provided through government defence contracts, and both the UK Ministry of Defence (MoD) and the US Department of Defence (DoD) have been involved at different times. One outcome of this funding structure is the element of competition involved in winning the finance for such projects, which means that collaborative ventures between firms require a large amount of pre-funding collaboration in order to develop the bid. Such arrangements also demand considerable investment in time involved in early development, thus generating a long-term commitment to the partnership, involving both a tight formal contract and an element of informal goodwill during the project. In addition, the product development itself becomes a highly specified process in terms of time, funding and outputs, and there is a typical concern, especially in the UK, that specified

deadlines are met to avoid losing a trusted reputation with the MoD by failing to deliver the contracted technology to time and budget.

The new product development network reported on in this case study is composed of representatives of different functions in the two firms. This does not stay constant over time but both the departmental and individual role in the network changes over time. High level decision making involves senior managers from both firms, while the two contract teams work closely together over time to put together acceptable project bids. In the execution of the project, the engineers in both firms have tasks to fulfil with respect to the specific development which involves a certain amount of knowledge transfer and demands a level of co-operation and trust. Over time catastrophic changes to the network form of development have resulted in major changes to the technological outcomes, most notably the takeover of FCo by BigHCo. It will be maintained that the network building processes are still influencing a successful outcome and that the joint technological development in the inter-firm network form of organisation is constantly under threat from the organisational situation in both participating firms.

Background

The initial collaboration between HCo and FCo was an early example of the commitment of HCo to a partnering strategy in practice -and is one of the longest running on-going collaborative projects in which the two firms are involved. Senior managers at HCo initially approached the US firm with a proposal for collaboration. A major part of the development work undertaken at FCo work at the time was concerned with sonobuoy receivers, which they were producing for the US Navy. HCo was keen to utilise this expertise to reduce their costs in developing a variant of the product for the Ministry of Defence in the UK . As a US company, FCo would not have been allowed to bid for participation in a contract without a suitable UK partner, so initially a management team was sent to FCo to assess the facilities and production quality standards, and was sufficiently impressed to offer a licence fee in exchange for the technical information and specialist assistance required for them to develop the product in the UK.

HCo had experience in supplying avionics equipment for helicopters and knowledge of the UK Defence Market that was instrumental in the partnership winning the contract despite strong competition from other major industry players. The two firms negotiated a manufacturing licensing agreement to cover limitations on territory as well as sort out the 'work share' arrangements. By teaming with FCo, HCo was able to reduce its own product development costs, and the arrangement gave UK market access to a small US firm, so managers from both sides expected mutual benefits to accrue from this partnering arrangement from this early stage.

HCo/FCo partnership - the early years

A good working relationship developed in the early stages, and HCo was able to spread its costs further by delivering similar products under other contracts alongside the work with FCo. However, differences in business practices in the US and the UK caused some difficulties in day-to-day dealings between the two firms. There were also personality clashes between individuals in the two firms, and effective working relationships that did build up often lacked continuity due to periodic changes in responsibility and staff turnover. Organisationally, it transpired that FCo was poorly run and had a bad record in meeting deadlines and delivering on promises made, as well as working to tight financial limits. Technically, HCo was initially very reliant on FCo for its technology and expertise.

These operational difficulties led to increasing friction and acrimony between the two firms, because HCo would have incurred the wrath of the ultimate customer if there were to be late deliveries or technical problems with the product. One of the major operational problems from

the point of view of HCo was that the US firm seemed to have a different attitude to deadlines, and tended to stop work when the budget was spent, due to their financial stringencies which meant they could not over run their budget, rather than rushing to provide the specifications that were expected in the contract. This caused problems for HCo whose engineers spent a considerable time in further developing the technology to the specifications that had been promised in the detailed and highly specified contract that had been awarded by the MoD.

A major problem emerged when FCo, which appeared to be suffering from its internal organisational and financial difficulties, was subsequently taken over by another US firm and a new management team was put in place. A major change of personnel involved the installation of a hawkish new Chief Executive Officer, who opposed the collaboration with HCo, a firm he considered a potential competitor, and one of his first acts was to replace the marketing officer who had initiated the initial collaborative agreement with HCo. In addition, and possibly in protest a number of key employees left the firm including some of the engineers involved in development the receiver technology.

Meanwhile, FCo's contract to supply the receiver in the US (the design of which was the basis of the joint MoD project which was ongoing at the time) was re-tendered by the US Department of Defence (DoD) for which a 'second source' of supply was required to ensure continuity. Thinking that this was just a contingency plan, FCo managers suggested that HCo should bid for this as they preferred the idea of sharing the business with a firm that was a known quantity. After devoting considerable time and resources to this bid, both companies lost out because the volume of sonobuoys required by the US government was cut following the end of the Cold War, and the new US contract terms were changed from 'first/second source' to 'winner takes all'. HCo and FCo ended up competing head to head for the business. Interviewees from FCo recalled being surprised because they had expected HCo to pull out rather than take up a competitive position against them, but HCo was annoyed at the new administration which had reneged on an existing royalties agreement, and was determined not to be seen to give in easily, as one of the contract negotiating team commented that for HCo, not to fulfill an agreement was considered ‘the kiss of death’ .

FCo won this business (mainly, HCo suspected, because it was a US company) but internal management problems contributed to an over-commitment of resources and consequently the firm's already precarious financial problems worsened. As a result of this experience, the now fragile relationship between FCo and HCo broke down completely, with HCo quite sure that its own rival bid had hurt the other financially and contributed to the developing internal problems of the other firm. This bid had also encouraged HCo an opportunity to put more resources into its own internal technological developments and the result of the effort to rival the erstwhile partner had gone some way to make up the technical ground that existed between the two firms. It also, however, illustrated to HCo the vast level of investment in terms of costs and technical resources that would be needed to continue development on its own version of the receiver. Nevertheless, potentially two rival versions of the technology were now a distinct possibility. Interviewees from HCo recalled an atmosphere of increasing frustration at the unreliability of FCo and the damage caused by competing with them on the second source contract was regarded as the final straw, even though, some parts of the complex network were still functioning cordially, for example, at this time a member of the Contracts Department at HCo found his counterparts at FCo to be continually ‘very helpful, with no problems getting access to information . FCo, however, was preoccupied with internal problems and a management buyout ensued in 1989.

Up to this point in the partnership, different relationships can be identified between different groups. In the UK the engineers, who started out as minor players with little understanding of the technology now emerge as a strong backup group should the US technical department fail. Changes in the network at senior management level at FCo had seriously undermined HCo's confidence both in the organisation and management of the US firm and in its commitment to the collaborative arrangement. However, the contract negotiation teams on both sides remained on friendly terms throughout the whole episode, and one UK team member reminisced that,

"at the working level we always had good relationships, even when this meant going against senior management, when FCo employees were told to withhold information from us. Informal communications went on, chatting, getting things through the back door" .

Second Time Around

By the early 1990s, FCo had started to develop a new generation of its receiver technology, and HCo was keen to gain access to the new development which they felt was considerably in advance of any comparable technology in the world and would be essential in bidding for another proposed project with the MoD. However HCo's senior managers were worried about the headstrong nature of the CEO at FCo whose management style was perceived to be, "uncontrollable, he never won our confidence", and also, "a hard negotiator who knew all the dirty tricks". The main concern was whether a new collaboration with the firm would endure so that HCo would be able to fulfill its own contractual obligations. In particular, HCo felt that if future collaborations between the two companies were to work, the scenario of both firms competing in the same markets for other business would have to be avoided. The damage caused by the breakdown of trust between the firms was considerable, and hence HCo was very cautious when entering into partnership negotiations again in 1996/7, so much so that the contract team were sent on a course to develop their negotiating skills before being sent to FCo.

FCo was perceived as technically excellent, but organisationally poor, financially weak, and habitually late in delivering on deadlines. Consequently a new partnership was regarded as a major risk but if the US firm reneged on the latest agreement, yet HCo felt it would be in a stronger position than in the 1980s when it did not have the expertise to cope with the development by themselves. It was clear that resurrecting the alliance was a 'necessary evil' and therefore contingencies would have to be built into the relationship to allow for expected delays and missed deadlines on the part of FCo. However, despite the expectations that a mutually acceptable agreement between the firms would not be possible, negotiations turned out to be less acrimonious than expected and an memorandum of understanding addressing a 'Teaming Arrangement' for a major UK MoD project was signed. HCo was able to bail FCo out of severe financial difficulties by paying a $1 million licence fee for the rights over another FCo technology. The partnership was awarded the contract to supply the UK MoD in February 1997.

Takeover and the Management Implications of the Ownership Change

The renewed collaboration was taken a stage further a few months later when the BigHCo took over FCo. According to HCo, the idea of purchasing the US firm stemmed from the perceived need to control what were described as 'loose cannons' within its management structure. Some of these individuals had contributed to both the earlier breakdown of the relationship and the company's financial problems. Interviewees from FCo claimed that their senior management had approached HCo at the Farnborough Air Show seeking a 'white knight' because the financial position had become so grave that the company may well have otherwise gone into receivership. HCo would also have then lost its newly resurrected US partner and the lucrative MoD contract would have been placed in jeopardy. The relationship would also have been doomed if FCo had been taken over by another firm with its own teaming arrangements to service. The $13 million

deal was concluded in May 1997 and FCo now operates as an BigHCo subsidiary. A condition of the deal was that the unpopular CEO, deemed responsible for the firm's unfavourable market reputation and financial plight, would leave FCo.

The feeling at HCo is that FCo was relieved at the purchase because the alternative could have meant receivership, and that the staff hoped that HCo would resolve the firm's financial problems. Conversations with FCo staff confirmed this to be the case. FCo management now report through HCo to the Managing Director of BigHCo as a control device to ensure transparency of dealings. HCo can therefore *'hold their feet to the fire'* in the event of any trouble making, although many of the individuals held responsible for the poor relationship in the 1980s are no longer employed by FCo. A number of outsiders have also been recruited with no experience of the chequered history. As a further control mechanism, HCo also has one of its own senior managers permanently based at the US firm's offices. However, his influence on the firm's activities is restricted due to the enforcement of a special security agreement (SSA) by the US government because of FCo's access to classified material. This tightly regulates the contact between FCo and HCo personnel, causing considerable operational difficulties at all levels. Hence despite its ownership of FCo, HCo has only very limited knowledge of the nature of its business with other US firms (just 40% of FCo's business is currently confined to HCo).

Cultural Gaps

FCo interviewees openly acknowledged that their firm had tended to act in an impulsive and undisciplined way in the past. Each one acknowledged that the arrival of HCo had brought much-needed stability and organisation to a hitherto chaotic working environment. The unpopular CEO had a distinctly operational perspective, and the firm had acquired a reputation for selling as much as possible with little regard for quality, customer service or future planning. HCo has now brought in a sense of commitment and customer focus that had been lacking in the past. HCo has a conservative attitude to risk and costs are carefully controlled through minute attention to detail. This policy is greatly admired in FCo, and interviewees all claimed that the atmosphere in the firm was now less frantic and it was a much more friendly place to work. Several key staff who had left the firm in frustration with the idiosyncratic CEO and the consequent low morale had now rejoined and could not believe the transformation.

HCo has a very traditional and paternalistic culture, with a hierarchical management structure that accords respect to length of service and educational achievement. Many of the management team (all male) have higher degrees, and historical trappings of power such as secretarial support (all female) and the quality of the allocated car parking space are jealously guarded. One FCo interviewee was impressed by the efficiency and evident success of the UK operation, but he claimed that he always *'had to be on my best behaviour'* when visiting the UK. In contrast, FCo is more informal, with everyone on first name terms and an 'open door' policy extending right to the top of the organisation.

Another illustration of the cultural gap concerns the differing work patterns in the two firms. FCo staff are impressed when they phone the UK in the afternoon and people are still at work there, late into the night. Some HCo perceive FCo staff to be idle because they would phone at 6pm and no one would be there. An undercurrent of resentment was evident in some of the more junior HCo employees, that FCo staff have a 'better deal' and go home early leaving HCo to sort out their mistakes. After visiting both firms, it is apparent that FCo staff start very early and work through without a break, whereas HCo staff start later in the day, have a long lunch break, and then stay on later in the evening. If there was a greater exchange of staff between the UK and the USA, misconceptions such as this could be overcome.

The strategy of sending a senior manager out from the UK for a two year period to manage the relationship helped to smooth over the cultural differences between the firms. The idea was that FCo would then be equipped to operate on its own as an HCo subsidiary after this trial period. Several FCo interviewees noted the advantage of having the Atlantic Ocean as a *'buffer'*. Despite admiring the business skills of their new bosses, they were glad that geography allowed them a certain level of discretion in their every day operations.

Operational Implications

The senior management team at HCo consider it to be more difficult to manage the relationship now than before FCo was purchased. There appears to be a degree of resentment at HCo about the practical implications of the takeover. Some staff commented that FCo's emphasis upon speed of production to enhance short term cash flow compromised the ultimate quality of the product, which might then require further modification at a later date. As described in the previous section which examined cultural gaps between the two firms, interviewees noted that there was still a tendency to blame the US firm for problems that occurred, and a lot of time was wasted in complaining rather than trying to deal with the operational problems more constructively. Relationship building with FCo counterparts was left to individuals' personal inclination and initiative rather than actively managed.

There appeared to be a recognition within HCo that FCo employees might well perceive the takeover as a personal threat and be suspicious of collaborating with HCo staff. Consequently many HCo staff appeared sympathetic and willing to tolerate teething problems while allowing time for bridges to be built and a degree of trust established. One interviewee felt that this factor could explain why FCo was reluctant to hand over technical information and only supplied the minimum that was necessary. Some HCo employees reported that they had established a good working relationship with their counterparts, and they also noted how the time difference between the US and UK helps in turning queries around quickly and hence improving productivity.

The position at July 1999 was that development for the MoD is well underway and the relationship between FCo and HCo is improving at the operational level. The passage of time means that fewer staff are aware of the chequered history of the relationship and many of the main protagonists are no longer involved. Conflict between the firms is now internalised following the purchase of FCo, and its continuance can only be detrimental to the performance of the Group as a whole. It appears that FCo is well on the way to being absorbed into BigHCo, and its staff have job security and a constructive working environment for the first time in many years.

Despite a 'gentlemen's agreement' that HCo is responsible for marketing in Europe, while FCo deals with the USA, in practice there is fierce competition between the two individuals involved to win business anywhere in the world. As the lowest bidder is likely to secure the business, it follows that a coup for the UK will result in development and production opportunities for his site at the expense of the other. Relations between contract teams, however, is as cordial as ever, with interactions via frequent visits, telephone and e-mail. There still appears to be no problem of access to information, and informal relationships are quite reciprocal, as one UK contracts manager commented, "if I want information on anything to do with the US I talk to their contracts manager - he s a great guy". Another member of this team also noted the persistent success of the relationships in terms of informal interactions,

"Long-term relationships depend on continuing good relations and trust. If this is not there, business relationships seem to deteriorate. We can fall out over business but still go out for a drink together".

Discussion of Changing Relationships Within the Technology Network

The inter-firm relationships which function at this level could not be in greater contrast to the relations between the two engineering sites. From the experience dating back to the early part of the collaboration an uneasy technical relationship developed, with HCo soon to realise that it could not totally depend on FCo to fulfill its share of the engineering tasks to the required specifications, on time or to budget, causing one manager to conclude that FCo were 'habitually late' at meeting deadlines, something that was put down to tight financial restrictions under which they were operating and a tendency to specify contracts that were 'technically impossible' to meet. Over time, this situation resulted in a development of the internal expertise at HCo which, as documented above, resulted in a fully functioning competitive design of the receiver technology which became the basis of the rival bid to the US Department of Defence which HCo appears to have lost primarily on grounds of nationality. However, despite a search of available options, HCo concluded that FCo technology was superior to anything else available, and despite all the organisational problems the consensus at HCo is that, "technically they are excellent".

At the operational level, the HCo employees have seen the earlier customer/supplier relationship change to something more collegiate where all the staff ultimately work for the same boss. The engineers' task is to ensure that the parts of the product supplied by FCo interface with their own so that the combined kit can be passed onto the customer in a saleable condition. Staff from both firms acknowledged that synergies were developing as a result of the two sets of engineers working closely together. In particular, HCo has a greater expertise in mathematics, and FCo has superior circuit designers. It is widely recognised that HCo is better at concepts, while FCo is more skilled in the operational detail.

From the point of view of FCo, despite the well documented vulnerabilities of small firms with respect to collaboration and the dangers of take over, this solution appears to have brought much appreciated organisational benefits and saved them from an inappropriate takeover by another non defence firm. HCo has not attempted to interfere in the day to day business of FCo, but some interviewees from FCo admitted that they tend to be more casual about deadlines now that HCo is no longer a customer, and therefore give priority to other, more pressing projects. HCo interviewees noted that it was difficult to ascertain what progress FCo is making because it appears to be cagey about sharing information about the extent of other commitments.

The FCo engineers complained that they had no specific 'road map' to work to on the UK contract now that they were part of the HCo group rather than an independent supplier. They claimed that the lack of clear guidelines sometimes led to operational difficulties, but at the same time they were glad that HCo was too far away to interfere too much in their day to day activities. They also realised that the firm could benefit financially from the new ownership structure. This is because it is now in HCo's interest to pay FCo promptly for work done, thereby improving the US firm's financial position. FCo is therefore in an unusual position (unique within the HCo group) because it is effectively reporting to its biggest customer. While HCo wants FCo to be profitable, hence remaining a secure source of supply and justifying the decision to purchase, at the same time it wants to minimise the cost of the product at the UK end. Whilst acknowledging the greater rigour that the HCo approach has brought to their operations, some interviewees were resentful of the degree of interest HCo showed in the detail of their business. In the words of one FCo engineer,

> "I wish we could just say 'trust us, we are the experts'. But they always make us feel that we have got something to prove, and cannot be trusted. I guess that goes back a long way though."

This plea for a recognition of specific expertise located at the FCo site, together with the existence of the SSA, which has an effect of controlling the exchange of technical knowledge has the effect which the UK engineers feel is promoting a culture of secrecy and competition between the two technical sites. One HCo engineer who visited FCo for training purposes was escorted at all times and not allowed to use the computers. In his view, the treatment he received was indicative of distrust and resentment on the part of FCo, and discussion of the issue with his colleagues on returning to the UK added to the antagonism between the two sites. They appear to be suspicious of the reluctance to share information and feel that confidentiality is used as an excuse to keep them out of the development stage, asserting that FCo engineers are secretive, competitive and protecting themselves by keeping as much work as possible and 'still seem to think that it's a case of different companies after the same business . This should be taken in conjunction with the stated antagonism of the UK management to funding engineering 'idle time which leaves the technical staff anxious to prove they are busy, and a question over the priority put on the UK technical skills. Not only was the UK engineering division rejected as the site for future development of the receiver, the division of development tasks has left the UK site with the role of testing the final development, but the decision to fund the final test rig was delayed while the management made a decision about where to manufacture the final product, in the UK or USA. The UK engineers are worried about deadline slippage and feel that they are underutilised in terms of becoming involved in troubleshooting;

"There is a lack of adequate technical exchange which is slowing the project up. We would like to be more involved in getting the new design to work, we expected the US team to open up and share problems but this hasn't t happened".

The original arrangement when the relationship between the firms was restored was that production for US contracts would take place in the USA, and UK contracts would be produced in the UK. However, FCo has recently been charged with product development for the UK MoD contract because it has spare capacity. This decision was taken after a protracted delay and caused considerable ill feeling and fears over job security at HCo. In particular they fear the slippage of deadlines which affects the time available for the final testing stage, for which the HCo team have to plan and build the required facilities, and would like to incorporate a range of features that, while not necessarily standard, experience has shown will be necessary. Part of the problem might actually be put down to a difference in technical cultures as one example was given of the HCo interpretation of the term 'test results' was a sheet of numbers summarising specific test findings with ticks to indicate where the required standards had been met. The US interpretation of the same term was merely the verbal expression 'it passed' - with no supporting documentation. There is also a difference in regard to testing which in the UK is more extensive and linked to future production problems with an attempt to iron out any potential problems at an early stage. In the US testing is regarded as part of engineering and completed before production is involved. This means that HCo testing is a more elaborate affair, facing more problems as they try and meet specifications from other involved groups, while the US would expect the engineers to write their own specifications. These unresolved divisions between the two engineering sites has left this section of the inter-firm network dissatisfied with the level and type of communication, and the HCo engineers, at least, believe, "If we had not bought FCo everything would have been cut and dried in terms

of responsibilities - now it s all blurred".

Summary

The dynamic of this network is twofold. On the one hand, FCo has a particular technology and technological know-how that HCo prefers to outsource rather than develop in-house. On the other hand, FCo is in constant need of financial and other forms of security that HCo is in a position to provide in return for access to FCo's technology.

The context for this network is the military-industrial complex that, through procurement contracts, provides a market for both HCo and FCo. However, the way in which each company operates within this context is different. FCo is a specialist in military technology and seeks military contracts that will enable it to develop and sell its specialised technology. HCo, on the other hand, specialises in getting military contracts. Rather than learning the knowledge to develop the technologies in-house, HCo's strategy is to outsource the technology through collaborative networking. Indeed, it worth noting that at a key moment, HCo chose to develop network knowledge for continued collaboration, rather than learn technological knowledge.

The network is characterised by a series of arrangements whereby financial and other types of support are transferred from HCo to FCo, in return for which technology is transferred from FCo to HCo. The collaboration between HCo and FCo is synergistic: the network they construct seems greater that the sum of its parts. The network is able to acquire more military contracts than HCo and FCo, operating independently of each other, could acquire without it. However, although it seems to be synergistic, the network is not symmetrical. For FCo, collaborating with HCo seems to be a financial necessity: but for financial necessity, FCo would perhaps prefer to exploit its technological monopoly alone. For HCo, by contrast, collaboration is a deliberate strategy. It could not undertake military contracts without collaboration. Its strategy is to obtain military contracts through collaboration with specialised technology providers like FCo.

Paradoxically, however, this particular network is more critical to FCo's survival than to HCo's. Without the network, FCo may well have gone into liquidation. This is almost certainly not the case for HCo. Whilst HCo undoubtedly values the network, as witnessed by its flexibility in adapting to facilitate its continuation, the network with FCo is just one of a portfolio of networks which HCo cultivates.

Whilst the acquisition of military contracts is the context for the network, other contracts, between HCo and FCo, are significant parts of the *modus operandi* of the network. These other contracts attempt to manage one of consequences of the key dynamic of this network, namely, the tension between cooperation over the exchange of finance and technology, and competition for contracts. Technology licensing agreements and manufacturing licensing agreements seem successfully to manage some elements of cooperation and competition. However, work share agreements seem to be a constant source of conflict between the engineering departments of HCo and FCo. In particular, HCo engineers are dissatisfied with the quality of the product that FCo engineers deliver.

It is worth considering the strategic position of the engineers in the network. It is HCo engineers, rather than FCo engineers, who are dissatisfied with the various work share agreements, and one can see why. The enrolment of FCo's engineers rather than strengthening its own engineering department is a deliberate strategy on the part of HCo Management. It seems to be part of HCo's strategy to maintain a division of labour between the two engineering departments, with FCo engineers as specialists in a particular technology and HCo engineers as specialists in understanding the stringent requirements of military contracts. From a managerial perspective, this division of labour not only makes HCo a 'lean' organisation, it also provides HCo with an effective in-house monitoring system for checking the quality of the technology provided from FCo through outsourcing. This division creates a structural antagonism between HCo and FCo engineers which serves to ensure that it is in HCo's engineers' interests to identify any failings and shortcomings in the technology produced by FCo that they subsequently have to rectify.

3.3.2: UK Case Study Two: NPD in Software Business Solutions

Introduction

This short case study describes the networking activities of a information technology firm involved in developing dedicated business software solutions for client firms. The development of information systems solutions to business problems raises fundamental questions about the management, organisation and control of inter-firm project teams, as well as the organisation of the technical work. This IT firm (referred to in the text as ABC) is, therefore, a fruitful case study, drawing on its networking experiences both externally with new clients and internally with a progressive structure designed to facilitate inter-company collaboration and communication. In addition, the main focus of this case is on a specific example of a network-based project with a client in the UK utilities industry (termed XYZ in the text). The ABC/XYZ network consists both of people in the two firms who came together in a novel 'hybrid' form of organization and of a number of organizations that were brought together to manage the collaboration.

Networking strategy of ABC

When it was founded in 1988, *ABC* was a young, dynamic and entrepreneurial company with something of a 'frontier ' ethos. Its core business is information technology systems integration, applications development, outsourcing and 'business transformation' through the application of state-of-the-art IT systems to improve business processes in client organizations. ABC's rapid growth has been built around the establishment of partnerships with key clients in a number of industry sectors, characterized by rapid or radical changes of various types requiring organizations operating within these sectors to fundamentally rethink business operations and processes. ABC selects new staff for their attitudes to innovation and risk taking, and new staff undergo an 'orientation' training course to introduce them to the particular structure and culture which allows ABC to establish teams which match the client hierarchy.

ABC maintains a lean administration and keeps few permanent staff. Legal staff are involved in developing new business opportunities and contracts, while other important functions are financial, marketing and technical. Specialist staff are also employed in several countries to work on different aspects of the projects. The internal culture is felt to be very client focussed, the firm has a relatively flat structure and seeks to challenge conventional thinking on internal organisation. The highly competitive and volatile internal environment is organised to deliver flexibility and adaptability in partnering situations, the aim is always to attract and employ the key existing IT staff within the client firms. The objective is to maintain a motivated staff who can cross boundaries easily which makes high demands on employees in terms of their personal networking skills.

External Network Building Activities

ABC's aim is to achieve change through establishing inter-organisational networks. The key to ABC's networking strategy is the acquisition of key knowledge and personnel. Several internal teams are set up with ABC to facilitate both the drawing up of contracts and the management of the inter-organisational relationship. Putting people into the client organisation before contract is called 'body shopping', and is a means of assessing expertise within the client and initiating a trouble shooting process. The contract is 'the seal on the deal' that in practice has already been agreed. In protracted negotiations, trust may be quite low as the differing positions and objectives of the two sides become clear. The negotiating team likes to work independent of ABC management or the trouble shooting team on the ground. When a contract agreement was imminent the 'change management' team becomes involved, working independently of the financial/legal and technical teams to negotiate and agree a formal collaboration agreement. The change management team has the responsibility to set up communication and trust building links

with potential new client staff, identify core skills and persuading core staff to transfer. Considerable effort is put into building the relationship with the client at a number of different levels, technical, inter-personal and inter-organisational in order to maintain relationships and to demonstrate the value of linking up with ABC. Communication appears to be a key aspect of this, particularly via face-to-face meetings.

An example of external networking in the UK Electricity Industry

The early 1990s saw the privatization of the UK's electricity industry with the aim of achieving complete de-regulation of the industry by 1998. This complex and innovative process involved the break up of the previous monopoly for the generation of electricity and its distribution between two privatized companies ('National Power' and 'PowerGen') and the allocation of responsibility for the transmission of electricity to a third company jointly owned by 12 regional companies. The latter mirrored existing regional electricity boards and were given regional franchises to continue the distribution of electricity to particular geographic areas. It was intended that the two new generating companies would compete to sell to the distribution companies and other larger customers. The ultimate aim was to allow all 26 million consumers (i.e. including individual households) to choose the source of their electricity by April 1998. In principle, therefore, customers would then have the right to choose their energy supplier.

This restructuring of the UK electricity market has given rise to the country's largest ever computer system development project at an estimated cost of £1 billion. Major change has been required throughout the industry to develop computing and information systems which would permit the new market to operate. For the 12 supply companies, for example, this meant being able to exchange information in order to allow customers to switch to another supplier and be billed. For the suppliers early adaptation of their systems could allow them to enter the de-regulated market place ahead of their competitors and thereby capture vital new market share. By the same token, there was an incentive to delay the transfer of information to competitors. The uncertainties of delivering working computing and information systems and the conflicting competitive pressures to do so became a cause of considerable concern for the industry regulator charged with bringing the new competitive market place into effect.

New systems development – the '1998 project'

This case concerns the role of ABC in the development and customization of one such supplier's computer and information systems (CIS) and associated adaptation of legacy systems (ie, those currently in use). For a large utility company (XYZ), privatization meant developing a strategic response to enable it to compete in the newly deregulated market. Like other supply companies, developing technological systems and infrastructure were identified as a key source of competitive advantage. However, in the wake of privatization XYZ had not seen the operation and maintenance of its computer systems as one of its core tasks and decided, in 1992, to embark upon an outsourcing arrangement. It was this arrangement that provided the basis for the collaboration with ABC to undertake the systems development and modification work required for participation in the de-regulated market.

Initiation of collaboration

XYZ's outsourcing strategy was driven by its then Chief Executive. He was convinced of the potential business advantage that innovative use of computing and information technology could bring to the organization in the new competitive market. These technologies were therefore seen as a critical resource for future commercial success and the outsourcing strategy a means of reducing uncertainty in ensuring that this resource was available to the organization. At the same time, it is envisaged that such an arrangement could be the basis for a joint-venture which would

create a new organization able to market its services and expertise elsewhere in the energy industry. A twelve-year outsourcing agreement was therefore signed between the two companies in 1992. ABC was precluded by its agreement with XYZ from working with other energy suppliers, but was allowed to undertake similar ventures in the UK with non-competitors, or with other energy suppliers in other countries. Part of ABC's longer-term strategy of learning about the UK energy market was the anticipation that considerable business could be gained in the future if the US market was deregulated in a similar manner.

As with most of its client partners, ABC was very different to XYZ in its way of organizing, operating and in terms of its culture. XYZ was an organization which had a public sector history and whose prior development had been based on a public service ethos, involved bureaucratic forms of organization and management style, and had been underpinned by high levels of collective regulation in the management of employee relations. One of the key capabilities of ABC was the strategies it had developed to 'bridge' such management, operational and culture 'gaps' with potential partners. In particular, this involved developing bespoke organizations comprising seconded ABC and former client personnel to work on IT system development and business transformation for the client.

In the wake of the formal outsourcing agreement in 1992 and in the light of ABC's internal strategy, 148 offers of employment were made to IT staff working for XYZ, of which 142 were accepted. The upshot was that *XYZ* had in effect ceded control of its entire IT function to the hybrid organization. No computing and information systems knowledge was maintained in-house. A small group of IT staff that had refused to transfer had to be managed according to union rules, and formed a distinct group within the new organization. Therefore, within one building both the collective system and the meritocratic highly individualistic system operated side-by-side. At XYZ computer staff were referred to as 'employees'. On moving to ABC they found themselves to now be 'associates'. In their former employment they were used to working within a formal system of rules and procedures. At ABC work tasks were far less structured and more informal. By the same token relationships were more lateral and less hierarchical.

In addition, ABC moved almost its entire – at that time - UK operation to the premises of XYZ and found itself in a unique position of strength from which to dictate strategy. As the initial outsourcing arrangement expanded into a collaboration on development of new systems the new organization evolved into a 'hybrid' and increasingly 'virtual' form. However, as this process began the fundamental differences in history, structure and culture of the two companies made both the development of this new organization and interactions between it and XYZ problematic. Interviewees on both sides openly admitted that the relationship did not work in the first years. Symbolic of this was a bridge walkway linking the separate sections of the site in which XYZ and the hybrid organization were housed. ABC had a very limited hierarchy – the aim was to be as 'flat as practical' - and it was difficult for XYZ to know who to go to in order to resolve problems. There were also problems within the new organization in assimilating ex-XYZ employees, used to working in a bureaucratized and more formal environment, into the more informal and less clearly defined culture of the new organization. Significantly, as the hybrid organization grew a human resources function was established. This used sophisticated recruitment and selection techniques to ensure a closer 'fit' between an individual's profile and the organization's culture as additional staff were recruited.

During the initial stages of the collaboration it was reported by some interviewees that ABC regarded its client as naive in its decision to hand over full control of computing operations, and was able in their words to 'milk' the account for revenue. XYZ managers talked in terms of 'costs, budgets and constraints' whilst ABC spoke a new language of 'business values,

return-on-investment and business solutions'. One ABC interviewees made the point more succinctly, that XYZ had 'not a competitive idea in its brain'. Consequently, XYZ felt that ABC had failed to treat both their client and the collaboration responsibilities seriously by being unwilling to transfer vital technical knowledge and relying too much on junior staff to manage the relationship between the two companies. This led to a lot of ill-feeling and resentment, documented by a frequent exchange of letters between the two companies reiterating each other's contractual obligations and threatening legal action for non-compliance.

Despite all these organizational problems, the 'hybrid' organization quickly demonstrated improvements in productivity and the rate of staff turnover remained well below the industry average. In terms of new product development, processes were updated, new applications developed and the complex structure of XYZ was simplified into a number of regional business units. ABC introduced its own organization charts detailing a structure that XYZ could relate to when addressing problems. This did not reflect a strategy of organizational change within ABC as much as an accommodation to the needs of the client - ABC staff paid little attention to the 'hierarchy' described on paper. Over the first four years of the relationship, ABC introduced a more commercial business attitude into XYZ. This meant that the value added by the collaboration became recognized throughout XYZ and no longer depended largely upon the support of the initial project champion, who retired in 1996.

This event coincided with a major review of the collaboration, because a break-clause in the contractual agreement allowed both sides to re-evaluate the mutual benefits derived from the relationship after four years. Acknowledgment of the dependency upon ABC expertise, and the increasing need for innovative systems in order to compete effectively, were both influential in ensuring the continuation of the relationship between the two companies, despite the problems that had been experienced. Ironically, the application of newly-acquired commercial acumen – in part provided through the existing collaboration with ABC - also allowed XYZ to negotiate far more favorable terms than had originally been the case, when it had seemingly meekly acquiesced to the contract terms drawn up by ABC. This victory illustrated the extent of learning that had taken place at XYZ.

Extension of the network

The new contract terms allowed XYZ to purchase computing services from other suppliers if required, and also linked part of ABC's fees to measurable business benefits accrued to XYZ. By introducing the threat of competition, XYZ was now in a far stronger position to demand high standards of performance from ABC. The increasing demands of deregulation in terms of the new computer systems required meant that ABC. did not have the resources to handle all the work anyway, so the involvement of other suppliers at some stage was acknowledged as inevitable. ABC retained the right to support the operation of all new computer systems introduced to XYZ, ensuring its involvement in negotiations with other suppliers. In addition, ABC brought in senior executives from its overseas operations charged with improving the still often confrontational relationship with XYZ. They collaborated more closely with the new XYZ executives and their considerable project management experience enhanced the level of expertise available to the client. Extensive service level agreements were drawn up to clarify the responsibilities of all the parties involved. These documents were reduced in size and scope as the level of trust improved.

As part of a deliberate strategy on the part of XYZ to exercise more control over the collaboration with ABC, a major consultancy firm was brought in to manage a particular project in which there had been friction between the two parties. The consultancy firm saw the contract as an opportunity to acquire more business at the expense of ABC and encouraged

disagreements and conflicts. This disruptive strategy was recognized by XYZ and the contract terminated after only 8 months. Despite this experience, XYZ subsequently contracted two further large consultancy firms to run the two major projects ongoing with ABC in intermediary roles. This resulted in the unusual situation of individual reporting lines containing representatives from 3 or 4 different companies. Other suppliers that are competitors of ABC have also been charged with developing particular parts of current projects. After experiencing the early problems of mismatched expectations with the core collaboration, ABC was conscious that forging a working relationship with all of these companies was essential to the smooth running of the whole operation, if its reputation in the eyes of the client was to be enhanced.

In 1998, six years after the signing of the initial outsourcing agreement, ABC had retained a small centralized administrative function in South East of England to support staff based in other client sites. However, the new organization at XYZ was now so large that it had its own support section also working at the site, using client facilities and equipment. In fact, out of 1100 people employed on the site, some 650 at this time worked for the hybrid XYZ/ABC organization. In addition, the workload in developing and revising software was now such that an ABC subsidiary had been contracted to carry out development alongside other ABC staff-based in its overseas headquarters. This enhanced the 'virtual' dimension of the 'hybrid' organization as development teams began to collaborate across three continents in what amounted to a 24 hr software development cycle.

Outcomes – Y2K comes early

Paradoxically, while on the one hand the increased complexity of the network had led to a number of operating difficulties**,** the changes instigated by the re-negotiation of the contract vastly improved the working relationship between the original collaborators. By early 1998 the CEO of XYZ was inviting senior executives of ABC to attend board meetings, while at the same time recommending the company's services to the leaders of other industries. One of the executives interviewed identified the need for both companies to profit from the collaboration if it was to succeed. He also emphasized that the strategy of developing a good understanding of the complex energy industry background had been valuable over time in establishing credibility and trust with the client. By mid-1998, other interviewees were claiming that the relationship between XYZ and ABC was now so strong, and the level of internal technical experience had been sufficiently increased, that the expensive strategy of using management consultants to police the collaboration was likely to be abandoned before too long. At this time ABC began work on a second major project to ensure XYZ systems were year 2000 compliant.

However, at this time both XYZ and ABC were experiencing further changes in their business environments. XYZ was the target of a successful takeover bid by another energy company. At the same time ABC became a publicly quoted company. The uncertainties generated by these changes meant that we were advised in early 1999 to cease field working for what we anticipated would be a short period whilst these sensitive issues were worked through. Subsequently ABC head office became very concerned about the fact that we had been conducting research within XYZ as well as at the 'hybrid' organization – despite the nature of the research as a study of collaboration being made clear at the outset. To date we have not been able to resume fieldwork at the location although some interviews have been conducted at ABC's UK headquarters.

In March 1999 XYZ, now under new ownership, gave notice of its intention to terminate the relationship with ABC as permitted under the original terms of the contract through a 'change of ownership' clause. The collaboration has now ended (as of end October 1999), five years short of the agreed 12 year arrangement due to expire in 2004. This was said by XYZ to be the result

of a ‘strategic business decision’ to ‘return control of key elements of IT infrastructure and systems in house’ and ‘provide the flexibility for IT to support [XYZ’s new owner’s] strategy of acquiring and merging with power companies in the United Kingdom, United States and worldwide’. The official view of XYZ’s new owners was that this decision was not a reflection on the quality of ABC’s performance in the seven years of the collaboration. Press reports referring to ‘leaked’ internal memos infer that the reasons for termination may be less amicable. The press reports also indicate that ABC now intends to utilize the skills and expertise of the former ‘hybrid’ organization by establishing a new development facility in the locality. However, there appear to be unanswered questions concerning how XYZ’s new owner will be able to bring computing and information systems expertise back ‘in-house’ if its former employees remain with ABC. There is some speculation that ABC will still offer services to XYZ.

Summary

The actors who form the network are the entrepreneurial/predatory ABC and XYZ, a regional utility company also in the UK. As a result of the network, ABC forms a new company staffed by personnel seconded from ABC and hired from ZYX. The context for this network is the deregulation of the electricity industry. This creates uncertainty but it also creates market opportunities that XYZ wants to be in a position to exploit. XYZ identifies computer & information systems as the key competitive advantage in the newly-deregulated industry, and its strategy is to acquire such systems through outsourcing rather than developing its existing in-house information technology (IT) expertise. The deregulation of the electricity industry provides exactly the type of business opportunity that ABC specialises in exploiting, namely creating networks to develop change management software for companies who, like XYZ, are operating in rapidly changing industries.

XYZ enters the network in order to develop a new product through outsourcing. However, XYZ networks with ABC, a company that is not a technology specialist, but a networking specialist. Within the network, ABC pursues it typical strategy which is to create a new company to develop the new product. The irony is that the new company acquires its technological and industrial knowledge base by recruiting almost the entire IT staff from XYZ. This leaves XYZ, the client organisation, without the independent, disinterested in-house knowledge base to evaluate the quality of the new product that the network develops.

3.3.3: German Case One: EDI in the German Automotive Industry:

Introduction to Electronic Data Interchange

EDI (Electronic Data Interchange) is a subset of the broader class of inter-organisational information systems (IOS) that may be defined as, "automated information systems shared by two or more companies" (Cash & Konsynski 1985). EDI is defined as, "the transfer of structured data, by agreed message standards, from one computer system to another, by electronic means" (Pfeiffer 1992). In terms of its definition as a product or good, it is necessary to consider Weiber’s categorisation.

Weiber (1992) identifies three goods categories: singular goods, compatibility goods, and interactive goods. While a singular good disposes of a proper utility for the purchaser, a compatibility good profits from the availability of compatible products (e.g. hard – software, video recorder – tapes), and communication technology like telephone is an *interactive good* where the use only makes sense as interactive communication between at least two parties. Following Weiber, EDI belongs to the category of interactive goods as a network used for communication and only a derived utility exists. As an *interactive innovation*, EDI requires the active co-operation of the respective communicating partners. Without this co-operation, the

objectives of the EDI implementation may not be reached. Indeed, the benefits of EDI implementation turn out to be interdependent. As such, EDI belongs by its very nature to the group of collective innovations employed and used jointly by more than one organisation. In contrast to a simple "one-step" purchasing act, EDI development represents a rather long and complex process with different stages. Such a process necessarily covers a time span with changing context variables. In particular, the progress in message standardisation as well as the progress in available technology influence the EDI development process.

The development of EDI systems in the German car industry is the result of two inter-related networks. The first and primary one is the 'VDA Network', a network developing so-called VDA standards under the lead of the German Automobile Industry Association (VDA: Verband der Automobilindustrie). The second or secondary networks are concerned with the realization of the data interchange using the standards. Secondary networks consist of car producers, suppliers and software companies. In the first part of this case study the VDA Network is discussed and in the second part aspects of the secondary networks are detailed.

The Development of EDI Standards through the "VDA Network"

The automotive industry in Germany was one of the EDI pioneers. As early as 1978, Volkswagen was the first German car maker to exchange structured data with suppliers. What was a proprietary project initially, rapidly evolved into an industry-wide movement as other manufacturers associated in VDA, had similar interests in electronic data exchange. Since 1980, the use of EDI has been promoted by VDA, and EDI programmes were defined step-by step to be implemented in the whole industry. VDA is a non-profit trade association that was founded in January, 1901. Membership of the organisation now comprises over 510 companies with 710.000 employees including car producers, components manufacturers, and other specialised auto manufacturers. Such a large, all-embracing trade association is not untypical in Germany and reflects the *'German association model '*. This model is very advantageous in that partners from all areas of the industry are active in committees and working groups. This implies more direct dialogue and faster, wider decision making in the German automotive industry, as well as a comparative stronger position of (larger) components manufacturers. VDA's goals are to promote co-operative relations among member companies and, nationally and internationally, to further the joint interests of its members and the German motor industry as a whole in all economic fields concerning motor vehicle industry, economics, transport and environmental policy, technical legislation, standardisation, quality assurance and logistics.

The logistics division at VDA is responsible for the implementation, standardisation and computerisation of logistic-processes in the German automotive industry. This division consists of 5 working groups: (1) electronic business; (2) container standardisation; (3) logistic-process; (4) CAD/CAM; (5) software and communication, all of which had their own ad hoc sub-groups. They are all engaged in the development of logistic systems including EDI. The beginning of the project, 'Data Exchange Through Telecommunication Networks' dates back to the mid-70s. In 1976 a working sub-group, *Arbeitskreis Formulare und Formulargestaltung,* had the idea to reduce the paper flood in the ordering of components. The main reason for doing this was not just to reduce paper use but to reduce the time needed for the ordering processes from nearly a week to hours. This was thought to be one important measure to master the shift from mass production to customer ordered production, implying the reduction of stocks and order quantities. Following the publication of their document on formula standardisation, the working group for *Vordruckwesen/Datenaustausch* , predecessor of the working group for 'electronic business', launched the first project on standardisation of EDI messages in 1978. The 'Call-off' (VDA 4905) was the first result of the project. Since 1978 the VDA has developed about 40 recommendations for EDI standards for the negotiation, production, and payment stages of a

market exchange, defined, registered and maintained by VDA. These VDA-Standards are implemented in more than 16,000 communication connections. Some of these are even used between primary suppliers and second tier suppliers.

The later ‘electronic business’ group, called ‘Circle of Experts’ was at the very centre of the EDI developments in the German car industry. The working group consisted of delegated experts from seven car producers and five (very large) suppliers. This means that from the very beginning, smaller suppliers were not part of EDI developments. Interviewed experts said the small suppliers have "no resources", and are, "not able to meet the demands of the development" of EDI. Looking back, the exclusion of small firms resulted in certain problems - at least to a certain degree the difficulties in implementing EDI even today in small firms is due to the neglect of their interests during many years of EDI development. It is remarkable that small suppliers have not been well integrated into EDI implementation until as late as 1988, ten years after the realisation of the first VDA standard.

The group still exists today, working on further international developments of EDI such as ODETTE, EDIFACT, etc. The use of VDA-Standards was largely restricted to German firms. ODETTE, ANX, & EDIFACT are attempts to develop international standards. ODETTE (Organisation for Data Exchange by Tele Transmission in Europe) is an European standard, which formally came into existence on 1st Jan 1985. EDIFACT (Electronic Data Interchange For Administration Commerce and Transport) is an organisation which develops U.N. rules for EDI, which consist of sets of internationally agreed standards, a directory and guidelines for the electronic interchange of data between independent, computer information systems. EDIFACT has become the definitive EDI Standard and ODETTE is working to provide its users with a complete set of official subsets of EDIFACT messages. VDA changed its position towards ODETTE and EDIFACT in 1991 from a rather sceptical attitude towards a more positive, co-operative attitude. German auto industry managers had apparently recognised that VDA-based messages would not satisfy future business needs in the long run. VDA became a strong promoter of future conversions of ODETTE to a real EDIFACT subset for the automotive industry (ODETTE-EDIFACT). A huge project started in 1991 and was supposed to be operational by 1995. Developments of German VDA standards was finally stopped in 1993. ANX (Automotive Network eXchange) is an initiative of the American car industry. ANX is using internet and appears as if it might replace traditional EDI. The European car industry is now on the way to develop an alternative to ANX.

The ‘electronics business’ group was the steering committee of the development of VDA standards. The group was (and is) meeting four times a year and ad hoc groups were working on certain tasks. The experts were working together in a – as has been said – "very good atmosphere". Personnel co-operation and mutual trust have been important from the beginning of the work. The interviewed experts judged the following points as being crucial to the good relationship:-

- They referred to the interactive tradition of the VDA working groups implying that there already exists mutual trust between members of different car and parts manufacturers.
- As ‘technical experts’ they co-operated mainly on technical subjects. That meant that more political dimensions were excluded from the ongoing work: "As members of the operative level of the enterprises you don’t negotiate tactically." (noted one expert of the committee.)
- They had one main ‘driver’, an expert of a large supplier, who was accepted informally as the leading person in the group (besides the fact that the formal leader of the committee was a delegate of a car manufacturer).

But the work of the electronic business group had its limitations and shortcomings, the main one being that the delegated experts didn't have the power to put through unified VDA standards. Instead the results of their work are 'open standards' that allow individual 'shaping' depending on the interests of the car manufacturers and the large suppliers. That implies that the experts haven't been free to design unified standards; their duty was, so to say, to translate the special interests of their enterprises in VDA standards as compromises. The electronics business group was in this respect an arena where certain conflicts hadn't been discussed, let alone solved. As experts said, one main reason for the development of non-unified standards has been the high costs the management of the large companies feared if 'real' standards would have been realised. But, on the other hand, the likely advantage of unified standards would have been lower costs in the future and less problems in inter-firm communications. Smaller suppliers especially suffer from the non-unified standards - most of them are supplying many car manufacturers and non-unified standards have the effect that they need special software to communicate with each different manufacturers.

All in all three weaknesses of the VDA network can be summarised:

- The exclusion of smaller suppliers of the development process.
- The non-unified standards. It is likely that this weakness arose because the top management of car producers and large suppliers didn't realise the future strategic importance of EDI.
- The outcome of the above mentioned points are high costs for the implementation of EDI especially for smaller suppliers and ensuing resistance of these suppliers against EDI.

EDI-Realisation Networks

Up to now the development of the VDA standards has been discussed. These standards are building the framework for the realisation of EDI software or EDI systems – the *product* that is needed for the communication between car manufacturers and suppliers. And in this respect one important point has to be mentioned here - in parallel with the standardisation of data formats and telecommunication by the VDA working groups, a new software market emerged: the EDI software market. It was a decision of VDA not to include special software companies into the process of standardisation, the making of software should be done by third parties, market forces being seen as the incentive used to develop the needed software. There seems to exist about 80 suppliers of EDI software on the German market today which supply the numerous components manufacturers. The process of the realisation of EDI, implying software development and the implementation of EDI, will now be described. At first the role of a large supplier as a major driver of the EDI development, is discussed. Then, the interrelationships between a car producer, parts or component suppliers and software companies are described.
LIGHT is a market leader for various car components, supplying all major car manufacturers throughout the world. In the German automotive industry LIGHT is viewed as one of the most innovative companies. LIGHT was among the few suppliers in the German automotive industry to implement the first VDA standard in 1978 as a pilot user, and in 1985 it was among the first fifteen European firms implementing the ODETTE standard as a test user. Before availability of industry-wide standards, LIGHT developed its own standards for internal transmission of messages within the LIGHT group.

Currently, LIGHT supports all major standards, such as VDA, ODETTE, EDIFACT or ANS.X.12 with a lot of different messages. This flexibility to meet individual customer's data transmission requirements is considered to be one of its strengths and a top priority for LIGHT. The leading use of innovative technology helps shape the company image. Its motto, 'Act, not react', is the goal of management. LIGHT exchanges around 120 files daily through 170 EDI links with 70 sub-suppliers, 60 customers, and various banks as well as its own factories and sales offices. In 1988, LIGHT was the first supplier to send call-off messages to its suppliers in

order to fully profit from the benefits that manufacturers have reached through EDI with their suppliers.

LIGHT participated actively in the above mentioned working group of VDA, that developed the VDA standards. And it isn't a surprise that the above mentioned main driver of the working group was a representative of LIGHT: He was the leader of the first project of VDA and applied the VDA standard to the DIN (*Deutsche Industrie Norm*). LIGHT and its representative also played an important role in negotiations around the development of EDI which have been necessary in this process. These negotiations included for example, those with the German ministry for finance concerning the so-called "collected invoice", the introduction of the euro (implying a complication of EDI) etc.

LIGHT also co-operates with HPC (see below). HPC wanted to embed a new EDI link into a larger re-orientation project. After the analysis of network and message compatibility, LIGHT realised that HPC's preferred options, X.25 point-to-point connection and transfer of VDA messages, did not represent state-of-the-art solutions for the next decade but were rather oriented towards the past. In order to fulfil the expressed wish for electronic integration in combination with a progressive EDI approach, LIGHT opted for a mailbox-based communication procedure across the IBM VAN and the implementation of ODETTE messages. ODETTE represented the message standard with the highest message compatibility for current and potential EDI partners among LIGHT's customers, which geographically are not restricted to Germany.

Networking of a Car Manufacturer, Suppliers and Software Companies
At the centre of this complex networking is one of the largest German car manufacturers. The rather complex co-operation between this company, suppliers and software companies will be discussed after a short description of the various actors.

The Car Manufacturer: HPC (a pseudonym for the car manufacturer under study, famous for its luxury cars) is a large manufacturer in terms of employees and turnover . It has factories in several countries in and outside Germany. EDI experts are working in the central plant of the enterprise and in the other factories. A software company is part of the HPC group.
Suppliers and their Relationships with Car Manufacturers : Using a simplified typology three types of suppliers are presented here (For a more elaborate typology, see Doleschal 199, VDA 1998).

- Large and ' high-tech' producing suppliers, independent from car manufacturers. These are global players producing parts for the world market.
- Just-In –Time Suppliers (JITS), are also generally larger suppliers producing advanced technology products. Car manufacturers and JITS are mutually dependent on each other.
- Small suppliers. According to Doleschal, about 63% of the suppliers in 1988 belonged to this category. It is likely that these small companies are more dependent on car manufacturers than the above mentioned suppliers.

Software Companies: an Example of an EDI Software Supplier: Many software companies were part of the EDI realisation process, and in HPC's case, this included their own software company and others. According to our research the following one is in many respects a typical one. It is described here in more detail to give some insights into this type of software house that arose alongside the development of EDI in German automotive industry. The software company under study, called ACTEDI here, was founded in 1978 by two professors and some students to concentrate on automotive industry processes. From that initial experience in this sector, the company developed an "extra" product in 19849, a data transmission system called Data Transmission Box, which was successfully installed in about 700 suppliers in the German automotive industry. Since then this company has concentrated even more on software

developments in the automotive industry. ACTEDI is now one of the leading providers of software systems and consulting services for all aspects of EDI and electronic commerce. Today (late1999), more than 1100 customers are using about 1600 application systems. By developing new products, this company is now expanding its business into other industries like chemicals. With 110 employees, ACTEDI manages a turnover of 25 million DM..

The EDI solutions that ACTEDI provides draw on a comprehensive and specialised range of services which includes: (i) the planning and installation of EDI solutions by qualified advisers, tailor-made to suit the particular needs of the client's business; (ii) software and project consulting and services, including remote maintenance and a hotline for users; (iii) practical seminars and workshops addressing security issues when working with EDI, including the discussion of new developments in the field of electronic data interchange. It can be said that 'continuous product development through networking' is business as usual for a software company like ACTEDI. From the requirements of customers, the business strategy of this company is, "innovative, customer oriented, product development". By offering the "best solution of customer requirements", ACTEDI gives priority to co-operation with not just customers but also standard associations, network providers and even (potential) competitors (like Baan, Gedas, Oracle, ProSTEP, QAD, SAP, SSA, Steeb, and others) For example, The EDI functionality of R/2 and R/3 was developed together with SAP.

In co-operation with NSOFT, a telecommunications system provider, and some other important suppliers, HPC implemented EDI on a large scale relatively late. By 1986 less than 100 suppliers were connected. After a strong growth in the early years (350 connected suppliers by 1988, one year after the project started), growth slowed down with approximately 100 links each year over the following years. Many suppliers are still reluctant to implement EDI.

It was also regarded as a problem that it is difficult for small and medium sized supplier to find a suitable and cost-effective software. Therefore, HPC decided to use its market power to get made such a software package and to provide the suppliers with it at a favourable price. Accordingly, several software companies were approached. However, inadequate technical detail was detected in most of their offers. Thus, HPC decided the offer the services of their own software company. Then, all suppliers were written to. Initially, if required, the suppliers would be passed to the own software company. However, this generated much annoyance because many suppliers thought that they were being pressed to co-operate with the HPC software company. Consequently most suppliers didn't react positively to this offer. Therefore, HPC decided to invite the suppliers, without offering them the co-operation with the software company, to several so-called 'suppliers days'. These meetings have been of great value for the experts. They learned a lot about the needs, expectations and anxieties of the small and medium suppliers concerning EDI.

The important results from the 'supplier day' meetings can be summarised as follows:

- One particular result was that those suppliers who supply only a little to HPC and have a small turnover have been removed from the EDI link. Instead, *transportation firms* have been asked to take over the EDI tasks for these suppliers - the reason is that the transportation firms in question are transporting the parts from these suppliers to the factories of HPC. This arrangement still has not been fully realised.
- The establishment of direct contacts with the suppliers to improve mutual understanding.
- The information from the meetings were sent to each plant. From this, the information exchange between plants has become better. This plays a essential role for the internal information politics.

· The publication of a manual for EDI.

Just-In-Time Co-operation and Developments: In a move towards stronger vertical relationships and single sourcing, car manufacturers offer some of their suppliers higher levels of commitments through long-term contracts allowing better long-term forecasts for the suppliers. This is especially true with JIT suppliers as car manufacturers and JIT suppliers are mutually dependent on each other. The case of a JIT supplier producing electrical components is now briefly discussed. The development of the 'JIT system' was a joint project of the JIT supplier, the car manufacturer and a software company. The software company was chosen by the JIT supplier – but, as in the case of the small suppliers above, HPC management tried to influence this decision in favour of either its own software company or other software companies that have worked for HPC for a long time. But the JIT supplier was confident enough to choose the same (small) software company that had developed another system for it before. This was done after some market enquiries. The main reasons for the decision had been the conviction that the larger, well known software companies they contacted during the market enquiries were no better than the small company and the past 'good experiences' in the former co-operation with that small, and not very well known, software company. As interviewed experts said, there was existing mutual trust and they especially knew that the software company was employing two people, "who are able to do the job".

The system development was done by a team consisting of some experts from all three firms, resulting in a successful system that operates, "outstandingly well". The complex system is working with few breakdowns but it requires continual interventions by human beings. Three experts, one person from the suppliers in permanent contact, and close co-operation with (mainly) two employees from the car manufacturer, are intervening via a continuous 'fine tuning process' and thus correcting the plans of the JIT system as necessary.

Outcomes of EDI Networking

The existence of the German Automobile Industry Association turns out to be a facilitator of the early developments of EDI in this industry. The tradition of "co-operation between rivals" concerning topics of overall interest was the key factor for the development of common standard – despite the fact that the result are open standards. It is remarkable that in this interplay of huge collective actors one enterprise, the large supplier LIGHT, and several individual actors played such crucial roles in the development. As in other co-operative networks, one main driving actor is significantly responsible for the success of the network.

The VDA network is, on the other hand, a less-than-impressive example for the exclusion of actors – in this case small suppliers – from co-operation. At first this exclusion seem to be necessary to facilitate the standardisation process. But in the longer term the exclusion can be seen to be responsible for the resistance of many of the small suppliers over the use of EDI. Concerning that and the fact that the VDA standards are not unified standards, it can be concluded that top management of car producers and large suppliers wasn't aware of the future importance of EDI.

Summary

This case study examines two types of EDI networks – the so-called primary network and four secondary networks. The primary network was a Working Group of the German Automobile Industry Association (VDA), which represents manufacturers and suppliers. The product developed by the primary network was a set of EDI standards for the German industry. However, these standards were open rather than unified. Reasons for this outcome include: exclusion from the network of small suppliers who, arguably, had the most to gain by the

establishment of unified EDI standards; the perception of the car manufacturers and large suppliers in the network that the establishment of unified standards would be costly to them; and the network's lack of authority to impose unified standards on the industry. The outcome was a set of open standards which allowed for the development of a range of different EDI systems which was, of course, a disadvantage to small suppliers many of whom did not adopt them.

The four secondary networks illustrate how open standards can be viewed as creating a problem requiring a solution, or as a business opportunity for the entrepreneurial. The first secondary network features LIGHT, a large supplier that exploits the diversity of EDI systems and standards. LIGHT's is flexible in its adoption of EDI systems, using systems that are compatible with all the different major EDI standards and with the EDI systems of its customers and sub-suppliers. This gives LIGHT a competitive advantage. The second network concerns ACTEDI, one of about 80 suppliers of EDI software in Germany that exploits the niche provided by the proliferation of EDI standards. Like other such software suppliers, ACTEDI is involved in continuous product development through networking.

The third network illustrates the consequences of the failure of the primary network to address the needs of small suppliers. This network was initiated by HPC, a car manufacturer, to enrol small suppliers in its EDI software network. To this end, HPC employs three strategies: Suppliers's Days; an EDI Manual; and the use of transportation firms as intermediaries. The fourth network is the response of a JIT supplier to EDI systems. The new product developed by this network is an EDI system that is specific to the needs of the JIT supplier and the car manufacturers it supplies.

3.3.4: German Case Two: CATS

CATS, Cargo Tracking System, is a customized, computerized fleet management solution for transportation services, developed during 1997/8 within a regional innovation network in the German city of Bremen[1]. It is an innovation in communication and data transmission systems which is very user-friendly and inexpensive. CATS is mainly the result of collaboration between two individual actors of two firms, CITY LOGISTIC (CL) and TELEDATA, both located in Bremen. Also involved were truck drivers who as sub-contractors to transportation firms, made specific important contributions to the product development by testing system prototypes in daily practice.

Regional proximity and existing 'regional innovation dialogue', were important factors for the initiation of this development, as was the co-funding of the innovation project by the state of Bremen. Initially the innovation project was highly contextualised (or 'embedded' in the region of Bremen). However, after the successful realisation of the new product, 'decontextualisation' (or 'disembedding') occurred, as the product was then marketed outside Bremen and further developed according to the wishes of new customers.

The CATS Network

The innovation process was mainly driven by two persons who possessed complementary but different resources (ie, knowledge and expertise): One, working with TELEDATA, is an expert in software development. He works in an organisation offering a high degree of self-determination of work and self-responsibility and he is also experienced in inter-firm co-operation.. The other person, the Head of CL, is very familiar with transportation and logistic

[1] CATS is an intelligent instrument for optimised cargo tracking. Depending on the orders stored in the base station, the managing clerk sets up the cargo list, together with precise information about each delivery, for the truck drivers. The vehicles are equipped with GPS (Global Positioning System) receivers. Knowledge of the truck's position and of the progress of deliveries then allows the managing clerk to give new orders to the actual-best-suited truck. The cargo orders and other information are transmitted to City Logistic through a mobile communications network. The truck driver reports the progress and completion of each delivery using his handheld terminal.

operations. Truck drivers played a minor but nevertheless important role in the networking process. They were not involved in defining the development programme, nor were they 'co-drivers' of the project, but they were important because of their role in testing the system on a daily basis. All the three parties brought complementary knowledge and experience into the development process. In addition, it is obvious that the *customer* of the innovation was also an integral part of the innovation network.

CL: Actor in the Network and Customer of the Product of the Network
City logistic, in general terms, is a concept for reducing traffic in agglomerated, larger cities. Discussion of it had emerged in Germany around 1980 and is closely related to the development of 'goods traffic centres' in the larger cities. One example is the Goods Traffic Centre Bremen (GTCB), where huge amounts of goods being transported to Bremen or from Bremen to other places are brought together. The idea of city logistic is that the transportation firms should co-operate in the delivery of goods to their customers within the city, especially by using one selected truck to transport certain goods to customers. This is possible and advantageous if transportation firms have some common customers – one truck can then replace several trucks from different firms to deliver the goods to these customers. City logistic is judged to have only 'winners'- the environment, the transportation firms and their customers. In Bremen the first city logistic project started in 1990, it was also the very first one in Germany too. The core of the network has been several transportation firms and certain state institutions. In 1994 GTCB and eight transportation firms founded CL. By 1999, GTCB and eleven transportation firms are involved in building up CL which now employs a handful of persons.

TELEDATA is a privately-owned 'high-tech' company, mainly engaged in fields of space and environmental technology as well as in wireless telecommunications. The company has grown very rapidly since it was founded in 1981 by a former professor at the University of Bremen. It currently employs about 210 persons, most of them are highly qualified, e.g. information scientists. TELEDATA is, inter alia, developing satellites for satellite telecommunication systems and a space transportation system for placing small-to-medium satellites into low earth orbits. The company launched its first satellite in 1994 and was the first European telecommunication company to operate privately owned, low earth-orbit satellites. Since October 1996 TELEDATA has been the German partner of ORBCOMM, an American satellite system used for data transmission and has provided low earth orbit satellites to establish a global service. TELEDATA also collaborateds, for example, with companies in Japan or South America, and, within Germany, with many different firms and scientific institutions. Through intensive networking TELEDATA has been building a high potential and as an ambitious, 'high flying' company, aims to be a 'global player' in telecommunications.

Building the Network: Context and Initiation
The initiation of the network under study was the result of an existing 'regional innovation dialogue', a term which refers to a continuous interchange of information between individual actors within Bremen. The actors represented various regional bodies, including Bremen University, other scientific institutions, the private economy, the state, etc. The rationale for this mainly informal concept was, and still is, to improve the innovation capabilities of Bremen. Some programmes, for example the so-called "Bremen Work and Technology Programme" have been undertaken with the objective to stimulate the regional innovation dialogue by supporting co-operation between regional companies, the Bremen University, other R&D institutes and other regional institutions like the Chamber of Commerce, etc. Building and supporting "learning networks" was thought to bringing together existing "complementary" capacities that are necessary and sufficient to create innovations.

Four individuals were engaged in the initiation of the CATS network - a highly-ranked employee of the Bremen Senator for Economics, the CEO of GTCB, the CEO of TELEDATA, and the Head of CL. There were also close links between the both CEOs and the Bremen authorities. The employee of the Bremen Senator for Economics heard from the CEO of TELEDATA about their potential in telecommunications and that they were searching for customers. Thinking that this could be interesting for GTCB, the employee of the Senator informed the CEO of that organisation who then spoke to the head of CL, and after an initial meeting CL and TELEDATA decided to undertake the development of CATS. It is important to note that Bremen financed 45% of the estimated development costs of the project through a Bremen State programme supporting the development of environmental friendly technology.

This innovation project was developed and realised by the above mentioned individual actors though its terms and programme were changed during the whole process. It is possible to differentiate between two steps implying different agendas:

- The development of the system. In this 'proper' innovation phase the actors changed the technical programme significantly - CATS did not incorporate the use of a satellite, as planned earlier, but rather exploited a terrestrial connection.
- The marketing of the system implied an extension of the network, and further developments of the product. These, however, have yet to be realised and are still an on-going process.

The 'proper' phase of the innovation itself was divided into two sub-phases:-
(1) Definition phase: To apply for a cargo tracking system development project to Bremen government, several meetings between the major actors took place. A systems concept of identification of vehicle position was established. In the project application, three factors were emphasised:- Firstly, the system shouldn't be too expensive because it had to be affordable for SMEs. But it must also be possible to upgrade the system, therefore it had to consist of modules. Secondly, the systems requirements specified by CL must be realised. Thirdly, the technological realisation should be matched with financial and other requirements of CL. After this first concrete definition phase, TELEDATA formally applied to the environmental authority in Bremen for the project.

(2) Re-definition and Realisation phase: Following the definition phase, a considerable modification of the planned system was made within the first weeks of co-operation. Through the new definition, additional modules for specific functions related to transportation in local areas were introduced into the system. The new, clearer project design and the requested modifications led to the technically successful and more user-oriented systems development and its successful marketing. The following factors were decisive:

- The co-operation was based on mutual trust between the two main actors even though neither partner knew each other previously. In this context, it was helpful that the larger partner (TELEDATA) had experience of trust-building and could minimize the risks that co-operation engenders. In one interview the expert said,

  > "We are co-operating if we are convinced that we are achieving an 'additional value'. If we get the feeling that we are co-operating but doing the job alone – than we will quit the co-operation."

  From the viewpoint of CL, the risk was also manageable, since its participation on the project was financially viable, and its other investments (work, time, etc) seemed to be justified by the recognised potential of the system.
- The mutual professional respect and technical understanding of systems requirements was of particular importance. TELEDATA's expert recognised very quickly the managerial capability of the Head of CL in bringing together technical enthusiasm and professional competence related to transportation. The competence of TELEDATA to meet the technical

requirements of CL was also simultaneously recognised by the Head of CL. Thus, mutually accepted professional competencies led to the clear and successful division of roles.

- There was very frequent communication between the two main drivers of the project during the development process; they met several times a week and phoned very often.

It is very important to note that, during the "proper" innovation process, no formal contract regulating work etc between the actors existed. Also the contract with the Bremen state didn't specify the work of the networking parties.

During the system development and systems testing phases, new actors entered the network for short periods. The system developed by TELEDATA was presented to CL and tested in local trucks. The co-operative behaviour of the drivers was critical in this phase, and they co-operated mainly because they were sub-contractors who receive transportation orders from CL. This situation facilitated the introduction of the possible cost advantages of the system to the drivers. In the test phase, only minor modifications, e.g. in the menu control, were necessary because of the experienced and efficient expert inputs during the definition phase. Regional proximity in this phase was helpful since the vehicles on their route plans could include a visit to TELEDATA in the case of problems with the system.

Stabilisation of the networking process was soon achieved through the very positive co-operative climate between the two main individual actors and the quickly achieved results, i.e. the prototype that was tested and quickly accepted as a well functioning system by the truck drivers. Consequently, all three parties benefited from the system. For TELEDATA, the potential benefits of the development of a cargo tracking system had been obvious from the very beginning of the project. Furthermore, its success would provide a very good reference system that could be used to gain access to a huge market where reliable and inexpensive systems were hard to find. CL expected the development to make further improvements in the optimisation process of the city logistic. The truck drivers benefited from cost reductions.

Outcomes of the Network

The main two partners were surprised by the great demand following an exhibition in Munich. What problems that did occur during later production and delivery of components and during the fitting of the system to the vehicles, were solved by the involvement of more regional and supra-regional co-operation partners. For wider marketing, it was necessary to co-operate with partners outside Bremen for obvious reasons of costs and marketing know-how.

The marketing phase resulted in an important modification in the relationship between CL and TELEDATA. Co-operation in marketing was for the first time organised within a formal contract. For example, proceeds from sales at the Munich exhibition were divided according to that contract. Similarly, the agreement noted that TELEDATA would focus more on the larger and international transportation companies while CL focused on local SMEs where local demonstration of the system and the use of a common language played a central role. Thus the co-operation between TELEDATA and CL was formally consolidated in this marketing phase of the network, despite the fact that TELEDATA's expert is no longer part of the network as he went to work for another firm. The success of the project resulted in the on-going building of new or modified networks, developing new versions of the former product. As one interviewed expert said, "This process is like playing billiards, after the first thrust of the cue, the balls form a configuration you have to deal with and must continue to deal with because unexpected chances [configurations] are always appearing."

Summary

The context for the network is regional, specifically the State of Bremen. It comprises the regional innovation dialogue, unemployment in Bremen and Bremen's precarious financial situation. Another important context, which is important both for mobilising immediate funding for the network in Bremen and furnishing the product with a potential national and international market, is the perceived widespread demand for logistic control of freight transport to relieve congestion and reduce environmental pollution.

Thus the development of the product in this network is characterised by both 'push' – available technology – and 'pull' – perceived market demand. The product was conceptualised as a 'technological fix' for regional environmental, logistical and economic problems. At present the main competitive advantage of CATS is its regional support. For the product to succeed, it must enrol interests outside of Bremen. However, at the end of the pilot phase, it had not even enrolled local lorry owners. Whilst the network was successful in developing a prototype, academic research on networks would suggest that the network has a number of weaknesses which need to be addressed. These can be summarised as the failure to the network to represent and respond to: alternative solutions to the problem – including alternative technologies such as mobile phones; sources of resistance to the product, for example lorry drivers; rivalry from competitors offering similar products. Responding to these other interests is vital if the product is to have a future market.

3.3.5: Danish Case One: Development of a Continuous Process Wok for the Food Industry

Introduction

In 1995 the first steps were taken to initiate a project which four years later resulted in development of a prototype. The innovation process still is going on and not yet resulted in a new commercial product. The artifact is a continuous process wok for the food industry. The scene is the Danish food sector including research and development institutions. The actors are: Fast Food, Bio Institute, and Food Engineering. Fast Food is a manufacturer of ready-prepared dishes. Bio Institute is a university department at a technical university in Denmark. Food Engineering is a small firm specialized in design and production of stainless steel equipment for the food, chemical and pharmaceutical industry. This case is a study of the innovation process taking place from the initial idea of a continuous process wok, to development of an operating pilot plant machine, and construction of a scaled up prototype, intended to be tested at Fast Food. Two main perspectives are pursued: Building networks during the course of the innovation process, and the role of artifacts in network building and shaping of the product.

The wok project is linked to the Danish national innovation system, it has been financial supported by a national research and development programme for food technology, abbreviated FOETEK. This is a programme aimed at improving the international competitiveness of the Danish food sector by increasing the research and development volume in that sector. One of the main tools in achieving this is support to collaborative projects involving both university research, governmental research institutions, and private firms in the food sector.

The Wok Network

The network under study was initially built by an individual - the inventor of the continuous process wok - namely a professor at the Bio Institute. He is the spokesperson for the network during the first years although as the network undergoes changes, new actors are enrolled, translations takes place, and a new network emerges which may be analysed with Food Engineering as the network centre. The network is considered to be temporary. Before the wok project there has been some contact between Fast Food and Bio Institute but not in any

formalized form. Similarly there has been some contact between Fast Food and Food Engineering but not to a great extent.

Fast Food: The firm was founded in the beginning of the sixties starting up in a basement. In the seventies the firm, together with a department at the Technical University and a supplier, developed an automatic machine for manufacture of spring rolls (baking a pancake and filling in the ingredients). Since then, the production process has been rather stable without major changes. The products are sold to the retail market as well as the catering market. More than half of the product volume is exported. Today there are around 330 employees at three manufacturing sites, two in Denmark and one in United Kingdoms. The development department has three permanent positions. In case of larger projects other persons are included, eg. production people. Most of the R&D activities are short termed, i.e. creating new product variants by changing the recipe. Market feedback is the most important basis for product development, and hence there is a close collaboration with the sales and marketing department. Recently a number of projects have failed when the new products have been introduced. The competition at the international market has tightened up. A major competitor to Fast Food has exerting pressure on the prices. The response from Fast Food is to put more emphasis on quality products.

Bio Institute: The Bio Institute is a department at a Technical University responsible for education and research within two areas: Food engineering and biochemical engineering. The faculty and scientif-ic staff amount to around 60 persons including PhD students. The department is operating in six research groups. The wok project is placed in the Food Science and Technology Group. As a unique facility the department has three pilot plants which are used both for teaching and research. Many of the activities within food engineering are funded via the FOETEK programme.

Food Engineering: The firm was founded in the 1940s based on design and manufacturing of vacuum equipment, eg. multi-chamber vacuum dryers. In 1981 the firm acquired the rights for automatic basket centrifuges, which today is one of the major products. Besides the two owners, two designers, two supervisors, and ten skilled craftsmen are employed. The firm has specialized in machines and equipment of stainless steel for the food, chemical, and pharmaceutical industry. The export volume is 70-80 percent. Formalized product development does not take place. All changes and adaptions of equipment are built into orders from customers. The strength of Food Engineer-ing at the market is short time of delivery and flexibility toward customer requirements.

The FOETEK programme: FOETEK (The Danish Research and Development Programme for Food Technology) is a long-term national R&D programme launched by the Danish government in 1990. Since then there have been three programme periods (1990-94, 1994-97 and 1998-2001) and the total funding exceeds 1 milliard DKK. A major aim of the programme has been to strengthen bridge-building between the public and private sectors and to develop new co-operative working methods between public research institutions, approved technological service institutions, sector research institutions and firms in the chain of production ranging from primary production and processing to distribution and sales. During the entire programme period, collaborative projects between public research and private firms has been a major mean to achieve the goals.

The constellation of governmental departments which have administered the program has changed over the three periods. The collaborative projects, however, have been administered by the Ministry of Agriculture (which today is the Ministry of Food, Agriculture and Fisheries) in

the entire period. Within the Ministry, the FOETEK funds are administered by the Danish Directorate for Development. Decisions on subsidies is primarily made by the National Board on Grants for Product Development of Agricultural and Fishery Products. This board consists of members from industrial organizations, and members appointed by different ministries. Because the Ministry of Research is also a partner in the FOETEK programme, all applications concerning collaborative projects are being subjected to a professional/scientific evaluation in relation to their research qualifications by the Programme Committee for Nutrition and Food Research (FELFO). However, this was a problem for this project because FELFO was sceptical as regards the scientific outcome. The FOETEK programme is a complex "institutional actor" with internal tensions because of participation of different ministries with different interests and perspectives.

The Problem: Boiled - Not Stir-fried : In the autumn of 1995 the quality manager at Fast Food contacted Bio Institute. He had previously had contact with the institute. The quality manager had problems with the processing of vegetables for the ready-prepared dishes. They were not processed properly, they were boiled instead of stir-fried as in a wok. And the huge amounts processed in a single batch resulted in a messy appearance in the dishes. The quality manager had a vison of new products in which the customers easily could see and identify crispy vegetables. The enquiry to Bio Institute resulted in a visit by the professor to Fast Food. He visited the production and was told of the problems. The professor was in fact looking for industrial problems and potential collaboration with private firms in the food industry. Getting financial support from the FOETEK programme required collaboration with industrial partners. Besides, the professor was head of a research group on heat treatment processes in the food industry. This group had built up competence within the area and had a tradition for collaboration with industry.

Back at the department he ‘started inventing’ or rather he started to solve the technological problem raised by Fast Food. He addressed the problem as caused by insufficient heat transfer per unit raw material and time units. In the cognitive process the concepts of ‘generative metaphors’ and ‘analogy’ seemed to play an important role. In considering alternative ways of frying the vegetables and obtain really stir-frying he was thinking of quite another process known to him, namely the diffusion process taking place in the manufactur-ing of sugar from sugar beets. This process is continuous and contained in a sort of tube with a transportation mechanism. He then asked himself: "Why don’t we fry in such a tube?". This was the origin of the professor’s vision: Frying in a tube with a spiral transporting the ingredients.

The Artifact: To obtain stir-frying - in contrast to boiling - requires a combination of high surface temperature, short processing time and an adequate evaporation from the ingredients (vegetables and meat). Continuous frying is established by using an iron frying tube which is open at the upper front. Underneath the tube is heated by natural gas. A stainless steel spiral conveyor in the tube transport the ingredients forward until they leave the tube as finished food. The spiral is suspended in a floating manner and are able to move transversely to the axis by means of double-acting hydraulic cylinders thereby scraping the heat surface continuously.

Mobilizing Internal and External Networks: To develop the vision of the continuous process wok into an artifact Bio Institute and Fast Food made a formal agreement and then an application to the FOETEK programme. They succeeded in getting financial support to their project. The goal was to build a pilot plant prototype to demonstrate the new principle. In this early phase a working prototype was seen as an obligatory point of passage in stabilizing the network. At Bio Institute the professor mobilized an *internal network* of resources, including the head of the pilot plant facility, a mechanical design engineer, PhD students, laboratory

technicians, and the in-house workshop consultant (J-Consult) who was headed by a mechanical design engineer. Based on the ideas, descriptions and sketches by the professor, in an iterative process this group managed to design and build a pilot plant prototype of the continuous process wok. The design process, which is not described in details in this paper, included experiments in plastic models of the tube and the spiral. Key problems were to determine the optimum diameter of the tube, the suspension of the spiral, and choice of material for the scrapers mounted at the spiral. Building up the prototype included parts which were obtained from suppliers on specifications from the J-Consult mechanical designer. He also that solved the problem of suspension the spiral in the tube.

During the development process Fast Food contributed by delivering processing know-how, recipes, raw materials and quality assessments of finished products. However, before that point two new external actors were enrolled in the network. At this stage the professor contacted a patent agency. The consultant from this agency became an important discussion partner challenging the professor's ideas and concepts. The result was a patent application specifying much broader than the original idea and covering different forms of the frying principle, also including a new batch wok.

The unfinished prototype was partly shown at a yearly open house event at Bio Institute. Food Engineering was participating this arrangement, maybe after being advised to do so by Fast Food. The managing director of Food Engineering contacted the professor and the same day they signed a confidentiality agreement enrolling Food Engineering in the *external network*. The professor had been well aware that he had to contact an engineering firm in order to scale up the process and commercialize it. But he did not expect that the specific firm would contact him. After that the engineering firm became a ÿsleeping partner' of the project.

Food Engineering influenced the final design of the prototype at least at one point. Bio Institute planned the heating system of the wok to be electrical or using superheated oil as in the existing process at Fast Food. However, Food Engineering advised the Bio Institute group to change the heating system to natural gas. This change mobilised other external actors. The natural gas heating system was delivered on specifications by a supplier. The safety aspects of the gas system were checked by contact to the Working Environment Service (The Danish Labour Inspection) and the Danish Gas Institute. The stainless steel spiral was designed by J-Consult but manufactured by an external workshop. Finally, the parts of the prototype were being built into a machine by the skilled draftsmen of J-Consult. When the prototype was built, testing took place in which different process parameters (temperature, processing time, rotational speed, etc.) were related to product quality. This work was done by PhD students and the laboratory technicians. Mathematical modelling of the process also took place.

In the autumn of 1998 the real 'obligatory point of passage' was coming up. Bio Institute was ready to demonstrate the functionality of the prototype to representatives from Fast Food and Food Engineering. The demonstration went well thereby establishing a basis for continuing the project. The professor and the managing director of Food Engineering had a meeting where they pooled their ideas of frying processes. At the end of the year the patent application was enlarged with these ideas and Food Engineering were given exclusive rights to the patent.

Network Translations: It was clear now that further development of the continuous process wok was strong influenced by the interests and visions of Food Engineering. At this point Fast Food was partly being excluded from the network. They had renounced all claims to the continuous process wok developed within the frame of the FOETEK project. The quality manager who had initiated the wok project had retired and been replaced by a new person. Fast Food's attitude to

the wok project became ambiguous (there may have been competing coalitions in the management but this is not known to the author). The new quality manager was afraid that a continuous system would constrain the flexibility of Fast Food which he conceived as crucial. But other factors played a role as well. Fast Food was losing money for the first time in many years and they were not sure that an investment in a continuous system would pay back. They also considered the implementation of a continuous system as too big a project. On the other hand Fast Food was not totally backing out. They were open to install a minor test model of a continuous process wok as a separate production line. But they wanted to make sure that they could back out without major problems in the production.

Food Engineering found Fast Food to be a suitable place of testing a new machine but at the same time they emphasized that they did not want to become dependent on the participation of Fast Food in the further develop-ment of the continuous process wok. The managing director expressed the desirable relation by the term "an arm's length".

In the spring of 1999 Food Engineering had to find out in which way the project should continue. Different opportunities were open, including building a larger prototype or building a full-scale machine which then could be tested at Fast Food. One of the key problems was the bigger volume of raw materials in a scaled up machine. It was not known how that would affect the product quality. Food Engineering decided to build a scaled up prototype which can be tested in their own facilities (which is the courtyard!). In the beginning Food Engineering was not interested in seeking financial support from the FOETEK programme but they were persuaded by the professor to do so (as this was the only way Bio Institute could maintain financial support for their work). With Food Engineering as the applicant they got support to build and test a scaled up prototype. However, the sponsoring agency in the FOETEK programme enrolled Fast Food again as they set their participation up as a condition for financial support to the project. The reason for this was found in the FOETEK programme's goal on strengthen the competitiveness of the *Danish* food industry.

At this stage the artifact changed again. Food Engineering did not feel secure about the spiral concept which they saw as risky because they had seen vegetables (onions!) stick to the frying tube. The managing director decided to choose one of the other concepts described in the patent application, namely a rotating tube. He found it less risky and easier to manufacture. The scaled up prototype is now under construction and a series of tests have been planned by Bio Institute which now participate as a consultant in the project. Some of the key problems to be studied are the bigger volume of raw materials, microbiological aspects of the process, contaminat-ion from the machine, capacity, temperatures, position of scrapers inside the tube etc.

From Machine to System or How to Configure the Product: Until now the content of the technology has been described as an isolated machine, the continuous process wok. Building the pilot plant prototype machine was the boundary object on which the collaboration between internal and external actors were centred. However, it turns out that the vision is not an isolated *machine* but a continuous process *system* including a feeding system for raw materials and a cooling unit after the wok. It is now up to Food Engineering to consider how to configure the product. It may be a turnkey package including feeding system, cooling unit and process control. For Food Engineering this will involve the enrollment of suppliers of such systems. Alternatively, Food Engineering sells a working, scaled up prototype to a larger firm which then configures the product.

Outcomes of Networking

It was necessary for the professor to enroll external actors in the network in order to scale up and commercialize the continuous process wok. The enrollment of Fast Food was a precondition for finding a problem to be solved with the expertise and competence at Bio Institute and for getting support from the FOETEK programme. Food Engineering gets most of the early phases of a radical product development done by Bio Institute (pilot plant prototype, studies of process parameters etc.) and obtain exclusive rights to the patent. The continued collaboration with Bio Institute is of great importance to Food Engineering. When "handed over" to Food Engineering one can look at the wok project as a product development project. Through the collaboration with Bio Institute, Food Engineering has almost free access to food science and food technology expertise and competence. It is Bio Institute that has planned test series and microbiological testing of the machine.

Fast Food has initiated the development of an industrial scale stir-frying process but ironically it may turn out that the process is not appropriate for the firm because of the market conditions. Their market requires flexibility and frequent shifts of products which seemingly is in contradiction to the inflexibility of the continuous process system, requiring standardised high volume products. However, the sponsoring agency in the FOETEK programme forced the re-enrollment of Fast Food in the network which may influence on the shaping of the artifact. One may point to one group of actors which until now have been excluded from the wok network: the future operators of the continuous process wok. They could have been represented by the operators at Fast Food. Instead they are inscribed in the technology by the designers. Implementation problems may be foreseen.

Summary
The key institutional actors in this network are Fast Food, a Danish medium sized enterprise; the Food Science & Technology Group of the Bio-Institute at a technical university; FOETEK, a national R&D programme for Danish food technology; and Food Engineering, a small Danish enterprise specialising in the provision of equipment in response to demands from the food, chemical & pharmaceutical industry. Artifacts are also important actors in the network. For example, models and prototypes mediated the distribution of knowledge, translated the concept of the product, legitimated further FOETEK funding of the network, and enrolled Food Engineering.

The context for this network is the national FOETEK programme, without which the pilot plant prototype would not have been developed. Without this prototype, it is unlikely that Food Engineering would have been enrolled in the network. Whilst the network in national, it seems likely that in the future the development of the product will require the enrolment of foreign actors as customers.

3.3.6: Danish Case Two: The Hansen Software Network

Introduction
The company at the centre of the network is a software house is called "Hansen", a pseudonym used to protect its real identity. The primary product of the network is a generic software package with around 20 main modules. The network is organised around the development, sale and implementation of this professional software package which is used in commercial enterprises and in the public sector. The network as a whole engages in a range of activities concerned with the development and diffusion of its products, including consultancy related to implementation, education and training together with additional software modules. Several

individual networks can be identified within this overall network, especially related to the development processes.

The network consist of over 100 companies in Denmark and over 500 international Value Added Resellers (VARs). These are independent companies with various formalised relationships with Hansen on one hand and with client enterprises on the other hand. Hansen itself has over 10 subsidiaries and is a typical result of the PC-software expansion in the 1980s, when a number of small, specialist companies emerged. It sells products in more than 20 countries, predominantly in Europe and USA. In contrast to many of its contemporaries, Hansen managed to initiate a rapid growth which is continuing 15 years later. In the first six years of its existence, Hansen's turnover was less than 100 million Dkr but over the last five years the annual turnover has tripled. The other firms in the network together produce several times that turnover, although there is a wide income range among the small and larger players.

Definition of the Network

This case describes and discusses three intertwined networks related to both past and present development of software applications for three generic software packages developed by Hansen and its network partners. The three are:

- the 'mature' network of Value added resellers (VAR's)
- the mainly internal network related to development of MARK III
- the mainly internal network related to development of the XAS module

The most dynamic network building in the case study period occurs in the development of the XAS-module for the software package, which is Hansen's newest product (labelled MARK III here). This network process is a combination of an intra organisational and inter-organisational development. Network building around the XAS-module has drawn on established inter-organisational relationships with a number of value added resellers (VARs). A central goal for Hansen management is to use the inter-organisatio-nal network to create a balance between in-house and out-of-house innovation vis-a-vis certain specialised VARs, which have competency to develop applications themselves and do so. Innovation can thus occur in a distributed manner at relatively high speed. It highlights that new applications are central to the competitiveness of most of the VARs as well as for Hansen.

The Mature Network of Value Added Resellers (VAR's)

The mature network of VARs was established more than ten years ago, but continues to include new players and adjust to firms exiting, merging or restructuring. Moreover the network is characterised by a coexistence of competition and cooperation. Many of the VARs have overlapping customer groups, while others operate in more restricted niches. The most distinct feature of the network is its customer base, as there are more than 50,000 clients in Denmark and more than 15,000 overseas. The existing VAR network now consists of more than 280 players including a much smaller group which play key parts in product development. These VARs are characterised by diversity in size, geography, sector specialisation and market domination. From this group 8 VARs was interviewed. These were all firms specialising in the Hansen product, sone very small, although others were actually larger than Hansen itself in terms of number of employees and turnover. Some VARs with a broad spectrum of product offerings tend to concentrate on local communities serviced through local offices, while other VARs with specific sector and technical solutions tend to cover a much bigger area., which is typically the entire market, from a central location. Thus Hansen can partner VARs that have specialised knowledge of individual customers or have broader coverage of a whole region.

The direct competition between most of the interviewed VARs relates to the functionality of the standard modules in the MARK III product. This could be due to the diversity in targeted

markets both geographically and sector. Many of the smaller VAR's concentrate their sales and knowledge production efforts specifically in small and well-defined sectors in which they individually regard themselves as market leaders.

Regarding influences on the XAS module and, on the MARK generations in general, there is a direct connection between the amount of influence and the size or specific sector knowledge of the VARs. Bigger VARs, or VARs with specific sector knowledge in the XAS area, tended to have much greater potential to influence and also had greater power over the development process. The interviewed VARs, specifically participated in a series of meetings with Hansen in the so-called 'VAR-council' during the process of developing the XAS module. These meetings where described as having both negative and positive outcomes.

The Product

On top of the standard system MARK III and modules like the XAS, the VARs adds several services and by-products. As the nature of the product has changed, the implementation role has moved from basically a technical task, which demanded a large amount of technical knowledge and expertise, to becoming more flexible and demanding in understanding the more organizational elements of the implementation. Moreover, the life-cycle of most custom-developed modules is very short so that most VARs now promote specific sector expertise as their main product, in terms of consulting and customising either the system to the organisation or the other way around. It has been observed by several different VARs that there is a trend towards fitting the organisation to the system because the built-in system processes seem more suitable than the existing ones in the customer companies. One VAR even suggests that their main product is to optimise business processes. Some VAR's consider themselves as being capable of delivering a 'total systems' solution consisting of both hardware and software, as well as implementation, customisation, consulting and training. Hansen has suggested a model, which implied that a maximum amount of 10% customisation of the standard system should be applied. Furthermore they suggest a model using a systems/process analysis of the organisation before implementation, most commonly resulting in a requirement specification. Only one of the interviewed VAR's has chosen to follow this procedure in detail whereas others have chosen to implement their own models. This leaves an interesting conflict between the VAR's and Hansen. Because the VAR's main product is the customisation of the system, whereas Hansen is more interested in branding it as a very flexible standard solution with little need to change the standard.

Trust Relations

Trust between Customers and VARs: One of the most important ways of building trust between the VAR and the customer is through personal relations. It is important therefore that there is a good chemistry between individuals from both companies, and that the VAR develops an strong interest in listening to the customer's needs. This trust is also product-related in terms of the general feelings about the product and the expertise supporting it in the market. Other trust creating factors, such as the ability to deliver a stable product (both in terms of software and the necessary business expertise), building up cross-company project management groups, recording details of meetings with customers and cooperatively producing a detailed contract are considered of great importance.

The growing popularity of project development workshops means that the customer is given the opportunity to learn and understand the standard system as presented by the VAR. Thus the VAR and the customer often jointly create a requirements specification, which according to many VARs, is a mutually beneficial, trust building process in itself. One of the factors that indicate that trust often exists is that there is a trend towards hourly pay work, instead of a fixed

amount based on a contract. This indicates that the customer trusts the VAR which, in turn, has a wish for a long-term relation, and that this relation can only be built on honesty and reason. The term honesty is a strong tool used by most of the VAR's in order to build strong and long lasting relations to their customers. Many of the VAR's offer additional services to help keeping these relations on-going. In two cases it included a customer magazine distributed typically 2-5 times a year. Also industry groups arose, where many customers attended or organised their own interactive groups or 'talk-shops' which sometimes were able to provide input on specific requirements for the next generation of modules created by the VAR.

Trust between the VARs: Trust between the VARs is often built on cooperation, such as the reselling of other VAR's modules, and personal contacts. Occasionally two or more VARs cooperate in larger cases in order to deliver competent consultation in different areas to a specific customer. Very often this is initiated by a request by the customer who wishes to benefit from the combined strengths and competencies. Some VARs developed modules feature on Hansen's official list and are made available for sale and implementation by other VAR's. The rate of circulation of salesmen, consultants and developers between the different individual VAR's is relative high which naturally maintains unofficial connections between former colleagues and helps maintain an informal cooperative network of contacts.

Trust between VARs and Hansen: Basically all the VAR's have great trust in the MARK III product, and some find it superior to any similar competing product on the market. Here three things arise as important parameters in creating trust in the product:- Quality, stability and content. Some VAR's indicated that early product releases lacked the necessary quality and created problems with customers. A few VARs still will not try to implement the main releases of the MARK III because of this quality issue. Although some mention stability problems, all VAR's seem to have faith in that these problems will be solved in the near future.

Because most of the VARs main income stems from customising the system to the customers' specific needs, a relatively long lifespan is considered a fourth feature of the product. Instead of having the customer buy a new system, the VAR is capable of making a continuous profit on existing customers without having to spend money on educating their sales personnel, consultants and developers in new systems and concepts. Finally it is of great importance that the product or specific modules cover to a large extent the specific needs of a broad customer group in order to target the product more widely.

The potential new customer sees Hansen as a stabile enterprise with a large installed base of basically existing satisfied customers. On the other hand, several VARs express consternation regarding infrequent releases of service packs for servicing the existing base, and some mention the lack of help in creating sales arguments in relation to competing standard systems. Most of the VARs have created their own personal networks into Hansen, with some of these even overriding internal structures and procedures inherent in Hansen. These personal networks are considered imperative to the VAR in order to keep a constant flow of information and to retain trust and cooperation in the network.

Furthermore several VARs participate in monthly strategic meetings with both distribution and management in Hansen. These meetings are described as a tool for sharing information and experiences and help both the VAR and Hansen to understand the functionality and content of the network. One VAR has even lent some of its systems developers in order to solve a specific task in Hansen's development department. This way the VAR gained substantial influence on the product and had their developers educated at the same time.

Description of the Network Building Processes

The long term development process of Hansen looks, from an ex post view, as a series of successful episodes. From an external research perspective, it is easier to 'track' and detail specific episodes than it is to comprehensively track the whole story and thus deliver an interpretation of why some of them became 'bubbles of innovations' and others not. Hence the emphasis on analysing the MARK III episode, as one such 'bubble'.

Commenting on the company's history, one of the founders asserted that the company has been in the same situation several times before as now, where the simultaneous launch of a new generation whilst maintaining the previous leaves the company is a vulnerable transition. He noted, "We have all the time understood how to exploit the situations, where our products have passed the summit, to invest in the next generation".

The episode of establishing the network of partners, system centres and value added resellers was a result of a strategic decision. The management of Hansen wanted the organisation to concentrate on the development of software rather than having the responsibility for sales themselves, so this task was out-sourced to the value added resellers. In doing this Hansen introduced a mutual interdependency with a network of independent companies, each pursuing their own goals. Moreover it introduced a distance to the customer companies which now relate more to the VARs rather than to the software house.

The MARK III Episode

Each of the episodes above could in principle raise the issue of inter and intra-organisational links. The organisation as well as technical innovations can and do have a bearing on product development. The MARK III episode, initiated in the mid-90s, is a clear example of 'classical product development', where changes in the technical content of the product is predominant. (In other episodes and on other occasions it might be organisational issues or the services offered that affect product development in a broader sense).

The occasion that gave rise to the third generation had a number of components, especially a wish to make a product aimed at middle sized companies, the Y2K problem, a new generation of programming language (an object-oriented programming language), developments in the internet, and finally the desire to expand into the international market. Even though the development of MARK III was a 100 man year investment, Hansen was aiming to reduce costs of maintaining over 20 country variants of the previous generation. After the first major investment, there was a need for a quick expansion of the functionality of MARK III. The expansion of functionality has both been a question of developing sub-modules and new features in relation to the core of the program, e.g. use of the internet and of 'thin clients' (Thin clients means that you are able to use the system from your home with a modem connection to the office and without having installed the entire application at home).

Microsoft Solutions Framework: The company introduced Microsoft solutions framework as the model for product development which represented a shift from a traditional organisation to a matrix organisation. Seen from the management level there has been two important elements of the shift. One is a shift in focus from functions to product and the other, decentralisation of decision making. There was an interest in focussing on 'time-to-market', which is an integral part of the MSF model. This is arguably done by a combination of small teams and short development cycles. The major effort in development combined with the general growth of the company gave an increased emphasis on human resources in that skilled programmers and other developmental expertise needs to be introduced quickly. Management saw small teams as a tool in this process. MSF has four main elements: a team model, a process model an application

model and a design for usability model. (We refrain from discussing the latter two models here). In short the MSF team model leads to an organisation consisting of feature teams with 4-12 persons. Each teams has the responsibility for a smaller part of the total product. In each team the employees has to divide 6 roles among them (if there is less than 6 persons in a team one person has more than one role). The 6 roles are:

1. A Product manager, responsible for relating product development to market expectations. This includes gaining market knowledge and keeping VARs informed.
2. A Program manager, responsible for resource allocation and scheduling.
3. A Developer, responsible for developing the program.
4. A Tester, responsible for testing the program.
5. A User educator, responsible for user education, manuals and courses.
6. A Logistics expert, responsible for team logistics but, even more importantly, for determining how the system be introduced to the market and at what price.

Even though one person is responsible for a task, the idea is that everyone should be responsible for completing the task and has the same level of influence on its "a group of peers". In order to secure the coordination across teams and the development of best practice in the feature teams, one function team for each of the six roles was also established. Support-knowledge is linked to the product development by knowledge teams, consisting support-people from different countries in the world.

The MSF process model is intended to be a circular process of four phases. MSF opens with a vision phase ending up in a vision scope approved milestone. This is followed by a planning phase. This phase ends when the team (and management) have agreed on a schedule and the resources allocated to the project. The third phase is development, ending with a first version of the intended software product (in Hansen this is called a beta version). The fourth phase is then the test phase called stabilisation.

The Development of the XAS-module

We now turn to the specific process of developing the XAS- module, which is part of the MARK III- development effort.

Initiation & Formation of Teams: When the company shifted to the MSF model, management assigned the single programmer to a specific feature team. There has been an increase in the number of people employed in the company with management policy being to recruit externals with practical experiences in the domain the software modules address. Of course the company would like to recruit higher numbers of IT-specialist who could program the new system but they are hard to get. At the same time testing of the product increased as the complexity of the product increased. Testing is normally done by employees who are not IT-specialists but in the case of the XAS module, it was a practitioner who did the testing.

Building: The development of the XAS software runs through several full cycles of the MSF procedure as described above. The number of people in the team rose from two in the early stages to four in permanent positions in the team and two persons who has been lent temporarily from other parts of the company. Their task was to develop the user education which was considered to be more demanding than normal since it was a new module.

The first two persons in the team where both programmers and at the time they decided to let one persons take all the roles while the other programmer was concentrating on programming tasks. As this happened at the same time as the MSF system was introduced, the person who had the six roles spent nearly all her time at meetings. When the team was fully staffed the

programmers chose to only have one role each, program manager and developer, while the tester also got product management and the user educator also got logistics.

In the vision/scope phase the team initially developed a general overarching vision, which in this case had the character of, "helping our clients to perform this (XAS) -task". The next policy formulation encompassed the pinpointing of main sub-tasks for the module. The team developed consensus over three possible points. Two external consultants hired to support the development had ideas of a sub-task, but it was dropped after the internal negotiation. Another sub-task was transferred back to management when the team informed top level management that they thought it was too big a task for them. In the first vision/scope phase, there was negotiations with VARs and other externals. The team's first move was to give three VARs a preview of the module an then ask them to tell the team which five features would be the most important and what additional features might be needed or desirable. This partial enrolment functioned as an information channel and as a mediator of VARs' expectations. At the same time it assisted in informing Hansen's management about these expectations.

The external actors and the VARs were 'formally' enrolled through the establishment of a so-called VAR council in relation to the XAS-module. This council held three meetings before management decided to halt the activity. There continues to be slight tensions around the issue of, "how much should the VARs know and when and what should be their role". Several different departments of Hansen articulated different views on this ongoing controversy. Internally in the XAS-team, some members proffered an interpretation that listening to the customers is in contradiction with being ahead of the competitors.

After the vision/scope phase, attention transferred to the specification of the required development. This implies a hand-over internally in the team from product manager to developers and a transition from general consensus on product content to attention on specific functions in the software.

In the Planning phase, the team prioritised certain tasks and downplayed others and informed management. Development of the software is in this early stage of the product development. In order to be sure about the quality of the code the company has developed a description of 'best practise' telling the programmers how the code should be made and how the user interface should be. An overall standard for the code became even more important because the company decided that although being on markets with different languages it decided not to supply the VARs in the different countries with documentation of the code in their own native language. It was considered to make the documentation in English but partly because the programmers was not used to writing in English and partly because management was afraid of how the French and German speaking markets would react.

During the development phase the program was stabilised once a week as the program was turned over to the testers, while the programmers where continuing development on other parts. An important point during the programming phase was to secure that the different parts and modules of the MARK III system would be functioning together. The testing of the preliminary version was done in so-called 'war-rooms', where the teams gather to investigates bugs, errors, etc. The team spent two weeks doing this after the first cycle. When number of new discovered bugs starts to decline then the closing/stabilisation phase is near.

At postmortem meetings, several activities were evaluated, including the internal collaboration in the team and how the roles was functioning. The team was not entirely happy after this first round. The beta version from this first cycle was released against the wishes of the development

team. This resulted in a heavy bombardment of telephone calls to the development team from VAR representativ-es and others, who wanted specific details incorporated in the next cycle.

Summary

The context for the network is Hansen's strategic decision to have a layer of VARS between Hansen and the product's 'end-customers'. The 'value added' aspect of the VARs' activity is that they derive their main income from customising the product. Therefore, new product development in this network is distributed between Hansen and the VARs. Generally speaking, Hansen develops a product that is both standardised and flexible, whilst the VARs customise this product to meet the specific needs of the customer. Product development increasingly involves reshaping the customer, a task which is undertaken by the VARs. In this respect, the customers themselves are also new products developed in the network.

The product itself plays an important role in shaping the identities, relationships and conduct of actors in the network. The quality of the product is important in the maintenance of network *trust*. The product must also be, at different times, standard and flexible, or customised and tailored. Whilst this dual product profile creates mutual dependency and cooperation around product development, it also creates the potential for competition between Hansen and the VARs. In order to develop a standard and flexible new product and enrol both the VARs and the customers, Hansen needs to collaborate with the VARs. But interacting with the VARs engenders a risk for Hansen that the VARs will learn the knowledge and contacts to take over Hansen's product- and market-space within the network. In other words, in order to develop a successful product, Hansen must expose itself to the risk that the VARs will exclude Hansen from the product loop.

3.4: Comparative analysis

3.4.1 Introduction

This section is concerned with an inter-country analysis of the implications of networks for new product development. Four themes have been identified, and have been applied to all six cases in turn as part of a common analytical frame. The comparative analysis initially focuses on the theme 'power/process', and identifies how this impinges and influences network function in each of the cases. The other themes focus on issues that help to elucidate the political processes that affect network building, its sustainment and support for innovation. These themes are trust, contract, and communication, knowledge and learning and the role of the artifact in network building.

3.4.2 : Power/process:

The six cases illustrate how 'political processes' affect building collaborative networks for new product development. Securing access to appropriate resources such as finance, technology, knowledge, information is necessary for collaborative product development projects in terms of planning programmes and activities. Creation of appropriate organisational processes and structures enables collaboration to be built and sustained, while establishment of clear linkages between inter- and intra- organisational collaboration can facilitate network process in product development. Together with a consideration of organisational strategy, these are all part of a process to build and sustain successful networks. Problems may be encountered, however, such as establishing a smooth flow of resources where project 'champions' have difficulty in building effective coalitions. Other problems can occur in changing existing organisational arrangements, procedures and routines which could act as a constraint on the capacity to develop and sustain effective collaboration. Finally it is necessary to consider problems in creating meanings which enable others in the network to understand the strategic significance and value of a new product development and collaboration as a means to achieve it.

Winning Resources

UK Case 1: Despite the many problems which beset this long term collaboration it is clear that technical knowledge and information were able to flow relatively freely between H Co. and F. Co. through informal networks at the level of product development teams. Financial resource issues were less significant in the context of MOD contracts. A key driver of the collaboration was the mutual benefits to be gained from the combination of the human resources of the two organisations.

UKCase 2: ABC's business strategy was based on its capacity to appropriate the necessary financial, technical and human resources required to deliver 'business solutions' to its clients. Of particular significance was its approach to securing the free flow of both technical and business information from the client organisation through highly developed informal mechanisms for communicating with clients at different levels of business operations over the full cycle of the product development process (including the pre-contract phase).

GERCase 1: The 'German association model' represented by the VDA organisation provided a formal framework within which the interchange of technical information could take place amongst industry experts from the major manufacturers and suppliers. Key individual experts were able to orchestrate the acquisition of these resources. For the software development phase the resource winners within the 'electronic business group' were also important.

GERCase 2: An important backdrop was the existence of a 'regional innovation dialogue' which inter alia allowed for access to financial resources by the state of Bremen. This framework provided the platform for the resource winning activities of the two 'product champions' in the logistics and the software organisations.

DENCase 1: Access to necessary financial resources was facilitated by the Danish Government's FOETEK programme aimed at encouraging collaboration between research institutions and industry. The University based inventor was effective in winning resources within the institution to establish technical facilities, engagement of human resources etc. which could facilitate and support projects aimed at industrial collaboration and enable the WOK product development to be initiated.
DENCase 2: The mature value added reseller network provided a conduit through which market and technical information could be communicated to the nodal organisation to inform the development of the MARK III product. As the nodal organisation Hanson grew it is notable that the human resource requirements for software engineers required entry into an international labour market.

Organisational Processes
UKCase 1: It is clear that for much of the period of collaboration H CO. and F. CO.. struggled to find appropriate processes and systems to enable inter-organisational collaboration. The decision by H CO. to purchase F. CO.. towards the end of the period covered by our research suggests a strategic intention aimed at framing future collaboration within inter- rather than intra- organisational processes and systems.
UKCase 2: ABC was in a position of considerable influence in defining the development of the collaboration with XYZ through the development of a 'hybrid' organisation. This approach represented a conscious strategy on the part of ABC underpinned by a sophisticated methodology for executing collaborations of this kind. This way of organizing for innovation consciously blurred all manner of accepted intra- and inter- organisational boundaries and divisions in the interest of finding new ways to synthesize knowledge.
GERCase 1: The long standing relationships established through collaboration in the VDA organisation provided a platform for subsequent software development in the industry. However, the adoption of EDI amongst suppliers required active network building on the part of software suppliers to provide information on EDI opportunities and benefits.
GERCase 2: Teledata had procedures to control the risk of collaboration and to ensure that 'added value' was secured. In addition the complementary capabilities of the two 'product champions' permitted a clear role definition whilst almost constant informal communication and information exchange occurred at key phases in the project. In the marketing phase of the project these relationships became formalised through contract defined relationships,
DENCase 1: The collaboration had not evolved sufficiently for systems and processes to be developed beyond the formalisation of the collaboration through a confidentiality agreement.
DENCase 2: A complex structure of networks provides systems and processes to support product development. We can note the inter-organisational mature network of Value Added Resellers and the inter-organisational network within the nodal organisation (' Hansen') based around the Microsoft solutions framework. The former development reflects the nodal firm's early strategic decision to focus on software development and to 'out source' sales to the VARs.

Intra- and Inter- firm linkages
UK Case 1: It is only in the final period of the collaboration reported in the case that intentions to fashion clear strategic links are evident.
UKCase 2: ABC defined the software development activity as one of solving client business problems requirements. This ensured strong 'product integrity' whereby software teams had clear parameters defined for their activity but were empowered to find novel solutions to client business problems.
GERCase 1: EDI was viewed as an important development within the German automobile industry but individual manufacturer and supplier interests shaped this development rather than a strategic perspective for the sector as a whole. One consequence was the development of open

standards which acted as a subsequent constraint on the development of fully integrated electronic linkages in the supply chain.
GERCase 2: The CATS system, as a prototype development could be considered as a system in which all parties – the environment, transportation firms, customers and truck drivers – benefited in various ways. In this sense, the 'strategic fit' of the product extends beyond the corporate interest to embrace, local state and societal interests, such wider linkages with the potential customers for the product need to be built.
DENCase 1: This product development process had reached the stage of prototype development. However, the 'smelt and tasted good' result of the prototype test potentially provided the basis for an on-going phase of development. While linkages with the Bio-institute remained cordial, the funding body FOETEK had to mediate between the strategies of Fast Food and Food Engineering to keep the network together.
DENCase 2: The value-added resellers adopted a number of strategies which ranged from presenting themselves as suppliers of 'total systems solutions' to a focus on software, consulting and implementation activities. The nodal firm sought to reduce 'time to market' and to decentralise decision making by focusing on its 'core competence' of software development. The MS Solutions framework represented a means of communicating high degrees of 'product integrity'.

Role of product champions
UKCase 1: The collaboration, in this case, was profoundly affected by a change in senior management at F Co who did not support the joint project with H Co. However, Senior staff at H Co continued to 'champion' the F Co technology throughout this split and were instrumental in implementing an in-house strategy at H Co which resulted in its continued long-term access to the F Co innovation.
UKCase 2: It is clear in this case that problems of this nature were minimised by ABC and XYZ's collaboration through a 'hybrid' form of network organisation. However, one issue emerging at the end of our period of study was how XYZ would re-engage technical knowledge and information 'lost' to it through the original out sourcing arrangement which gave rise to the 'hybrid' organisation. This case also suffered at an early stage due to loss of the senior product champion at XYZ, who had initially set up the collaboration.
GERCase 1: Small suppliers were not part of EDI development in the automotive industry because they were not perceived by members of the 'electronic business group' of manufacturers and large suppliers to have the necessary resources to be able to meet the demands of the development process. One consequence was that problems occurred in implementing EDI in small suppliers who found software products and systems did not meet their needs.
GERCase 2: Whilst not evident in the initial phases of the CATS system development, the subsequent interest in the system from outside Bremen required enlargement of the network in order to market and further enhance the system.
DENCase 1: Problems began in the post-prototype phase as the retirement of the 'product champion' within Fast Food and the firm's deteriorating financial position made the continued support of the company for the development of the WOK problematic.
DENCase 2: The relationship between the nodal firm and the VAR network contained elements of both collaboration and competition. Whilst a conduit through which information about product/customer requirements could be passed, it was not in the interests of the VARs to pass on all such information and thereby reduce the opportunities for revenue generation offered by their customisation capability. At the same time, passing on full product information was not in the competitive interest of the nodal firm for the same reasons. In the development of the module the development team did not want to pass full product information to the VARs nor

was the team convinced that knowledge of customer requirements as viewed by the VARs was essential for the development of a competitive product.

Organisational procedures

UKCase 1: A major issue in this case is the are failure in integration of processes and systems in HCo and FCo for effective inter-organisational collaboration. Problems here also reflected failings of processes and systems for inter-firm collaboration within each of the collaborating firms. It is by no means clear that these problems have yet been resolved following the takeover.

UKCase 2: The process of the collaboration is characterised, in particular in its mid-stage, by a struggle to regain control on the part of XYZ. This can be seen in particular, through the negotiation of tighter formal contractual controls and the introduction of third parties to manage the relationship. In these respects we can see XYZ seeking to gain control of the product development agenda by drawing upon new sources of network support in the form of formal rules and procedures and the agency of consultants in an attempt to build systems and processes to more effectively 'police' the relationship with ABC.

GERCase 1: The VDA organisation facilitated technical information exchange amongst experts but these individuals saw their role as confined to discussion of the best technical means to establish EDI standards rather than to negotiate on the issue of whether an 'open' or a 'unified' standards was the most appropriate outcome for the industry. However, failure to find inter-organisational arrangements which would enable the inclusion of small suppliers in the 'electronic business network' had long term implications for the diffusion of EDI in the industry.

GERCase 2: In this case the inter-organisational arrangements for product development were divided with regard to the complementary nature of the work programme and supported by the funding body. However, the end users were not part of the initial development.

DENCase 1: The stalled development of the WOK reflects the embryonic status of inter-organisational processes and systems. It seems likely that future development will be contingent upon Food Engineering becoming the nodal point for further network developments. It is also true future operators of the Wok were missing from the network during the prototype stage. This obviously has potential implications for the optimisation of human/machine interface design.

DENCase 2: There is evidence that inadequacies in the formal linkages between the VARs and the nodal organisation, Hansen, have resulted in numerous informal linkages at various levels. At the same time informal linkages established by the development team were broken by senior management within the nodal firm in efforts to control the flow of information to the VARs. Future developments involving more dispersed software development activity, perhaps through more virtual organisational forms, suggest a further set of problems and issues will need to be confronted to ensure systems and processes do not constrain the development process.

Meaning, value and significance of new product development

UKCase 1: This is a further problematic area in this case. There is a clear sense in which the collaboration was sustained, in large part due to a set of strategic meanings which provided a means through which the value of such collaborative activity to product development in both H Co and F Co could be articulated and understood within them. Significant differences in culture and thereby the interpretations and behaviour of organisational members in relation to the collaboration at various levels remained evident throughout in this case. There was no 'road map' through which collaborative activity could be guided.

UKCase 2: Whilst remarkably successful in articulating a strong set of meanings the viability of ABC's approach ultimately still rested on the client accepting that the resources on which it depending could most effectively be procured through such means. Once XYZ had been acquired by an owner whose strategic priorities viewed IT systems as a core activity which

should be retained in-house and not-out sourced the dependency relationship which had given initial impetus to the collaboration was brought to an end.
GERCase 1: Senior management of the major car manufacturers and large suppliers did not realise the future strategic importance of EDI and therefore supported the development of open-standards (rather than a strategic unified standard), and ignored the need to take small suppliers interests into account. The result in the longer term was higher implementation costs.
GERCase 2: The regional background to this project imparted a shared meaning and significance to the collaborating institutions. However, the stage of production and implementation will introduce new network members who do not share this background and new meanings and values will become part of a wider product.
DENCase 1: No clear strategic linkages had been established to enable either Fast Food or Food Engineering to see the potential new process technology as of strategic significance. However, the fact of a working proto-type suggests there is potential for this to be achieved.
DENCase 2: There was a lack of consensus between some of the VARs and the nodal company (Hansen) as to whether the software product was best presented to the market as one that is primarily something that can be customised to suit particular circumstances or is a flexible standard solution which required little customisation. This basic tension was further exacerbated by the rapid growth of the market place and its globalisation.

Discussion
Each of these categories has been interpreted in the light of outcomes from the six cases. While the cases stand independent of each other, in this interpretation they serve to highlight the role of political processes in new product development networks. The various topics from resource to organisational processes and finally to cultural values and meanings expose the processes involved in building and sustaining networks as pivotal to new product development within organisations. Each of these categories can be seen as a constituent part of the concept 'network knowledge', referred to in the section on policy implications below.

3.4.3 : Trust, Contract, Communication and Networking

In this cross case thematic analysis, the three factors trust, contract and communication are considered to be related to each other in the ways indicated in the theoretical introduction. For the purposes of comparing the case studies six categories have bee utilised. Concerning trust the dimensions are competence trust, inter-personal trust and system trust. Interpersonal trust is perceived as being more than just competence trust; as it focuses on interpersonal interactions. It is suggested that higher trust level in this dimension means better co-operation and an improved opportunity to develop innovations in longer term situations of inter-firm co-operation. In the role of contract in the case studies is identified through two dimensions: the overall importance of contract for networking (implying to a certain degree this may overcome a lack of trust in these networks), the function of contract, that is contract used as a means to initiate and stabilise networking or to regulate the exploitation of achieved results of networking. Concerning communication, both the opportunities for formal and informal communication are considered.
The Role of Competence Trust
UKCase 1: Trust there is a continual high level of trust by H Co in the technological capabilities of F Co and it is the desire to capture this capability which fuels the on-going collaboration between to two firms, even to the extent of renegotiating a contract after the first one had broken down completely. There is, in contrast a very low level of trust by H Co in the organisational capability of F Co in terms of keeping to deadlines, and controls have to be brought in to aid management. It is worth noting that there is an apparat competence trust by F Co technical staff in the engineering ability at H Co which has worked against the development of high level of inter-personal trust between the two divisions.

UKCase 2: XYZ had to acknowledge its dependence on the technical expertise of the software firm, and to trust their ability to deliver the technical specifications to the standards required by the contract. The lack of in-house expertise at XYZ was also acknowledged as a problem in terms of assessing the technical competence of the other firm. In response, ABC brought in more senior executives to manage the relationship and increase the appearance of both technical and organisational competence. New agreements helped to clarify the responsibilities between the two firms. Paradoxically, a third firm that had been brought in to help manage the situation increased the problem relating to the lack of competence trust by trying to optimise their own interests in the agreement.
GERCase 1: There was a great deal of competence trust and respect between the highly qualified experts in the VDA. The innovative work of these experts, however, was limited insofar as they had no power to put through unified standards. Their duty was to translate the special interests of their firms into VDA standards as compromises. Small suppliers were excluded from the VDA network, because the networking experts judged them to be less technically competent. In the secondary networks this lack of knowledge and competence had to be overcome by the EDI systems developed**.** On the other hand, concerning the relationship between car producer and JIT suppliers there are relatively higher levels of trust between the experts of both sides concerning competence trust.
GERCase 2: Both firms involved in the development accept each other as competent experts (concerning technical and organisational issues), so very early on it was clear that both sides would contribute to the innovation according to necessity and competence
DENCase 1: Fast Food had some existing trust in the technical competence of the Bio-engineering professor. It was this professor who introduced Food Engineering to the network for testing purposes, and had trust in their ability to build a scaled up version of the prototype. FOETEK, as the sponsor of this development exemplified trust in the competence of the network by continuing to fund the product and by using its influence to keep Fast Food in the network.
DENCase 2: This case is a typical strategic network (Sydow 1992). VARs and the customers depend on Hansen, as the hub of the network. The competence to develop applications has been a key criteria for selecting the VARs as partners. The trust between Hansen and VARs is rooted in their technical competence, but this is a case where, as trust in the technical competence is high, there is a certain amount of secrecy and mistrust about organsiational and commercial intentions of the VARS. In the development of the AS-module, the selected VARs was formally enrolled through the establishment of a VAR-council. Nevertheless the tensions have continued around the issue of how much should the VARs know and when and what should be their role.

Interpersonal Based Trust
UKCase 1: During the period immediately after H Co purchased F Co there is some evidence that the two firms were involved in a process of building up inter-personal trust from a low level of suspicion to a level of higher mutual trust achieved through activities such as exchanges of personnel and inter-firm visits.
UKCase 2: One particular area of difficulty was the perception by XYZ managers that they were communicating with more junior staff on the ABC side. The concept of a 'flatter', less hierarchical structure was not easily accommodated by the utility firm. This low level of inter-personal trust was changed after ABC brought in higher level managers so there could be a more equal level of exchange within the network. This was an example of the flexible internal networking skills of ABC. XYZ, however, responded to the low level of inter-personal trust by introducing more external consultants to manage the network interactions, so maintaining a low trust situation.
GERCase 1: The VDA experts knew each other quite well, and had a high level of interpersonal trust Lower personal trust is one of the main reasons why small firms were slow to

implement EDI. This lower personal trust is partly due to the exclusion of small suppliers from the primary network.
GERCase 2: The CATS development network is an example of high trust between central network actors who are mutually dependent on each other
DENCase 1: In this case trust has been an issue at different levels during the network building process. The professor, who was the initiator of the network, already knew the product champion at Fast Food, but did not know the managing director of Food Engineering personally. As Food Engineering was a new network partner there was no particular inter-personal trust with the other two organisations.
DENCase 2: Inter-personal trust is low between Hansen and its customers. Although there is some trust between Hansen and certain VARS, there is also mistrust. This is particularly evident in the VAR-council because the risk of making a wrong promise could lead to frustration and to unintended differentiations across markets.

System based Trust
UKCase 1: The level of system trust is low in this case, but inter-firm organisational processes begin to improve after the takeover of F Co, with closer communication between the firms.
UKCase2: XYZ was considered by the software firm to be somewhat naive in its software dealings, especially in terms of losing its total software expertise. The response of XYZ was to reduce the dependence of XYZ on one software supplier, by allowing other software firms to be brought in as necessary. This threat of competition was seen by XYZ as increasing their control of the situation. Other management consultancies brought in tried to improve communication and trust building.
GERCase 1: System trust is high in this case, mainly due to the existence of the VDA association. System trust is lower between car producers and small suppliers in the secondary networks than between car producers and large suppliers.
GERCase 2: The level of system trust is high within the new product development network, mainly due to its embeddedness in a region.
DENCase 1: There is a low system based trust due to the fact that the actors did not know each other well and there is a low level of mutual interest in the project.
DENCase 2: The networks in this case face increasing tension as Hansen becomes a global firm. The country specific features and differences in market-demands make the innovation decision difficult. Early interaction with the VARs on new features create expectations, which are capitalised by the VARs in the sales processes and by Hansen as content for the software development process. At the same time however the expectations then become relatively fixed and Hansen have less room for manoeuvre in the development.

Role of contract in the Network
UKCase 1: Contract relationships are very important in the development of the technology in this case. In particular the contract specifies very tightly issues over the timing and specification of the project leaving very little room for manoeuvre in the collaboration. Inter-firm contracts cover the role and responsibility of each firm with respect to the project. One of the major problems in terms of the progress of the relationship between the two firms has been the lack of trust that H Co had in the ability of F Co to actually work to the deadlines and budgets set by the contract. H Co was forced to make up the difference between the contract specification and the work actually delivered by F Co during the first phase of collaboration.
UKCase2: The initial contract between the utility company and the software provider was generally considered, by the former, to be most favourable to the latter. ABC was granted exclusive rights to the XYZ software business, early threat of legal action over 'non-compliance' to the contract illustrated the lack of trust between the two firms and the level of suspicion on the part of the utility company, XYZ.

GERCase 1: Contracts didn't play a role in the networking process. There was a continuous and intensive communication of the VDA group over years, although the outcome was more of a voluntary than a contract based nature. Between JIT and the car producers important are long term contracts regulating the relationships between both companies. The experts are acting in this frame.
GERCase 2: During the developmental stage there was no a contract between the actors. TELEDATA was responsible for the contract with the Bremen state. This contract didn't specify the work of the networking parties. Marketing of the developed product is regulated by a contract defining which partner can sell the product in which market segments.
DENCase 1: The actors could trust each other when the confidentiality agreement was signed. Trust was reconfirmed when the two merged their ideas and knowledge in the patent application and signed an agreement giving the exclusive right to Food Engineering to exploit the patent commercially. This is an example of contract-based trust
DENCase 2: Even though the VAR-network is mainly held together by a mutual interdependency, this is underpinned through a certification program, where VARs can obtain different status vis a vis Hansen.

Function of contract
UKCase 1: A question concerning contracts was in the ability if H Co negotiators to control the terms of a new contract when it was being negotiated for a second time, and it was for this reason that the H Co negotiating team were sent on a training course. Even so, the extent of the lack of trust in the management and organisational abilities at F Co resulted in a number of contingencies to cover lost deadlines which were built into the relationship. Finally, it was due to concerns over the fate of the inter-firm contract between H Co and F Co, should F Co be taken over by another firm for a second time that led to the acquisition of F Co and its subsequent assimilation into the H Co group.
UKCase 2*:* The first contract was renegotiated and the new contract concerned issues to do with both the provision of technology and the management of the network. The renegotiated contract did, in this case, result in better communication and a higher level of trust between the two firms. This was backed up by the obvious efforts made by ABC to actively improve the situation from their side. Even so, it must be recognised that these efforts, made a the local level between specific managers in the two firms, were not inviable when the entire utility firm was taken over. The cancellation of the contract demonstrated that the software firm was not irreplaceable, even after working in collaboration for a number of years and having developed some expertise in the business software requirements of its partner.
GERCase 1: A lack of contract means there are opportunities for individual and specific EDI systems to be developed and implemented where opportunities existed.
GERCase 2: From the beginning benefits from the project were expected even without a formal contract.
DENCase 1: The position of Fast Food changed. The quality manager retired, the firm lost money, and management was afraid of the inflexibility (standardisation and high volume) they perceived as built into the continuous process wok. Fast Food signed away their rights to the invention, and Food Engineering had achieved what they wanted.
DENCase 2: The certification program is a means of managing the relationships between Hansen and the VARs.

Communication
UKCase 1: The relationship between trust and communication is aptly illustrated in the interpersonal relationships within the product development network. The Contract teams in both firms, for example, have an ongoing relationship based on high trust and a high level of communication and information exchange throughout the whole period of the relationship. The

relationship between the Senior Managers on both sides starts off well, but deteriorates with the appointment of the new CEO who is hostile to the collaboration and instructs F Co staff to cease communication with H Co. Relationships between the engineers on both sites, however, develop into a hostile confrontation, characterised by a lack of information exchange, and a failure to develop informal communication links. This state of affairs, however, appears to have developed due to a the fact that F Co trust the engineers at H Co with the technical ability to continue the development of 'their' technology should they themselves 'fail' in some way. Lack of communication and secrecy in this case appears to emerge from a relationship of high trust in the engineering skill of H Co by F Co.

UKCase 2: Early difficulties in communication between the two firms, in particular originating from differences in organisational structures. The period during which the contract was re-examined, however, proved to be an opportunity to improve the problems of mistrust which appeared to exist between the two firms, which had been complicated by the introduction of new firms as part of the control mechanism.

GERCase 1: Concerning the relationship between the car producer and the small suppliers a serious lack of communication seems to be responsible for the low trust relation between these both parties. Especially missing is personal face to face communication. There is lack of knowledge on the side of the car producer concerning needs, expectations and anxieties of the small suppliers concerning EDI; a lack of knowledge concerning EDI on the side of the small suppliers; including a lack of knowledge concerning the software market; there is a "social distance" between producer and suppliers, a "power distance" between both parties; small firms being more or less dependent from the car producer. There is also an intensive communication between the experts of JIT suppliers and car manufacturers.

GERCase 2: There has been an intensive communication between the two main actors in different forms. They have been meeting several times a week during the development process. The communication was less intensive between the both main actors and the truck divers. But the truck drivers have sometimes been driving directly to TELEDATA if they had problems with the system meaning that there was direct face to face contact between them and the expert of TELEDATA. There was also direct contact between the expert of CL and the drivers.

DENCase 2: There are numerous communication channels between Hansen and the VANS, both formal and informal. Also between the VANS and their customers, including training days and newsletters in some cases. Some VANS, however, have a much closer communication with Hansen than others.

Discussion

Networks can function with both high and low levels of trust at certain key points, as long as there are mechanisms in place to manage and control activities in the network, another constituent of 'network knowledge' as referred to in the policy section. It is not desirable to have to much conflict, nor too much co-operation in product development, as these may make it difficult to control. A contract helps to define formal limits and boundaries for mutual trust and interest in product development networks, but the existence of such a formal agreement is not always necessary at the very start of a project. Formal communication channels are always necessary to allow transfer of information essential to the project. However, informal communications indicate a close network where inter-personal trust is high, although such communication might not be welcomed or easily controlled.

3.4.4: Knowledge and learning in networks

In this cross case analysis, the four themes identified are related to the role of knowledge and learning issues. Movement of knowledge between case study networks, technological, managerial and organisational learning are considered

Knowledge flow in networks

UKCase 1:During the course of the first takeover of F Co by the US firm, F Co went through a process of losing, and rehiring technical expertise. H Co, in contrast, responded by developing in-house knowledge, but subsequently ceased work on the receiver. H Co, however, then wanted to control access to F Co's expertise and the solution to this was a complete takeover of the firm by H Co.

UKCase 2: On-going transfer of knowledge about the business practices in the sector resulted in a build up of expertise by ABC with respect to the business solutions that had to be developed. It is not clear, however, whether such knowledge transfer, from what was, after all, a one-off situation, resulted in a developed competence for offering particular support to the industry as a whole, either in the UK or elsewhere.

GERCase 1: In comparison with other innovation networks, shared, rather than complementary knowledge was necessary in this case. Large amounts of information move through these networks via the implemented EDI systems.

GERCase 2: All participants are bringing their practical knowledge and experience into the development process.

DENCase 1: Information flows from Fast Food to the Bio-institute. Then as the prototype was developed, from the university to the food engineering firm.

DENCase 2: Knowledge exchange takes place between Hansen and VARS as well as between VARS and customers.

Technological learning

UKCase 1: H Co has gone through a process of quite rapid learning through 'catching up' with F Co, but then the acquired knowledge was not applied further after the decision to buy the other firm. F Co, in contrast, appears to engage in a process of continual learning as far as the technology is concerned, despite quite major changes in personnel who must have left the firm with relevant knowledge related to the technology. In general the lack of interaction and knowledge sharing between the two engineering sites can been seen as a barrier to the more general diffusion of knowledge between the two firms.

UKCase 2: A major opportunity for technical learning was lost by the electricity firm at the start of the project through the transfer of nearly the whole of the IT department to the software firm. There are also questions in this case about the accumulation of technical expertise within the 'virtual' organisation of the software developers, situated as they were both in India and the USA. It is possible that such '24 hour' work organisation may have costs in terms of developing experiential learning opportunities.

GERCase 1: The VDA group represents an inter-organisational network which has survived over a long period of time and has gone through a collective learning processes. One aspect of this is that the co-operating experts could not fully realise their developing expertise, because as representatives of organisations with conflicting interests, they could not develop optimal technical standards. The specific EDI solutions that were developed linked into particular supplier - customer networks.

GERCase 2: As the innovation moves from a prototype, to local, national and international use, the truck drivers emerge as a central group, who are part of the technical learning process in terms of testing the systems in practice.

DENCase 1: The Bio-institute developed the prototype but cannot develop the scaled -up version or test it without the involvement of the engineering firm. Fast Food initially had a technical problem to solve but then found that the developed technology was not suitable.

DENCase 2: Technological learning for Hansen takes place through continuous innovation of the Mark III software product. The VARS also develop technology either by customising the Hansen product or developing their own product.

Managerial learning

UKCase 1: H Co went through a phase of rapid management learning in terms of training the contract negotiators with the objective of improving their skills before returning to F Co for a second round of negotiations. In a sense this illustrates the priorities for H Co in maintaining a set of skills related to interfirm relations at the expense of developing in-house technological expertise.

UKCase 2: The 'hybrid' structure that developed during this collaboration was an unusual development for the software firm and dissatisfactions were expressed by XYZ in the way this collaborative venture was managed. In terms of management learning, XYZ appears to have also lost out due partly to its lack of experienced staff left in the firm during the on-going, rapid reorganisation of the sector that was taking place during the period of the collaboration. Their response, which was to bring in a consortium of external consultants to manage the progress of the project, but this again mitigated against experiential knowledge building up in-house, particularly with respect to trouble shooting.

GERCase 1: One of the main management tasks was to devise means for bringing in small firms that had been excluded from the standards setting procedure. In some cases this resulted in improved relationships with small suppliers, and even offering specific benefits such as training days, or suppliers manuals.

GERCase 2: The collaborating organisations have learnt how to obtain regional funding and support for development projects. Success in the development phase was based on mutual respect between senior managers of each firm, that each had the required capabilities for innovation.

DENCase 1: Both the Bio-institute and Fast Food had previous informal contact, but collaborating together with funding from FOETEK, involved developing new skills.

DENCase 2: Management learning can be seen in the need to manage the Hansen relationship with the VARS in terms of wanting to obtain information from them without exchanging too much confidential knowledge about their plans for developing their product.

Organisational learning

UKCase 1: In terms of organisational learning, the suggestion is the F Co have suffered over the long terms from a weakness in working to contractual deadlines. This general failure of the organisation was not addressed by the first change in ownership, and is not yet adequately tackled by H CO as the new owners. Currently, the two firms have to learn to work together in an organisational sense, and F Co has to become oriented towards the different way of operating within H Co. This has demanded great adjustments at a firm wide level in terms both of working practices and cultural understanding.

UKCase 2: The software firm has an identifiable flexible organisation which has been set up specifically to manage complex, inter-organisational situations by retaining maximum flexibility within its own structure. In this sense it almost acts routinely as a 'learning organisation' responding to the perceived organisational structure in the partner firm, in order to facilitate the collaboration and maximise the potential for working together.

GERCase 1: In at least one case, introduction of an EDI system involved some organisational change in terms of letting larger transportation firms carry out EDI tasks for small suppliers.

GERCase 2: Organisational change is unlikely to occur as a result of one development project.

DENCase 1: The engineering firm had not participated in such a project before so this was a new direction for the firm.

DENCase 2: Hansen has developed from a nationally based firm to one with an international customer base, which is exemplified by the change to using English from Danish as the software development language. Also, changing relationships with the VARS means organisational changes for Hansen.

Discussion
Depending on specific contexts, technological learning may meet organisational and network barriers to its assimilation within a firm. There is an important function in managing these networks although becoming a part of one product development network will not necessarily result in organisational learning. Some firms, however, are using their product development networks strategically, and this is an indication that their networking knowledge is high.

3.4.5 The role of the artifact in network building

The case studies are examples of the means by which artifacts develop within network forms of organisation. A number of factors can be identified in the cases which are relevant to the development of the artifact. These can be summarised as: location of expertises, technological dependencies within the network, changes of network personnel, funding sources, and identification of markets or customers. In terms of changes that take place both to the artifact and the network over time, such adaptations raise questions about the state of 'continuous innovation' that some of these projects appear to emulate, and about endings in others.

Location of Expertise
UKCase 1: Technological expertise initially resides with F Co, but due to their failure to meet a particular contract deadline, H Co invests in its own in-house version of the receiver. F Co, however, take the lead in continuous innovation as a new generation of the technology is developed. As a result, H Co decide not to continue development of its own technology but to secure access to the new F Co innovation. The development of expertise is continually assessed by the joint development of contract specifications and inter-site visits.
UKCase 2: ABC initially capture nearly all of the information technology personnel from XYZ which initially gives them essential expertise regarding the business but ultimately is a source of mistrust and suspicion as XYZ is left without adequate in-house technical resources to assess the product as it comes on line. The system of disaggregated software development at ABC allowed them to offer 24 hours development possibly at the expense of institutionalising the developing expertise.
GERCase 1: The outcome of the negotiations within the VDA was not to agree on one common standard and this left the field open for many different, and individual EDI solutions to be developed in different parts of the network.
GERCase 2: In this case the two firms involved have complementary expertise. Teledata is an expert in software development and City Logistic has expertise in transportation and logistic operations. Initially this is a co-operative development which brought in the expertise of the cab drivers at a later stage for testing.
DENCase 1: This was a problem, initially for a food processing firm which looked for the expertise of the Bio-institute to suggest a solution. As a prototype was built and an engineering firm brought into the network for its experience in building a scaled up version. The Bio-institute would like to continue to develop the technology drawing on the expertise of this new partner.
DENCase 2: The expertise in software product development lies primarily with Hansen, although some of the VARs undertake further development work at the customer site. The VARs are also in touch with customer requirements for further innovations in the software and these are relayed to Hansen in a number of ways. Development teams in Hansen comprise cross disciplinary teams to bring complementary expertises together.

Dependence
UKCase 1: H Co was mainly dependent on the F Co technology, however, F Co is now financially and organisationally reliant on the H Co Group as its new owners.

UKCase 2: At the beginning XYZ was totally dependent on the technical and organisational operation of ABC. However, various changes to the contract between the two firms aimed to minimise this dependence and finally, with the cancellation of the contract, it appears that the relationship has been severed.
GERCase 1: For EDI success it depends on uptake and use by all members of the network. The different versions on offer appear to link some firms together while excluding others.
GERCase 2: The success of this innovation depends on all network members working co-operatively together
DENCase 1: Each part of the Wok network depends on co-operation. The bio-institute is dependent on FOTEK funds and for that reason must retain the interest of Fast Food. Food Engineering, however, is dependent on access to the technology but not on the participation of Fast Food directly.
DENCase 2: Hansen and the VARS are mutually dependent on each other, while the customers dependent on the VARS both to help them implement the software and to convey their ideas back to Hansen.

Impact of changes in network personnel on artifact development
UKCase 1: The initial takeover of F Co resulted in a new CEO who was hostile to the collaboration with another defence firm. This almost ended the opportunities for joint development of the technology.
UKCase 2: The retirement of the initial project champion within XYZ led to a review of its contract with ABC. Finally, the takeover of XYZ led to the termination of the existing partnership
GERCase 1: Initial exclusion of the SMEs resulted in the need to encourage them to join the EDI networks
GERCase 2: Expanding the network, such as bringing in truck drivers and gaining new customers, leads to changes in the management of the network.
DENCase 1: The initial product champion leaves Fast Food and this leads to an attempt by this firm to withdraw from the network. This is not helped by the fact that, introducing Food Engineering results in an attempt to exclude Fast Food from the development network
DENCase 2: Change in organisation in Hansen leads to a change in status of some VARS and an attempt to exclude them from detailed knowledge of the innovation process.

Factors in funding
UKCase 1:A considerable amount of pre-funding co-operation between the parties before applying for a military contract. There was a long period of relationship, and technological development between the two firms involved before the bid for the MoD contract was put in, which was necessary to prove that the alliance would be able both to work together and to deliver the technological specifications to the terms of the contract.
UKCase 2:UK software case involved funding partners for development reasons vulnerable to internal review and cancellation by partner
GERCase 1: EDI network involve funding of the technology for implementation but once installed a supplier is secure of their own participation in the network. For EDI software developers the rationale for the project was a private arrangement between supplier and customer
GERCase 2: CATS is an informal network between the two major firms and a sympathetic local politician which secured the regional funds that eventually funded 45% of the communication development.
DENCase 1: The Bio-institute and Fast Food had to co-operate to win funds from FOETEK. Although at a later time, Fast Food wanted to extract itself from the development project, the

firm was then persuaded to stay in the development network in order to allow funding to continue. Without this money it is not clear that the project would have continued.
DENCase 1: Hansen, financed its developments in house, due to secrecy concerns. The preoccupation with confidentiality of the product development means that the funding was internally provided.

Markets and Customers
UKCase 1: This case is assured of a production run on the development under the terms of the defence contracts
UKCase 2: It is the business strategy of ABC to develop a close relationship with the customer and build up specific expertise on the business practise with the aim of completely updating those practices
GERCase 1: EDI is used exclusively by the firms which have installed it, and use is only expanded as the supplier base expands.
GERCase 2: The CATS technology was developed in quite a protected regional environment. As it enters the market it will be in competition with other, similar technologies. There is a question of persuading the cab drivers, as ultimate target users, to adopt the technology.
DENCase 1: Still at prototype stage. National funding, in a way, protects this network. Food Engineering predict an international market, while Fast Food do not see a use for it.
DENCase 2: Hansen have a large group of customers which are locked into taking the continual updates to their product. They have good access to customer feedback and requirements through VARS which also help customer development.
Continuous innovation, and finished projects
UKCase 1: New generation of the technology
UKCase 2: End of project
GERCase 1: EDI software updates and development
GERCase 2: In a critical stage, still to be proven in production
DENCase 1: In a critical stage, still to be proven in prototype and production
DENCase 2: Continuous innovation with additions to basic product.

Discussion
Development of an artifact depends on the relevant expertises initially brought together and subsequently ensuring that access is maintained. This situation can render development of the artifact vulnerable to changes of personnel, commitment or strategy of all collaborating parties. Factors, such as finding markets for the product, which are involved in sustaining these networks have an impact on funding commitments over the longer term and has an impact on the final outcome of the project.

4. CONCLUSIONS AND POLICY IMPLICATIONS

4.1: Introduction: The Contexts of the NPD networks under Different National Settings

New products are developed in different contexts. In this report the following aspects of the dimension 'context' are dealt with:-

- Context as the chance or necessity for new product development; that is a description of more "external" reasons for innovations, the opposite are intended innovations.
- Context as the 'milieu' within which the innovation takes place; this may be more or less favourable for innovation; important is that the milieu can be positively changed – at least in the long run – to stimulate innovation; but it can also be made worse.
- Context and de-contextualisation; hereby the possibility is meant to sell the – in most cases – in a local, regional or national context developed innovations outside these contexts.

Context is a dimension that can be influenced by politics in order to enhance the innovative capabilities on the levels of region, nations, and not least the European level. It is considered that very different contexts influence network building for new product development. They can be categorised into social, cultural, institutional, economical, and political one. In the following review of the cases studied by three research teams in UK, Denmark and Germany we try to highlight the central contexts working on building network for new product .

UKCase1: Through the Ministry of Defence (MOD) has opened the door into collaborative projects. However, the government has required a large amount of pre-funding collaboration in order to develop the bid, the length of time involved in the development, and thereby a long-term commitment to the partnership, involving both a tight formal contract and an element of informal goodwill during the project. With this requirement from government, the partner firms have to meet specified deadlines to avoid losing a trusted reputation with the government by failing to deliver the contracted technology to time and budget.

UKCase2: the market-driven de-regulation process can be regarded as the stimulus for the innovation reported here as privatisation gave rise to the computer system development project. Facing this de-regulation of the industry XYZ required the development of new computing and information systems which permit it to operate in the new market. The new systems could be a strategic instrument to enter the de-regulated market place ahead of their competitors and thereby capture vital new market share.

GERCase2: the "institutional" innovation dialogue on regional level gives a decisive chance to initiate the network. The Bremen State has launched some regional programs, for example " Bremen Work and Technology Programme" which have been undertaken with the objective to support co-operation among regional companies, Bremen University, other R&D institutes, industrial associations, the sate etc. In the end, building and supporting "learning networks" has been thought to bring together existing complementary capacities that are necessary and sufficient to create innovations. The regional programs give a space in which diverse actors from university, other scientific institutions, industry, the state etc playing within Bremen exchange information each other. The actors having relationship with the open informal dialogue initiated the network. The state, this is the Senator of Environmental Protection of Bremen, financed 45% of the estimated costs of the project under the programme to support the development of environmental friendly technology.

DENCase1: This case highlights the role of government in the innovation process. The Danish government supports financially the national research and development programme for food technology (FOETEK) to improve the international competitiveness of the Danish food sector and to increase the research and development volume in that sector. In order to reach this objective the Danish government has stipulated that the programme participants must develop collaborative projects involving university research, governmental research institutions, and

private firms in the food sector. Only collaborative projects can get financial support from the FOETEK programme. This promoting tool has contributed to the evolving of the actors from University, private firms in the development of new product.

DENCase 2: the national innovation systems programs could have supported the Hansen network building for the development of new product. But, actually the programs for the information technology industry have not contributed to the networks. The most national programs were oriented towards the technology development for larger manufacturing companies, for example computer integrated manufacturing (CIM). Giving the priority on the development of the large systems, the national innovation system did not give any attention to the development of the bulk of a administrative software solutions like Hansen products. This fact attests that in Denmark the relations between small new companies, the Technological Service Net and other parts of the national innovation system are traditionally weak. On the other side, this implies that it is necessary for the small companies to network with the technological service net to get support from the state.

4.2 Policy Implications of the Case Studies

4.2.1: Introduction

In this section we review the networks studied for BiCoN in order to identify policy implications. We also draw attention to features of the networks of relevance to what is understood by the concept of national systems of innovation (NSIs). In our analysis we shall be mindful Nelson & Rosenberg's (1993) caution:

> In the absence of a [well-articulated and verified analytical framework linking institutional arrangements to technological and economic performance], there were (and are) only weak constraints on the inclinations of analysts to draw possibly spurious causal links between differences in institutional structures that clearly are there, and differences in performance that clearly are there also (p. 4).

Such caution is necessary because, whilst there is empirical evidence of differences in national rates of technical change, NSIs, and national culture, the causal relationships between such factors are open to different interpretations, and different analysts draw completely the opposite conclusions. Sharp (1997, p. 105), for example, argues that NSIs shape national and firm culture, whilst Nelson & Rosenberg (1993, p. 16), on the other hand, argue that both technical change and NSIs are themselves shaped by national culture. Lundvall (1998) sees the relationship as being one of interdependency and interaction (see pp. 411-412). Clearly, the difficulty in disentangling cause from effect problematises the simple derivation of policy from NSI research results. Moreover, there is no consensus over whether or not NSIs themselves can properly be described as policy.

4.2.2: NSI as a Level of Analysis

In this section we take a broad view of the case studies in order to identify features of each which are characteristic of their respective NSIs, as outlined in Section 3.2.10. We will consider some of these features in more detail in subsequent sections. The objective of this section is to make an initial assessment of NSIs as a unit - or level - of analysis for networks for new product development.

One of the features of individual NSIs is their relative strengths and weaknesses in different industrial sectors. In terms of the industrial sectors of the new product developed, there is some correspondence between BICoN networks and NSI strengths. Specifically, UK Case 1 is for software development, Germany Case 1 is for the automobile industry, and Denmark Case 1 is in the food sector. Other ways in which NSIs are characterised is the distribution of innovation

activities at regional, national and international levels, and the level of SME activity. Again, characteristic NSI features can be observed in our networks. Germany Case 2 has a regional network that includes an innovating SME, whilst both UK cases are international (McLoughlin et al., 1999). .

Other features used to characterise NSIs are the level of expenditure on R&D, the public/private split of R&D expenditure, and the civilian/military split of public R&D expenditure. Again our networks provide examples which typify their NSI. Germany Case 1 is characteristic of the German NSI in that the EDI system networks involve R&D expenditure by the car industry, Denmark Case 2 in that it receives no public funding, and UK Case 1 in that it receives military funding. However, it is worth noting where our networks are uncharacteristic of their respective NSIs. Specifically, Denmark Case 2, which is a large, international software network, and Denmark Case 1 which receives financial support from a national public programme. However, given that the Danish NSI is characterised by low tech products and low R&D spending, then networks for *new* product development are in themselves uncharacteristic of the Danish NSI, and this could account for their lack of national 'fit'.

Clearly our sample of networks is small, and we make no claims that it is representative. What we can say is that our networks exhibit some features that are characteristics of their respective NSIs, and other features that are not. Our conclusion from this limited sample is that NSIs are a useful level of analysis, but one that does not explain all of the features of our networks.

We think that there is a need for NSIs to be supplemented by other levels of analysis. We are not alone in holding this opinion. In December 1998, a Special Issue of *Technology Analysis & Strategic Management* (*TASM*) was published based on papers presented at the 1997 conference on 'Advances in the Sociological and Economic Analysis of Technology'. The theme for the conference and the Special Issue was 'differences in styles of innovation'. This topic was chosen rather than NSIs for two reasons. Firstly to provide a forum for analysing national features of innovation that are more ephemeral and less formal than implied by the term 'system'. Secondly, to provide a forum for features of innovation displayed at levels other than national, for example, at the level of the firm, industrial sector, or region (see Green *et al*. 1998). We would add to this the need to study at the level of the network too.

As was stated in Section 3.2, technological innovation is now best understood through a focus on networks (Tidd 1997), a view that is supported by the BICoN case studies. Accordingly we make the following policy recommendation.

Policy Recommendation:

- **Studies of innovation at the NSI level should be supplemented by studies at other levels, especially the network level.**

4.2.3: Civilian Funding

Of the six BICoN networks, three were directly funded from public monies and three were not. The three networks in receipt of direct public funding were UK Case 1, Denmark Case 1 and Germany Case 2. The types of funding were, respectively, military, national and regional. In this section we focus on the networks funded by civilian funding, namely Germany Case 2 and Denmark Case 1. (We shall consider the military-funded UK Case 1 in a separate section below.)

Features shared by Germany Case 2 and Denmark Case 1 are:

1. But for public funding, neither network would have been formed;
2. Both networks have a regional dimension;

3. Initial contact between actors was via informal links rather than through formal technology transfer schemes or intermediaries;
4. SMEs are key actors in both networks;
5. The products developed in both networks were pilots or prototypes;
6. Diffusion into international markets is one aim of future product development by the network;
7. Both networks are at risk of fostering 'product champions';
8. Both networks are deficient in representations of actors opposed to or disinterested in the new product.

These findings are in accordance with previous findings on networks and innovation (see Section 3.2). In particular, they illustrate that SMEs are active in new product development, and that if SMEs are to compete internationally, it may be necessary to support SME networks with public funding on a national and/or regional level. Moreover, the stage at which public funding is most critical is at the pilot stage. As illustrated in Denmark Case 1, once developed, the pilot itself can enrol other actors to the network.

A recognised risk of public funding of new product development is that rather than increasing competitiveness it can result in 'product championism'. The risk that this will occur in Denmark Case 1 and Germany Case 2 is heightened by the way the networks are constituted. Specifically, both networks have a deficiency of representations of resistance, competition and alternatives to the new product under development. Such representations could be human, for example, a human actor in the network, or non-human. Non-human representation could be through the inclusion, as an actor in the network, of intelligence about opposing interests. Non-human representations are actors if they, like other actors, have power to influence product development.

The importance we attach to the inclusion of representations of opposition, resistance and competition in new product networks derives from our commitment to constructive technology assessment (CTA) and to the studies which have informed the CTA approach. Originally developed for technological projects in the public domain, CTA has also been adopted by commercial enterprises as a method of increasing the likelihood of successful technological innovation. CTA has the potential to increase the likelihood of successful innovation by minimising mismatches, wrong investments and possible social conflicts (Rip *et al*. 1995). One of the meanings of the 'constructive' element of the CTA approach is that it stresses the co-evolution of technologies and the human beings that interact with them. One of the practical ways in which this can be achieved is to include representations of a diverse range of interests in the product development network. Specifically, all those actors upon whom successful product development depends should be represented in the network for new product development, right from the very beginning. The CTA approach would not advocate delaying their inclusion in the network until after the 'technological' development of the product had 'stabilised', which seems to have been the strategy in Germany Case 2 and Denmark Case 1. In both of these networks the SME actors found each other through informal local contact. Both used exhibitions to publicise their pilots and enrol new actors in the networks. Where their network building skills need improvement is in respect of the representativeness of the networks. They lacked the expertise – or incentive – to build networks that also included representations of disinterestedness, resistance, and competition. One radical approach to this is PROTEE, a tool for managing innovation projects, developed for the European Commission. When PROTEE is used, continued funding is dependent upon 'risky' project descriptions - descriptions which highlight the obstacles to innovation (PROTEE, 2000).

In the light of these considerations and observations, we make the following policy recommendations:

Policy Recommendations:

- **SME networks for new product development need public funding if they are to compete internationally.**
- **Such funding should be targetted at funding networks for the pilot stage of product development.**
- **From the very start, and as a condition of funding, publicly funded networks should include representations of opposition and disinterestedness with the power to influence product development.**
- **The development and use of innovation management tools such as PROTEE should be supported for both publically and privately funded networks.**
- **Support is needed for education and training to improve the deployment of 'network knowledge' (see 4.2.6 below).**
- **Exhibitions are an effective way to enrol actors to new product networks and should be supported.**

UK Case 1 is the only network that is funded via military contracts. One of the key characteristics of the UK NSI is its relatively low expenditure on basic research combined with an unusually high public expenditure on defence R&D. Indeed, among Western nations it is surpassed in this respect only by the USA (Walker 1993). In this respect, this network reflects the NSIs of both the UK and the USA.

The military context has influenced the shaping of this network in several respects. HCo has developed a networking strategy specifically for the acquisition of military contracts. The reason that HCo outsourced the technology to a USA company was because of the military context. The longevity of the network is both *necessary* because of the long lead time in obtaining military contracts, and *facilitated* by the relative lack of uncertainty that product development under military contract offers compared to product development in the civilian sphere.

UK Case 1 also illustrates typical drawbacks to military, rather than civilian or private, funding of new products. Firstly, there is the secrecy - even HCo is only informed of 40% of FCo's product development activities. Also typical is the highly elaborate product specifications, which can result in 'baroque technology' of limited application. Thirdly, the lack of a role for actors other than military funders and military contractors in this network is typical. The enrolling of opponents and civilian customers is not critical for the development of new military products. This military 'championism' is liable to result in uncompetitive products, which, together with the above features, reduces the potential for civilian 'spin-off', and is a barrier to diffusion.

This network is consistent with the findings of previous studies of the effect of military funding on new product development. Our policy recommendation is:

Policy Recommendation:

- **Military funding is not an efficient way of publicly supporting networks for the development of competitive new products.**

In Section 3.2.10, we discussed the debate about the effect of NSIs on national innovation performance in an increasingly globalised economy. In this section we consider the location of networks for new product development in the context of globalisation.

One side of the debate on the effect of globalisation on NSIs is based on the view that basic research results in codified knowledge that is costly to produce but almost cost-free to transfer and re-use. The policy implication of this argument would be, in view of the easy globalisation of codified knowledge, to advise against national investment on basic research. Rather, the advice would be to appropriate such knowledge cost-free, from other nations in the form of publications and patents. The other side of the debate is based on the viewpoint that person-embodied linkages are critical for learning, and that such linkages are sensitive to linguistic & geographic constraints. In support of this viewpoint we cited the findings of research by Patel (1995) and Patel & Vega (1998) that firms perform a high proportion of their innovative activities in their home country. The policy implication of this is that despite globalisation, national investment in basic research does make a difference to national innovation performance. In the words of Patel & Pavitt 1994, NSIs 'still matter' (p. 86).

The data used in Patel's (1995) and Patel & Vega's (1998) research was from the activities of the world's largest companies that were technologically active. However, as was argued in section 3.2 of this report, technological innovation is best understood through a focus on networks rather than on a single enterprise unit (Tidd (1997). Moreover, multinational companies are not the only players in globalisation and innovation. Small and medium enterprises (SMEs) are also involved, as an increasing body of literature and the case studies in this report testify.

It is by no means certain that, were a Patel & Vega type analysis repeated using networks & SMEs, the results would be the same as they were for large single enterprise units. This is indicated when the BICoN networks are analysed with respect to whether the primary site of product development is in the home country or abroad. The first complication with this type of analysis is that when a network is international, as in UK Case 1, it may be difficult to assign one country as the 'home' country. However, taking the UK to be the home country of this network, the majority of the product development activity takes place outside of the home country. Although the technological excellence of the foreign company was a factor in the decision by HCo to outsource to this particular company, the military context of the network predisposed HCo to outsource the technology to a non-UK company. The national policy implications of this case study would address the impact of military funding as well as the funding of basic research.

In UK Case 2, product development is divided between the home country and programmers in India (see McLoughlin et al., 1999), the policy implications of which would include economic & employment policy, as well as the funding of basic research.

Denmark Case 2 complicates that argument that product development is located in the home country because of a shared language. In this network Hansen Co adopted the Microsoft Solution Framework (MSF) as part of its strategy to facilitate the internationalisation of its

product development activities, and liberate software development from the Danish language and Danish programmers (see Koch *et al*. 1999). The networks in Germany Cases 1 & 2 and Denmark Case 1 are regional or national, and product development take place in the home country. However, in Germany Case 2 and Denmark Case 1 this is because of public funding rather than the excellence of national basic research *per se*.

Whilst our sample of networks is small and unrepresentative, it does illustrate that the geography of new product development in networks is complex and could be different, and have different policy implications, to that of large single enterprise units. If research on the location of innovation and product development activities is relevant to innovation policy making, as Patel & Pavitt (1994) argue, then the research agenda should be broadened to take into account the location of innovation and product development by SMEs and networks. Therefore our policy recommendation is a refinement of our recommendation in Section 4.2.2.

We recommend investment in research on the national and international distribution of product development in networks, including networks with SMEs. The results of this research would supplement those of Patel & Vega on large single enterprises. They would enrich understanding of the relationship between NSIs and new product development in the context of globalisation, and would provide a basis for policy making.

Policy Recommendation:

- **Investment in research on new product development networks, including networks with SMEs, to map the geographical distribution of their activities**

4.2.6: Network Knowledge as a Resource

Evidence from our case studies is that new product network formation is partly driven by the desire on the part of one actor to gain access to scientific and/or technological knowledge it perceives is possessed by another actor. The value of scientific and technological knowledge as an important economic resource is recognised in each of the BICoN networks. In this section we look for influence of other types of knowledge & learning, in particular a type of knowledge we call 'network knowledge'. Network knowledge is the resource required to create, maintain and benefit from a network. Its importance is illustrated by examples from BICoN networks, where actors display varying degrees of network knowledge.

UK Cases 1 & 2 illustrate the importance of network knowledge as a resource when balancing internal and external expertise and competences. The strategy of both HCo in UK Case 1 and XYZ in UK Case 2 was to develop a new product by outsourcing, rather than developing internal competences. XYZ, whom we consider to be relatively poor in terms of network knowledge, transferred almost all of its technological knowledge to the actor that was to develop the product, leaving XYZ incompetent to evaluate the product. HCo, whom we consider demonstrates considerable network knowledge, maintained an in-house team of engineers and thus retained the resources to monitor and evaluate the product produced by FCo.

Throughout the period of study, HCo was always confident, but never complacent about its network knowledge. HCo recognised that specialising in network knowledge was as important as specialising in technological knowledge. Indeed, at a critical moment in the life of the network, HCo responded by improving its network knowledge. XYZ, by contrast, was competent in neither technological knowledge nor networking knowledge. Indeed, the irony of XYZ was that having recognised that the network may not be functioning in its own interests, XYZ's response was not to improve its in-house network knowledge but to outsource this too! XYZ's potentially disastrous technology transfer is directly attributable to its lack of network

knowledge, a particularly damaging deficit when collaborating with the skilled networker ABC. However, by the end of the period under study, there is evidence that XYZ was learning network knowledge through its interactions with ABC – even if it was the hard way!

Another way in which the deployment of network knowledge is evident is in the composition of the network. Network knowledge recognises that all those actors upon whom product development depends should be represented in the network for new product development, right from the very beginning. In 4.4.3 above, Denmark Case 1 and Germany Case 2 were identified as networks from which representations of opposition, competition and alternatives were absent. The primary network for the development of EDI standards in Germany Case 1 illustrates the importance of including *potential* customers and users who, until enrolled in the network *as* customers and users, constitute *barriers* to the successful development of the product.

By contrast, one of the factors that makes Denmark Case 2 a robust network is its comprehensiveness. The product is shaped by many actors. Not only is product development distributed between Hansen Co., VARS and the customers, the network also includes representations of internal and external competition as actors in the network with the power to shape the product. Hansen Co. demonstrates good use of network knowledge.

Network knowledge is a resource that, like scientific and technological knowledge, makes a difference to the likely success of the networks developing new products. Also, like scientific and technological knowledge, network knowledge can be learnt through the process of interaction.

Policy Recommendations:

- **Invest in research to improve the network knowledge resource base**
- **Raise awareness of the importance of network knowledge to competitive product development**
- **Fund network knowledge training & education programmes**
- **Facilitate learning by interaction with skilled networkers.**
- **Make the learning of network knowledge a compulsory requirement of participating in publicly funded networks**

4.2.7: Time for a Paradigm Shift?

In keeping with the NSI approach, we endorse the primary importance to the economy of knowledge as a resource and learning as a process, and conceptualise learning as an interactive process. However, we go further than the NSI approach. Whilst the NSI approach conceptualises knowledge and learning in terms of science and technology, our case studies illustrate that network knowledge is also an important economic resource. Moreover, given that new product development increasingly takes place in networks, network knowledge and learning will become of increasing importance to the economy.

Uhlin (1999) suggests that knowledge and learning were conceptualised so narrowly in NSIs because it was *economists* who developed the concept of learning in relation to innovation. He argues that if it is true that learning is the most important process in the economy, then the concept of learning defined and used in policy recommendations must be broader than that offered by innovation economists. Disciplines other than economics, such as the social sciences, the natural sciences and the humanities, must contribute to the definition of learning used in policy recommendations.

Uhlin (1999) argues that the emergence of the NSI concept was, if not a paradigm shift, then at least a major change in influence and power with respect to policy-making. As a consequence, the power of the neo-classical economists in the policy arena has declined leaving a space for 'new economists, for new policies and for "learning economies" (p. 3). However, maybe it is now time for the innovation economists to move over and make room in the policy arena for a broader expertise from the social sciences, from disciplines who have much to contribute to the concept of learning, disciplines which include management, sociology and politics.

Policy Recommendation:

- **Broaden the concepts of knowledge and learning in innovation policy by drawing on expertise from the disciplines of management, sociology and politics.**

4.3 Conclusions

The project has focussed on the role of networks in new product development, and as such had a wide ranging brief which could cover the role that all form of networks play through all stages of product development in all three countries. The basis for most literature on innovation networks has been highly context dependent, contingent on the sector, technology and stage of technology development. This study has attempted to approach the issue by identifying the networks involved in new product development, in a range of sectors and organisational settings and at different stages of the development process. Thus it cuts across many of the areas traditionally covered by the management of innovation and technology, as the thematic cross case analyses highlights the common aspects involved in all network building. The project, therefore contributes to the research which focuses on the role of managerial and organisational factors in innovation. The outcome has been to identify network building in terms of relationship development within a political process model of the organisation. In addition, a number of inter-personal, legal, organisational and technical issues expand on this analysis.

These network building issues have been applied to all six case studies across the three participating countries, and in these cases, the development of new technological knowledge is seen as related to the functioning of associated network processes. A major conclusion, therefore, is that network processes impinge on the shaping of technology as it develops in its organisational setting. In general, the findings from this project emphasise the heterogeneous nature of new product development networks. These networks, once they have been initiated require building and sustaining as they develop change and adapt over time. Such process skills need to be acquired in order to manage both instances of co-operation and of conflict in the network. In new product development both formal and informal networks are involved. Formal networks are linked to legal contract as well as established routines in the organisation while informal network processes are based on communication and trust building and are influenced by existing organisational cultures and embedded behaviours. All these network processes require appropriate management strategies and expertises. The policy recommendations reflect this aspect for encouraging successful new product development networks.

5 DISSEMINATION AND EXPLOITATION OF RESULTS

5.1 Strategy for Dissemination

In addition to already published work (see attached Annex 7.1), a number of further dissemination activities are planned as follows:-

a). Special issue of Technology Analysis and Strategic Management, a major international, academic journal dealing with innovation issues, has been agreed in principle with the theme of networks for new product development.

b). Conference papers arising from this project will be reworked into publishable articles for appropriate international journals.

c). Copies of the final report may be distributed to appropriate national institutions with the agreement of the Commission.

d). An abridged version of the final report may be produced, with the agreement of the Commission, into a Working Paper of the School of Business and Management at Brunel University to exemplify current research interest in this area.

5.2 Future Publications

See attached Annex 7.1

6 ACKNOWLEDGEMENTS AND REFERENCES

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6.1 Staff involved in the project

UK: Project Leaders: Professor Keith Dickson, School of Business and Management, Brunel University, Uxbridge, Middx, UB8 3PH, England; and Professor Ian McLoughlin, Business School, Newcastle University, Newcastle Upon Tyne,

UK Research Staff: Dr Anne-Marie Coles, Dr Lisa Harris, Ms Ruth McNally, School of Business and Management, Brunel University, Uxbridge, Middx, UB8 3PH,

Denmark: Project Leader: Associate Professor Christian Koch, Technical University of Denmark, Lyngby, DK-2800, Copenhagen.

Denmark Research Staff: Dr Allan Pleman, Henrik Hansen, Per Richard Hansen, Technical University of Denmark, Lyngby, DK-2800, Copenhagen

Germany: Project Leader: Professor Dr Fred Manske, Forschungszentrum Arbeit und Technik (ARTEC), Universitat Bremen, Bibliothekstrasse, Bremen, D - 28334.

Germany Research Staff: Yonggap Moon, Forschungszentrum Arbeit und Technik (ARTEC), Universitat Bremen, Bibliothekstrasse, Bremen, D - 28334

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7.0 ANNEXES

7.1 Publications

Published Articles

L Harris, A M Coles, K Dickson, I McLoughlin (1999) *Building collaborative networks: New product development across organisational boundaries* in P Jackson (ed) Virtual Working: Social and Organisational Dynamics, Routledge, London

L Harris (1999) Building inter-firm networks: A case study of EMC (SW) Ltd, *International Journal of New Product Development*, Sept/Oct, 211-218

Accepted for Publication

L Harris, A M Coles, K Dickson (2000) Building innovation networks: Issues of strategy and expertise, *Technology Analysis and Strategic Management*, 12,2

Submitted by Invitation

L Harris, A M Coles, K Dickson, I McLoughlin(2000): Testing goodwill: Conflict and co-operation in product development networks, *International Journal of Technology Management*, forthcoming.

Conference Papers

L Harris, A M Coles, K Dickson, I McLoughlin (1999) Building inter-firm networks for new product development, given at *2nd International Conference on Stimulating Manufacturing Excellence in SMEs*, Plymouth, April

H Hansen, C Koch, A Pleman (1999) Small is beautiful: Customer driven software development, given at *Technology and Innovation Management Conference, PICMET*, Oregon, USA, July

I McLoughlin, C Koch, K Dickson, F Manske (1999) 'What's this tosh?' Innovation networks and new product development as a political process, paper given at *CISTEMA Conference, 'Bringing materiality back into management'* Copenhagen, October

C Koch, I McLoughlin, K Dickson, F Manske (1999) Highflying or embankment in innovation networking - Spaciality and timing in the age of cyberspace, given at *Regional Innovation Systems in Europe, NECSTS 99*, San Sebastian, September

Working Papers

A-M Coles, L Harris, P Jackson, K E Dickson (1999), Ignore them and they will go away: The failure of process in network building, Brunel School of Business and Management Working Paper.

7.2 List of Agreed Deliverables

Deliverables outline in the contract:

A final report, highlighting the principle policy implications arising from the research.

7.3 Diagrams

1. Schematic Diagram of UKCase 1
2. Schematic Diagram of UKCase 2
3. Schematic Diagram of GERCase 1a
4. Schematic Diagram of GERCase 1b
5. Schematic Diagram of GERCase 1c
6. Schematic Diagram of GERCase 1d
7. Schematic Diagram of GERCase 1e
8. Schematic Diagram of GERCase 2
9. Schematic Diagram of DENCase 1
10. Schematic Diagram of DENCase 2